United States Department of Agriculture

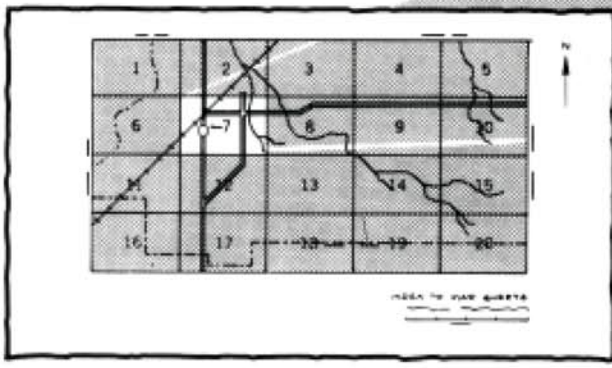
Soil Conservation Service

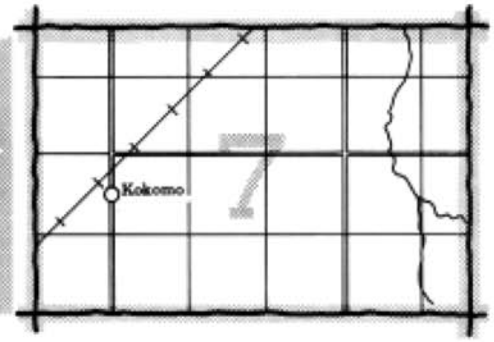
In cooperation with Kansas Agricultural Experiment Station

Soil Survey of Wilson County, Kansas

HOW TO USE

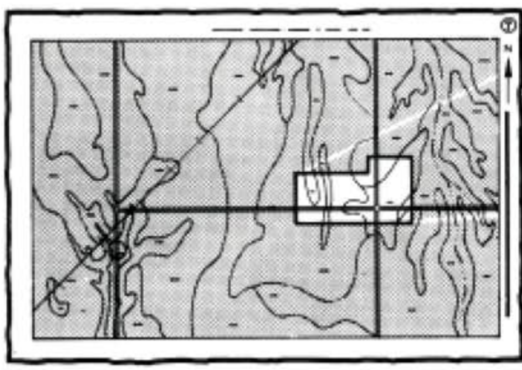
1. Locate your area of interest on the "Index to Map Sheets"

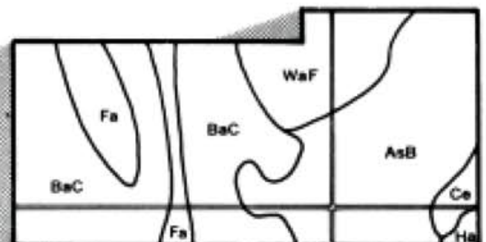




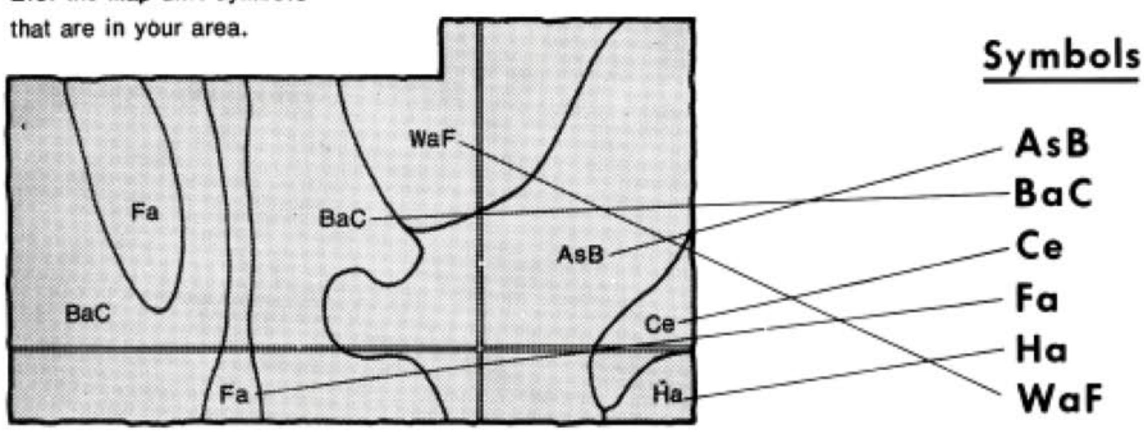
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



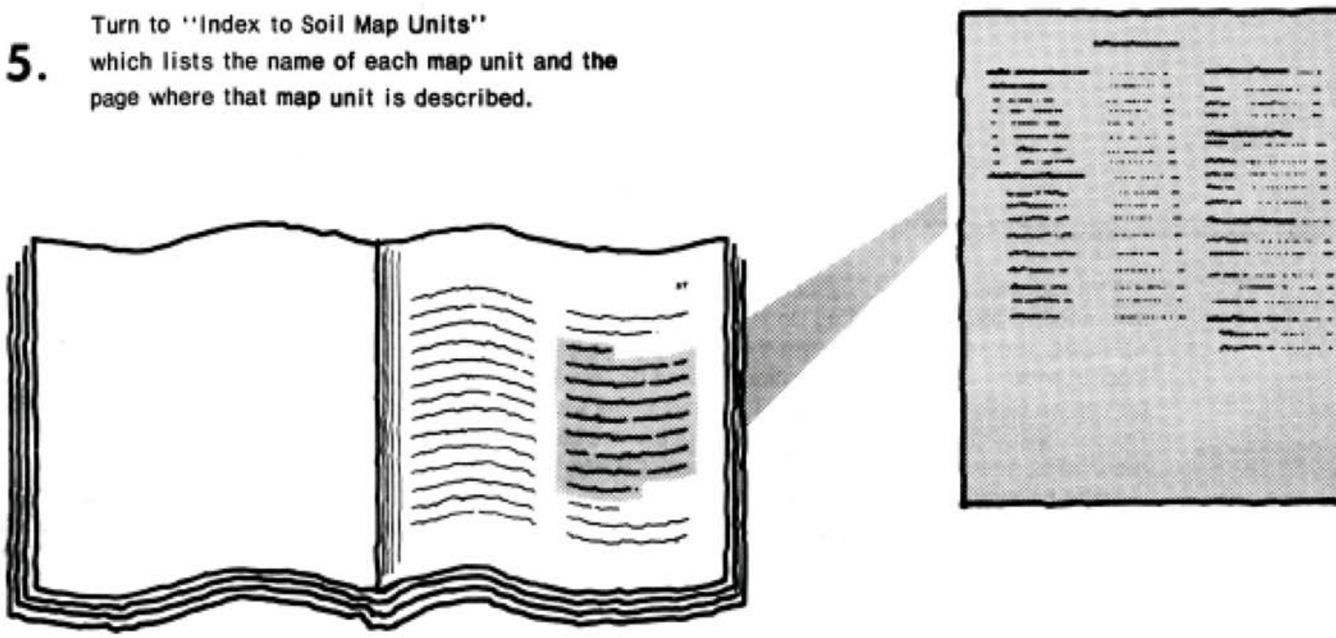


4. List the map unit symbols that are in your area.

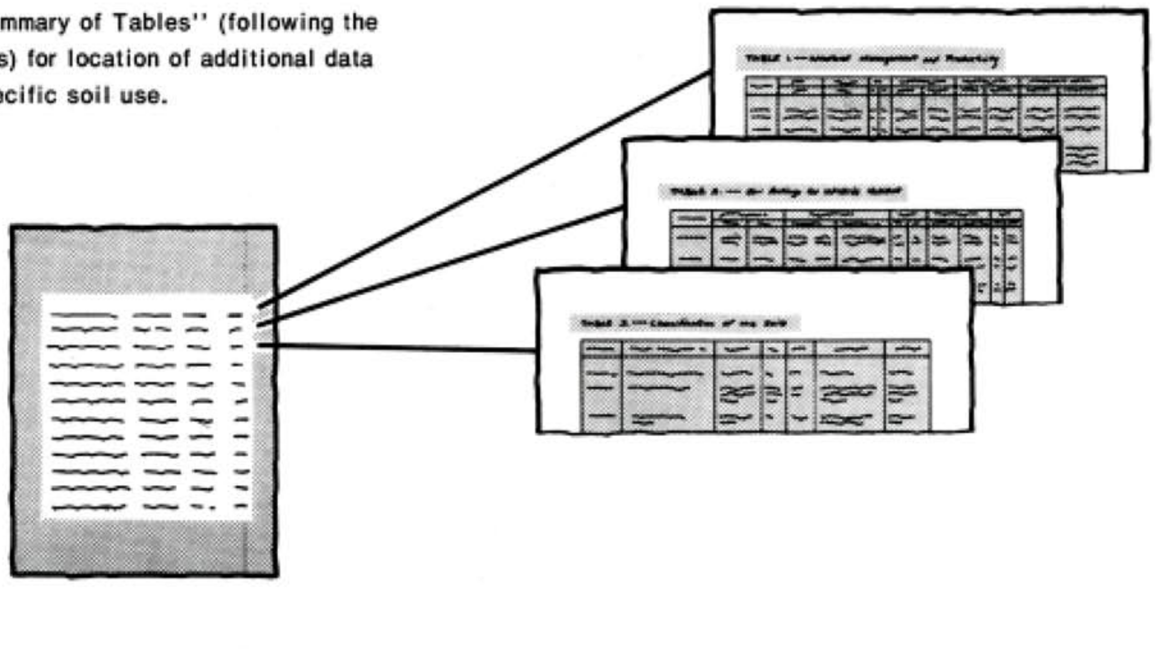


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, handicap, or age.

Major fieldwork for this soil survey was completed in 1985. Soil names and descriptions were approved in 1985. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1985. This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Wilson County Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Soybeans double cropped into wheat stubble on a Dennis silt loam. This method of cropping reduces the runoff rate and helps to prevent excessive soil loss.

Contents

Soil Series

Issued February 1989

Index to Map Units

Summary of Tables

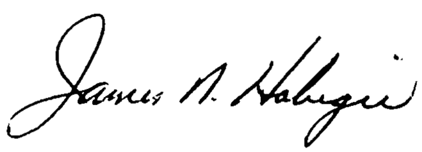
Foreword

This soil survey contains information that can be used in land-planning programs in Wilson County, Kansas. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.



James N. Habiger
State Conservationist
Soil Conservation Service

Soil Survey of Wilson County, Kansas

By Deane W. Swanson, Soil Conservation Service

United States Department of Agriculture,
Soil Conservation Service,
in cooperation with
the Kansas Agricultural Experiment Station

WILSON COUNTY is in the southeastern part of Kansas (fig. 1). It has an area of 368,058 acres, or about 575 square miles. In 1981, it had a population of 12,128. Fredonia, the county seat, had a population of 3,047. Neodesha, the largest town, had a population of 3,414.

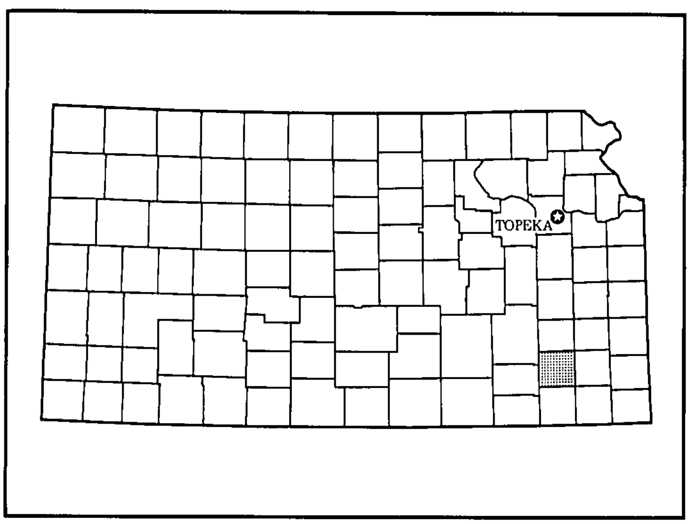


Figure 1.—Location of Wilson County in Kansas.

Most of Wilson County is in the Cherokee Prairie major land resource area. The western third, however, is in the Cross Timbers major land resource area. The soils in the county are generally deep or moderately deep, are gently sloping or moderately sloping, and have a clayey subsoil. Elevation ranges from about 760 to 1,100 feet above sea level.

Most of Wilson County is drained by the Verdigris and Fall Rivers and their tributaries (fig. 2). These streams flow in a southeasterly direction across the county. The southwest corner is drained by tributaries of the Elk River and the northeast corner by tributaries of the Neosho River. Wilson County State Lake is the largest body of water in the county. There are many farm ponds and watershed reservoirs.

Farming and ranching and services related to these activities are the main enterprises in the county. About 48 percent of the county is cropland, 33 percent is range, 9 percent is pasture, 3 percent is woodland, and 7 percent occurs as farmsteads, roads, and urban and other areas (*7*). Grain sorghum, wheat, soybeans, and alfalfa are the principal crops.

This survey updates the soil survey of Wilson County published in 1927 (*4*). It provides additional information and larger maps, which show the soils in greater detail.

Climate

Prepared by L. Dean Bark, climatologist, Kansas Agricultural Experiment Station, Manhattan, Kansas.

The climate in Wilson County is typical continental, as can be expected of a location in the interior of a large landmass in the middle latitudes. This climate is characterized by large daily and annual variations in temperature. Winters are cold because of frequent outbreaks of polar air. The cold temperatures prevail from December to February. Warm summer temperatures prevail for about 6 months every year.

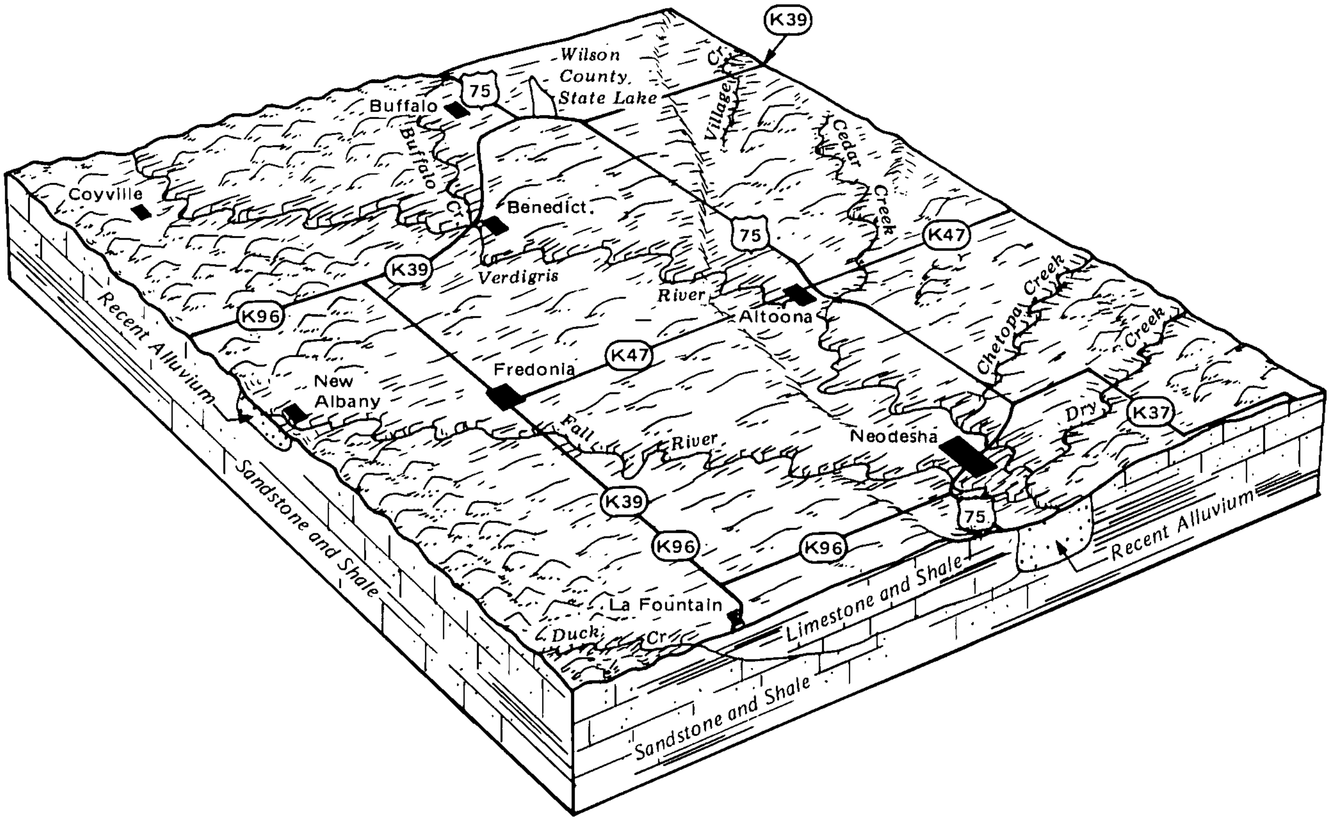


Figure 2.—Drainage pattern, relief, and parent material in Wilson County.

They provide a long growing season for the crops grown in the county. Spring and fall are relatively short.

Wilson County is in the path of a fairly dependable current of moisture-laden air from the Gulf of Mexico. Precipitation is heaviest late in spring and early in summer. Much of it falls during late-evening or nighttime thunderstorms. Although the total precipitation generally is adequate for any crop, its distribution may cause problems in some years. Dry periods of several weeks are not uncommon during the growing season. A surplus of precipitation often results in muddy fields, which delay planting and harvesting.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Fredonia in the period 1941 to 1970. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 35.9 degrees F, and the average daily minimum temperature is 24.5 degrees. The lowest temperature on record, which occurred at Fredonia on February 13, 1905, is -26 degrees. In summer the average temperature is 78.4 degrees, and the average daily maximum temperature is 91.0 degrees. The highest recorded temperature, which occurred at Fredonia on July 18, 1936, is 121 degrees.

The total annual precipitation is 35.04 inches. Of this, 24.93 inches, or about 71 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 16.58 inches. The heaviest 1-day rainfall on record, which occurred at Fredonia on July 3, 1976, is 7.19 inches.

Severe windstorms and occasional tornadoes accompany well developed thunderstorms, but they are infrequent and of local extent. Losses from hail are more severe, but they are not so great as the losses in counties to the west of this county.

The average seasonal snowfall is 13 inches. The highest recorded seasonal snowfall is 44 inches. On the average, 12 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The sun shines 70 percent of the time possible in summer and 56 percent in winter. The prevailing wind is from the south. Windspeed averages 11 miles per hour during the year. It is highest in March and April.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

Map Unit Descriptions

This section describes the map units in the survey area at two levels of detail. The general soil map units, called soil associations, are described first and then the detailed map units. Most of the general soil map units represent the soils of major extent in the survey area. The detailed map units represent all of the named soils in the survey area.

General Soil Map Units

The general soil map at the back of this publication show the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The descriptions and names of the soils identified on the general soil map of this county do not fully agree with those of the soils identified on the maps of adjacent counties. Differences result from a better knowledge of soils, modifications in series concepts, a higher or lower intensity of mapping, and variations in the extent of the soils in the counties.

1. Woodson-Kenoma-Dennis Association

Deep, nearly level to moderately sloping, somewhat poorly drained and moderately well drained soils that have a dominantly clayey subsoil; on uplands

This association is on broad ridgetops, high benches, foot slopes, and long side slopes. Intermittent drainageways are common. Slopes range from 0 to 7 percent.

This association makes up about 21 percent of the county. It is about 29 percent Woodson soils, 25 percent Kenoma soils, 24 percent Dennis soils, and 22 percent minor soils (fig. 3).

The somewhat poorly drained Woodson soils formed in old alluvium. These nearly level soils are on broad ridgetops. Typically, the surface layer is very dark gray silt loam about 8 inches thick. The subsoil is mottled extremely firm and very firm silty clay about 42 inches thick. The upper part is very dark gray, and the lower part is gray. The substratum to a depth of about 60 inches is dark brown, mottled silty clay.

The moderately well drained Kenoma soils formed in old alluvium. These gently sloping soils are on broad ridgetops. Typically, the surface layer is very dark grayish brown silt loam about 9 inches thick. The subsoil is very firm and extremely firm silty clay about 35 inches thick. The upper part is dark brown and mottled, and the lower part is brown. The substratum to a depth of about 60 inches is mixed yellowish brown and gray, very firm silty clay.

The moderately well drained Dennis soils formed in shale residuum. These gently sloping and moderately sloping soils are on side slopes and foot slopes. Typically, the surface layer is very dark grayish brown silt loam about 10 inches thick. The subsoil extends to a depth of more than 60 inches. The upper part is dark brown, firm silty clay loam, and the lower part is dark brown and yellowish brown, mottled, very firm silty clay.

The minor soils in this association are the Apperson, Eram, Verdigris, and Zaar soils. Apperson soils are deep over limestone. They are on side slopes and along upland drainageways. The moderately deep Eram soils are on the upper side slopes. The occasionally flooded and frequently flooded Verdigris soils are on flood plains. Zaar soils are on toe slopes and broad flats. They are more clayey than the major soils.

This association is used mainly for cultivated crops. A few areas are used for hay and pasture. Wheat, soybeans, and grain sorghum are the chief crops. Controlling water erosion, conserving moisture, and maintaining tilth and fertility are the main concerns in managing the cultivated areas. In some areas of the Woodson soils, a bedding system is needed to improve surface drainage.

2. Bates-Dennis-Eram Association

Deep and moderately deep, gently sloping and moderately sloping, well drained and moderately well drained soils that have a loamy, silty, or clayey subsoil; on uplands

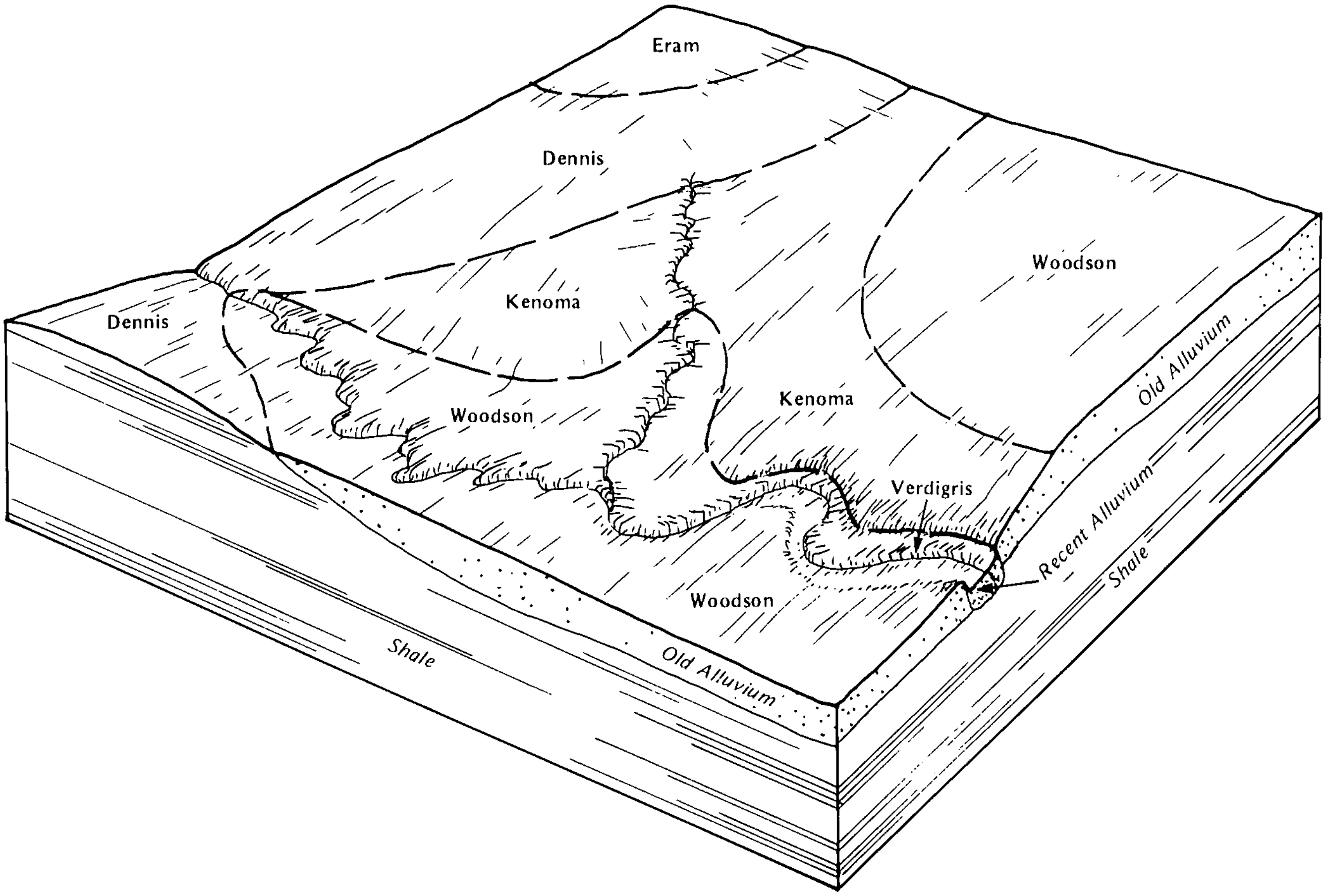


Figure 3.—Typical pattern of soils and parent material in the Woodson-Kenoma-Dennis association.

This association is on foot slopes, side slopes, and moderately broad ridgetops. It is commonly dissected by small drainageways. Slopes range from 1 to 7 percent.

This association makes up about 6 percent of the county. It is about 26 percent Bates soils, 23 percent Dennis soils, 18 percent Eram soils, and 33 percent minor soils.

The moderately deep, well drained Bates soils formed in material weathered from sandstone and shale. These gently sloping and moderately sloping soils are on ridgetops. Typically, the surface layer is very dark grayish brown loam about 11 inches thick. The subsoil is about 17 inches thick. The upper part is dark brown, friable loam; the next part is dark yellowish brown, mottled, firm clay loam; and the lower part is dark brown, mottled, firm gravelly clay loam. Soft sandstone and sandy shale are at a depth of about 28 inches.

The deep, moderately well drained Dennis soils formed in material weathered from shale. These gently sloping and moderately sloping soils are on foot slopes and the lower side slopes. Typically, the surface layer is very dark grayish brown silt loam about 10 inches thick. The subsoil extends to a depth of more than 60 inches. The upper part is dark brown, firm silty clay loam, and the lower part is dark brown and yellowish brown, mottled, very firm silty clay.

The moderately deep, moderately well drained Eram soils formed in material weathered from shale. These gently sloping and moderately sloping soils are on ridgetops and side slopes. Typically, the surface layer is very dark grayish brown silt loam about 9 inches thick. The subsoil is mottled, very firm silty clay about 23 inches thick. It is dark brown in the upper part and olive brown in the lower part. Soft shale is at a depth of about 32 inches.

The minor soils in this association are the Woodson and Verdigris soils. The deep, somewhat poorly drained Woodson soils are in broad, nearly level areas. The deep, well drained Verdigris soils are on flood plains along drainageways.

About half of this association is used as range. Many areas are used for cultivated crops, mainly wheat, soybeans, and grain sorghum. The major concerns in managing range are controlling undesirable vegetation and maintaining a vigorous stand of grasses. Controlling water erosion, conserving moisture, and maintaining tilth and fertility are the major concerns in managing the cultivated areas.

3. Catoosa-Shidler-Zaar Association

Deep to shallow, nearly level to moderately sloping, well drained and somewhat poorly drained soils that are silty throughout or have a clayey subsoil; on uplands

This association is on toe slopes, foot slopes, escarpments, and ridgetops and along drainageways. It is commonly dissected by small drainageways. Slopes range from 0 to 8 percent.

This association makes up about 37 percent of the county. It is about 27 percent Catoosa soils, 25 percent Shidler soils, 24 percent Zaar soils, and 24 percent minor soils (fig. 4).

The moderately deep, well drained Catoosa soils formed in limestone residuum. These nearly level soils are on broad ridgetops. Typically, the surface layer is very dark grayish brown silt loam about 10 inches thick. The subsoil is silty clay loam about 20 inches thick. The upper part is dark brown and firm, the next part is dark reddish brown and firm, and the lower part is dark

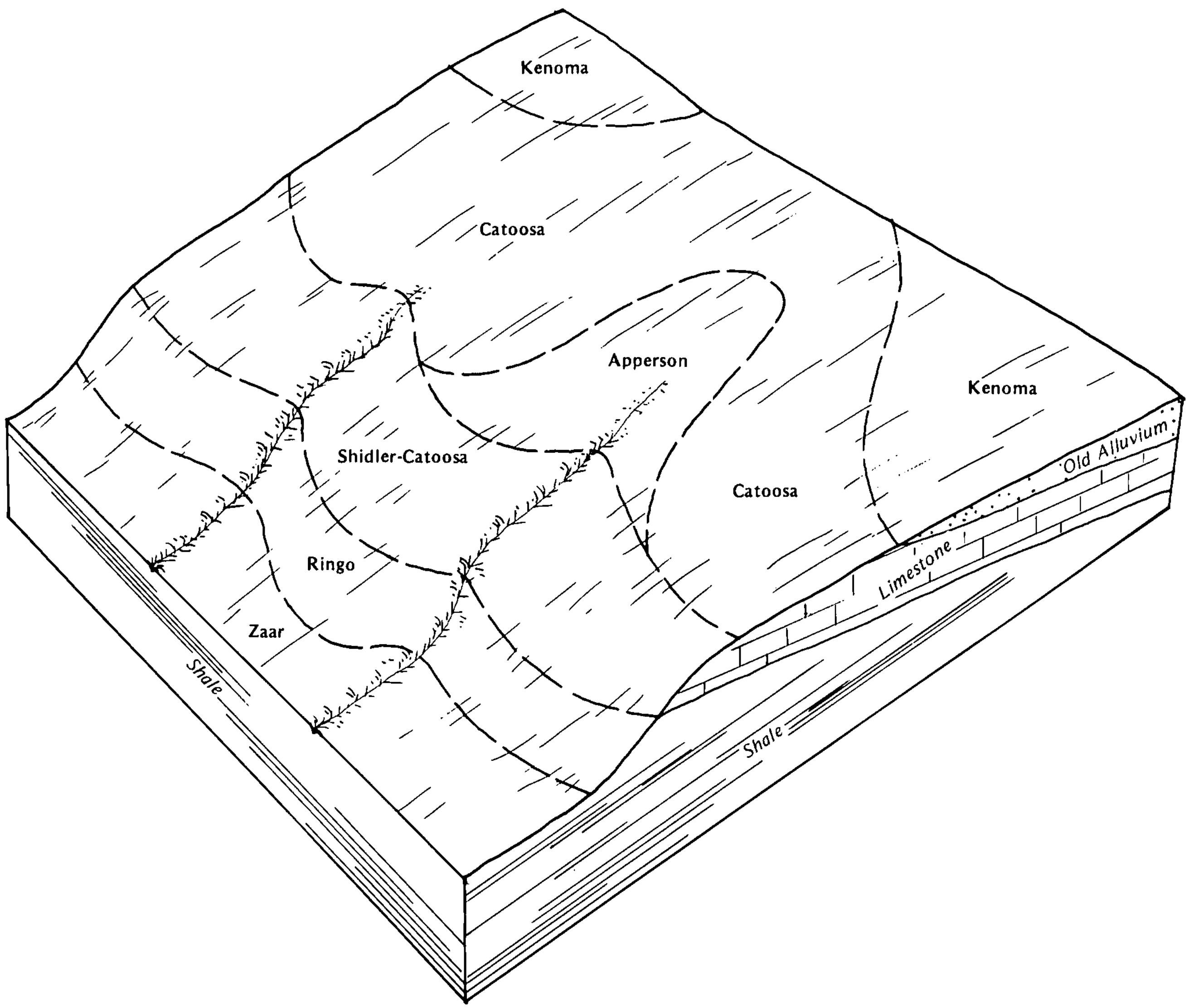


Figure 4.—Typical pattern of soils and parent material in the Catoosa-Shidler-Zaar association.

reddish brown and very firm. Hard limestone bedrock is at a depth of about 30 inches.

The shallow, well drained Shidler soils formed in limestone residuum. These gently sloping and moderately sloping soils are on moderately broad ridgetops, along drainageways, and along the rim of limestone ledges. Typically, the surface layer is very dark brown silty clay loam about 10 inches thick. Hard limestone bedrock is at a depth of about 10 inches.

The deep, somewhat poorly drained Zaar soils formed in clayey material weathered from shale. These nearly level and gently sloping soils are on toe slopes and broad flats and along drainageways. Typically, the surface layer is black silty clay about 10 inches thick. The subsoil is mottled, firm and very firm silty clay about 46 inches thick. The upper part is black, the next part is very dark gray, and the lower part is dark grayish brown. The substratum to a depth of about 60 inches is dark grayish brown, mottled silty clay.

The minor soils in this association are the Apperson, Kenoma, and Ringo soils. The deep, moderately well drained Apperson soils are on the tops of ridges above the Shidler soils. The deep, moderately well drained Kenoma soils are on the tops of ridges above the Catoosa soils. The moderately deep, moderately well drained Ringo soils are on escarpments.

About half of this association is used as range. Many areas are used for cultivated crops, mainly wheat, soybeans, and grain sorghum. The major concerns in managing range are maintaining a vigorous stand of grasses and controlling undesirable vegetation. Controlling water erosion, conserving moisture, and maintaining tilth and fertility are the major concerns in managing the cultivated areas. The wetness of the Zaar soils is an additional concern.

4. Bates-Collinsville-Dennis Association

Deep to shallow, gently sloping to strongly sloping, well drained and moderately well drained soils that are loamy throughout or have a loamy, silty, or clayey subsoil; on uplands

This association is on foot slopes, side slopes, and narrow ridgetops. It is commonly dissected by small drainageways. Slopes range from 1 to 20 percent.

This association makes up about 15 percent of the county. It is about 39 percent Bates soils, 21 percent Collinsville soils, 20 percent Dennis soils, and 20 percent minor soils (fig. 5).

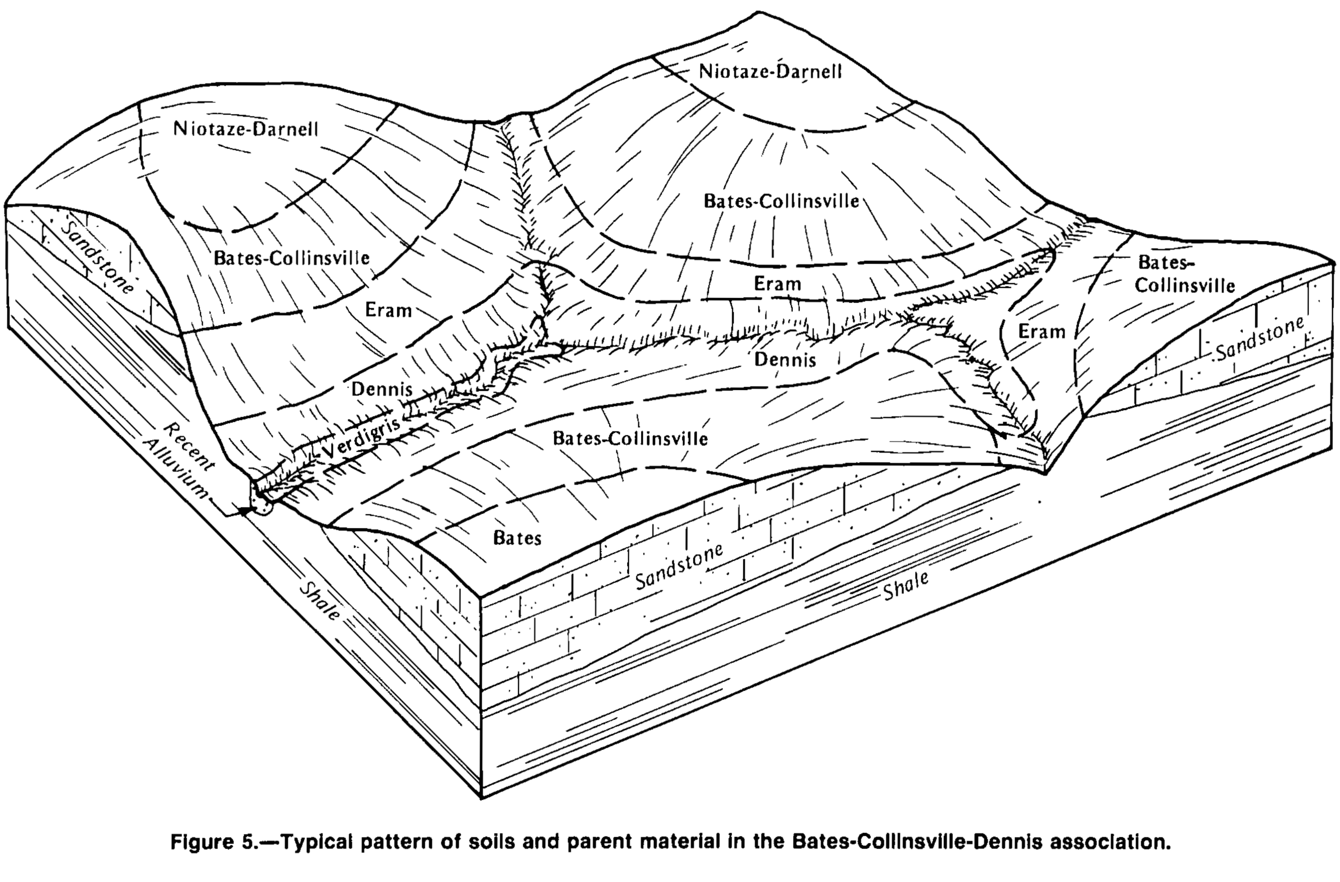


Figure 5.—Typical pattern of soils and parent material in the Bates-Collinsville-Dennis association.

The moderately deep, well drained Bates soils formed in material weathered from sandstone and shale. These gently sloping and moderately sloping soils are on ridgetops and side slopes. Typically, the surface layer is very dark grayish brown loam about 11 inches thick. The subsoil is about 17 inches thick. The upper part is dark brown, friable loam; the next part is dark yellowish brown, mottled, firm clay loam; and the lower part is dark brown, mottled, firm gravelly clay loam. Soft sandstone and sandy shale are at a depth of about 28 inches.

The shallow, well drained Collinsville soils formed in material weathered from sandstone. These moderately sloping and strongly sloping soils are on the steeper side slopes. Typically, the surface layer is very dark grayish brown loam about 6 inches thick. The substratum is dark brown fine sandy loam that has common small sandstone fragments. Sandstone bedrock is at a depth of about 14 inches.

The deep, moderately well drained Dennis soils formed in material weathered from clayey shale. These gently sloping and moderately sloping soils are on foot slopes and the lower side slopes. Typically, the surface layer is very dark grayish brown silt loam about 10 inches thick. The subsoil extends to a depth of more than 60 inches. The upper part is dark brown, firm silty clay loam, and the lower part is dark brown and yellowish brown, mottled, very firm silty clay.

The minor soils in this association are the Darnell, Eram, Niotaze, and Verdigris soils. The shallow, well drained Darnell soils are on ridgetops and the upper side slopes. The moderately deep, moderately well drained Eram soils are on ridgetops and side slopes. The moderately deep, somewhat poorly drained Niotaze soils are on the steeper side slopes. The deep, moderately well drained Verdigris soils are on narrow flood plains.

About 70 percent of this association is used as range. Many areas are used for cultivated crops, mainly wheat, soybeans, and grain sorghum. The major concerns in managing range are maintaining a vigorous stand of desirable grasses and controlling undesirable vegetation. Controlling water erosion, conserving moisture, and maintaining tilth and fertility are the major concerns in managing the cultivated areas.

5. Steedman-Niotaze-Darnell Association

Moderately deep and shallow, moderately sloping to moderately steep, well drained to somewhat poorly drained soils that have a clayey or loamy subsoil; on uplands

This association is on side slopes and narrow ridgetops. It is commonly dissected by small drainageways. Slopes range from 2 to 30 percent.

This association makes up about 8 percent of the county. It is about 35 percent Steedman soils, 15 percent Niotaze soils, 13 percent Darnell soils, and 37 percent minor soils (fig. 6).

The moderately deep, moderately well drained Steedman soils formed in material weathered from shale. These moderately sloping to moderately steep soils are on side slopes and narrow ridgetops. Typically, the surface layer is very dark grayish brown gravelly silt loam about 8 inches thick. The subsoil is dark brown and dark yellowish brown, very firm silty clay about 24 inches thick. Soft, clayey shale is at a depth of about 32 inches.

The moderately deep, somewhat poorly drained Niotaze soils formed in material weathered from shale interbedded with sandstone. These moderately sloping to moderately steep soils are on side slopes. Typically, the surface layer is dark brown cobbly fine sandy loam about 5 inches thick. The subsurface layer is brown cobbly fine sandy loam about 4 inches thick. The subsoil is very firm silty clay about 27 inches thick. The upper part is yellowish red, and the lower part is dark brown and mottled. Silty shale is at a depth of about 36 inches.

The shallow, well drained Darnell soils formed in material weathered from sandstone. These moderately sloping and strongly sloping soils are on ridgetops and side slopes. Typically, the surface layer is dark brown fine sandy loam about 6 inches thick. The subsoil is dark yellowish brown, friable fine sandy loam about 11 inches thick. Soft sandstone is at a depth of about 17 inches.

The minor soils in this association are the Dennis, Prue, and Stephenville soils. The deep, moderately well drained Dennis and Prue soils are on the lower foot slopes. The moderately deep, well drained Stephenville soils are mainly on ridgetops.

This association is used mainly as range. Some areas on the lower foot slopes and along drainageways are cultivated. Blackjack oak and post oak grow in some areas. The main concerns in managing range are maintaining a vigorous stand of desirable grasses and controlling undesirable vegetation.

6. Osage-Verdigris Association

Deep, nearly level, poorly drained and moderately well drained soils that have a clayey or silty subsoil; on flood plains

This association is on bottom land along the major streams in the county. The soils are subject to flooding. Slopes range from 0 to 2 percent.

This association makes up about 13 percent of the county. It is about 46 percent Osage soils, 33 percent Verdigris soils, and 21 percent minor soils.

The poorly drained Osage soils formed in clayey alluvium. They are on broad flats that generally are a short distance from stream channels. Typically, the surface layer is black silty clay about 7 inches thick. The subsurface layer also is black silty clay. It is about 9 inches thick. The subsoil to a depth of more than 60 inches is extremely firm silty clay. The upper part is black, and the lower part is very dark grayish brown.

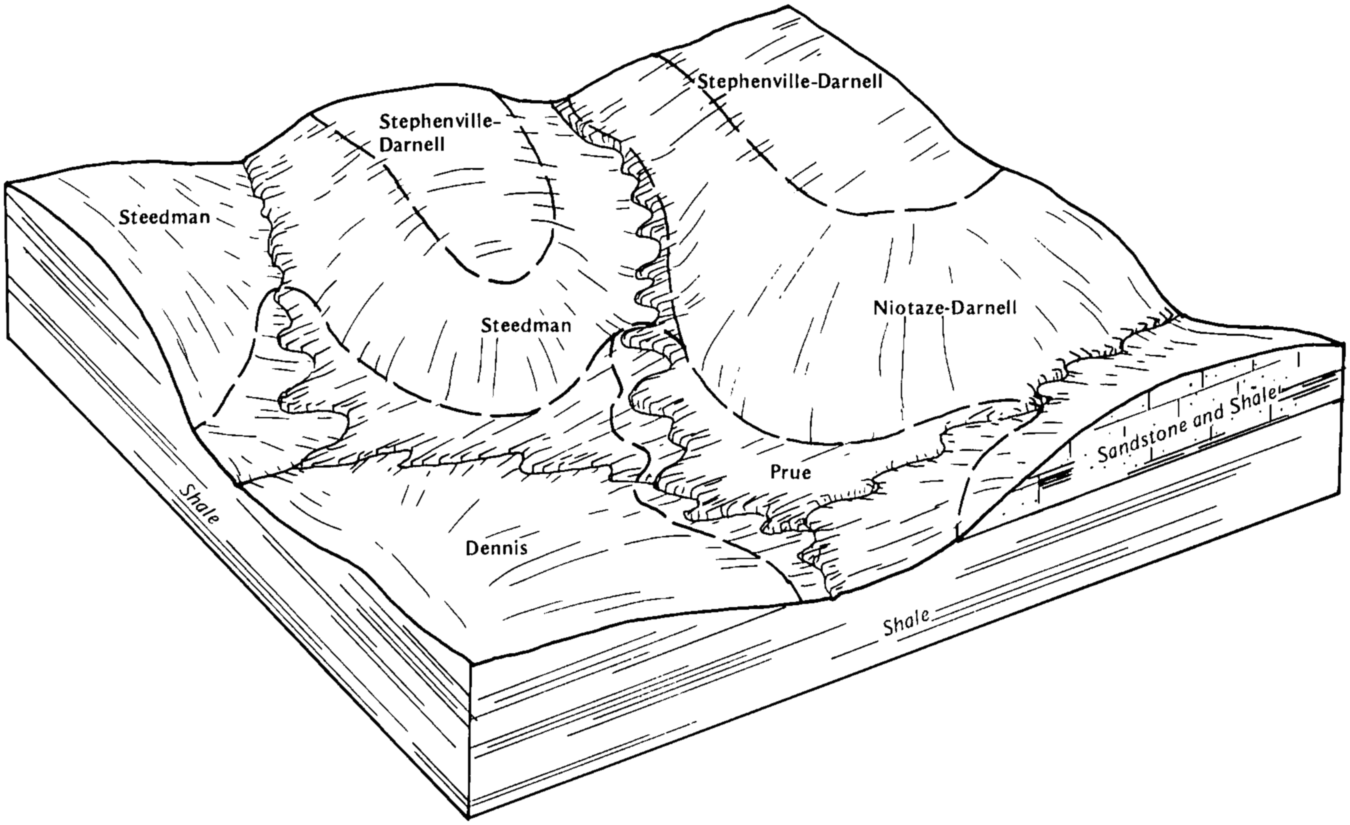


Figure 6.—Typical pattern of soils and parent material in the Steedman-Niotaze-Darnell association.

The moderately well drained Verdigris soils formed in silty alluvium. They are on flood plains adjacent to most of the streams in the county. Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 14 inches thick. The next layer is dark brown, firm silty clay loam about 9 inches thick. The substratum to a depth of about 60 inches is dark brown silty clay loam.

The minor soils in this association are the somewhat poorly drained, silty Lanton soils along creeks.

Nearly all areas of this association are used for cultivated crops, mainly wheat, grain sorghum, soybeans, corn, and alfalfa. A few areas along drainageways are used as range or woodland. The main concerns in managing the cultivated areas are controlling flooding and maintaining tilth and fertility.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Dennis silt loam, 1 to 4 percent slopes, is a phase of the Dennis series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Shidler-Catoosa complex, 1 to 8 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, quarries, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

The descriptions and names of the soils identified on the detailed soil maps of this county do not fully agree with those of the soils identified on the maps of adjacent counties. Differences result from a better knowledge of soils, modifications in series concepts, a higher or lower intensity of mapping, and variations in the extent of the soils in the counties.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Ae—Apperson silty clay loam, 0 to 2 percent slopes. This deep, nearly level, moderately well drained soil is along drainageways and on side slopes in the uplands. Individual areas are irregular in shape and range from 20 to 300 acres in size.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsoil is about 35 inches thick. The upper part is black, firm silty clay loam; the next part is very dark grayish brown and dark brown, mottled, very firm silty clay; and the lower part is dark yellowish brown, mottled, very firm silty clay. Limestone bedrock is at a depth of about 43 inches. In places the surface layer is silty clay. In some areas the depth to limestone bedrock is 20 to 40 inches.

Included with this soil in mapping are small areas of Catoosa and Shidler soils. The moderately deep Catoosa soils have a loamy subsoil. They are slightly higher on the landscape than the Apperson soil. The shallow Shidler soils are on ridgetops and along drainageways. Included soils make up 5 to 15 percent of the map unit.

Permeability is slow in the Apperson soil, and available water capacity is moderate. Surface runoff is medium. The surface layer is firm, and tilth is fair. A perched seasonal high water table is at a depth of about 1.5 to 2.0 feet in winter and in early spring. Reaction varies widely in the surface layer as a result of local liming practices. The subsoil typically ranges from neutral to moderately alkaline. It has a high shrink-swell potential.

About two-thirds of the acreage is used for cultivated crops. The rest is used as hayland, range, or pasture. This soil is well suited to legumes, soybeans, grain sorghum, and wheat. Water erosion is a hazard if cultivated crops are grown. A system of conservation tillage that leaves all or part of the crop residue on the surface, terraces, grassed waterways, and contour farming help to prevent excessive soil loss. Returning crop residue to the soil improves tilth and fertility and increases the rate of water infiltration.

This soil is suited to range and pasture plants for hay or grazing. Water erosion is a hazard in overused areas and in areas where the pasture is becoming established. An adequate plant cover on the established pastures and mulch in the seeded areas help to prevent excessive soil loss, reduce the runoff rate, and conserve moisture. Applications of fertilizer are generally needed in the pastured areas.

This soil is poorly suited to dwellings because the shrink-swell potential is a limitation. Wetness also is a limitation on sites for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material around the foundations help to prevent the structural damage caused by shrinking and swelling and by wetness.

Because of the slow permeability and the wetness, this soil is generally unsuited to septic tank absorption fields. A suitable alternative site is needed. The soil is generally unsuited to sewage lagoons because of the wetness.

The land capability classification is IIe, and the range site is Loamy Upland.

Ba—Bates loam, 1 to 4 percent slopes. This moderately deep, gently sloping, well drained soil is on the tops of ridges in the uplands. Individual areas are irregular in shape and range from 20 to 300 acres in size.

Typically, the surface layer is very dark grayish brown loam about 11 inches thick. The subsoil is about 17 inches thick. The upper part is dark brown, friable loam; the next part is dark yellowish brown, mottled, firm clay loam; and the lower part is dark brown, mottled, firm gravelly clay loam. Soft sandstone and sandy shale are at a depth of about 28 inches. In places the surface layer and subsoil have common sandstone fragments. In a few areas the soil is redder.

Included with this soil in mapping are small areas of Collinsville, Dennis, and Eram soils. The shallow Collinsville soils are generally more sloping than the Bates soil and are on ridgetops. The deep Dennis soils have a dominantly clayey subsoil. They are on the lower side slopes. The moderately well drained Eram soils have a clayey subsoil. They are in positions on the landscape similar to those of the Bates soil. Included soils make up 10 to 15 percent of the map unit.

Permeability is moderate in the Bates soil, and available water capacity is low. Surface runoff is medium. The surface layer is friable, and tilth is good. Root penetration is restricted by the bedrock at a depth of 20 to 40 inches. Reaction ranges from strongly acid to slightly acid in the subsoil and varies widely in the surface layer as a result of local liming practices. The shrink-swell potential is low.

Most areas are used for cultivated crops. Some are used as range, pasture, or hayland. This soil is well suited to soybeans, grain sorghum, and wheat. Water erosion is a hazard if cultivated crops are grown. A system of conservation tillage that leaves all or part of the crop residue on the surface, terraces, grassed waterways, and contour farming help to prevent excessive soil loss. Soil depth should be considered when a terrace system is designed. If the bedrock is exposed during the construction of waterways or terrace channels, a layer of topsoil is needed. Returning crop residue to the soil improves tilth and fertility and increases the rate of water infiltration.

This soil is suited to range and pasture plants for hay or grazing. Water erosion is a hazard in overused areas and in areas where the pasture is becoming established. An adequate plant cover on the established pastures and mulch in the seeded areas help to prevent excessive soil loss, reduce the runoff rate, and conserve moisture. Applications of fertilizer are generally needed in the pastured areas. Gullies form along some cattle trails. Fencing and other means of controlling livestock traffic patterns help to prevent gullying and give gullies time to revegetate.

This soil is well suited to dwellings without basements, but it is only moderately well suited to dwellings with basements because the depth to bedrock is a limitation. The rock is rippable and can be excavated.

Because of the depth to bedrock, this soil is generally unsuited to septic tank absorption fields and is poorly suited to sewage lagoons. During the construction of sewage lagoons, fill material should be borrowed or the bedrock ripped. Sealing the bottom of the lagoon helps to prevent excessive seepage into fractures in the bedrock.

The land capability classification is IIe, and the range site is Loamy Upland.

Bc—Bates loam, 4 to 7 percent slopes. This moderately deep, moderately sloping, well drained soil is on ridgetops and side slopes in the uplands. Individual areas are irregular in shape or long and narrow and range from 20 to 200 acres in size.

Typically, the surface layer is very dark brown loam about 8 inches thick. The subsoil is about 19 inches thick. The upper part is dark brown, friable loam; the next part is dark yellowish brown, mottled, firm clay loam; and the lower part is dark brown, mottled, firm clay loam and gravelly clay loam. Soft sandstone and sandy shale are at a depth of about 27 inches. In places the surface layer and subsoil have common sandstone fragments. In a few eroded areas, the clay loam part of the subsoil is at or near the surface.

Included with this soil in mapping are small areas of Collinsville, Dennis, and Eram soils. The shallow Collinsville soils are on side slopes. The deep Dennis soils have a dominantly clayey subsoil. They are on the lower side slopes. The moderately well drained Eram soils have a clayey subsoil. They are in positions on the landscape similar to those of the Bates soil. Included soils make up 10 to 15 percent of the map unit.

Permeability is moderate in the Bates soil, and available water capacity is low. Surface runoff is rapid. The surface layer is friable, and tilth is good. Root penetration is restricted by the bedrock at a depth of 20 to 40 inches. Reaction ranges from strongly acid to slightly acid in the subsoil and varies widely in the surface layer as a result of local liming practices. The shrink-swell potential is low.

About three-fourths of the acreage is used as range. The rest is used for hay, pasture, or cultivated crops. This soil is moderately well suited to wheat, grain sorghum, and soybeans. Water erosion is a hazard if cultivated crops are grown. A system of conservation tillage that leaves all or part of the crop residue on the surface, terraces, grassed waterways, and contour farming help to prevent excessive soil loss. Soil depth should be considered when a terrace system is designed. If the bedrock is exposed during the construction of waterways or terrace channels, a layer of topsoil is needed. Returning crop residue to the soil improves tilth and fertility and increases the rate of water infiltration.

This soil is suited to range and pasture plants for hay or grazing. Water erosion is a hazard in overused areas and in areas where the pasture is becoming established. An adequate plant cover on the established pastures and mulch in the seeded areas help to prevent excessive soil loss, reduce the runoff rate, and conserve moisture. Applications of fertilizer are generally needed in the pastured areas. Gullies form along some cattle trails. Fencing and other means of controlling livestock traffic patterns help to prevent gullying and give gullies time to revegetate.

This soil is well suited to dwellings without basements, but it is only moderately well suited to dwellings with basements because the depth to bedrock is a limitation. The rock is rippable and can be excavated.

Because of the depth to bedrock, this soil is generally unsuited to septic tank absorption fields and is poorly suited to sewage lagoons. During the construction of sewage lagoons, fill material should be borrowed or the bedrock ripped. Sealing the bottom of the lagoon helps to prevent excessive seepage into fractures in the bedrock.

The land capability classification is IIIe, and the range site is Loamy Upland.

Bh—Bates-Collinsville loams, 3 to 7 percent slopes. These moderately sloping, well drained soils are on uplands. The shallow Collinsville soil is on side slopes. The moderately deep Bates soil is on ridgetops. Individual areas are long and narrow or irregular in shape and range from 20 to 300 acres in size. They are about 50 percent Bates soil and 35 percent Collinsville soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Bates soil has a surface layer of very dark brown loam about 10 inches thick. The subsoil is about 17 inches thick. The upper part is dark brown, friable loam; the next part is dark yellowish brown, mottled, firm clay loam; and the lower part is dark brown, mottled, firm gravelly clay loam. Soft sandstone and sandy shale are at a depth of about 27 inches. In places the surface layer and subsoil have common sandstone fragments. In some small areas the lower part of the surface layer is grayish brown silt loam.

Typically, the Collinsville soil has a surface layer of very dark grayish brown loam about 6 inches thick. The substratum is dark brown fine sandy loam that has common small sandstone fragments. Sandstone bedrock is at a depth of about 14 inches. In places the surface layer has only a few sandstone fragments.

Included with these soils in mapping are small areas of the deep Dennis and moderately deep Eram soils. Dennis soils are on foot slopes, and Eram soils are on the upper side slopes. Both of these included soils have a clayey subsoil. They make up about 15 percent of the map unit.

Permeability is moderate in the Bates soil and moderately rapid in the Collinsville soil. Available water capacity is low in the Bates soil and very low in the Collinsville soil. Surface runoff is rapid on both soils. The subsoil of the Bates soil and the substratum of the Collinsville soil typically are strongly acid to slightly acid. Reaction varies widely in the surface layer of both soils as a result of local liming practices. Root penetration is restricted by the bedrock at a depth of 20 to 40 inches in the Bates soil and 4 to 20 inches in the Collinsville soil. The shrink-swell potential is low in both soils.

Most areas are used as range. A few small areas are used as pasture. Because of the hazard of water erosion on both soils and the shallow depth to bedrock in the Collinsville soil, these soils generally are not used for cultivated crops. They are better suited to range. Water erosion is a hazard in overused areas and in areas where the pasture is becoming established. An adequate plant cover on the established pastures and mulch in the seeded areas help to prevent excessive soil loss, reduce the runoff rate, and conserve moisture. Applications of fertilizer are generally needed in the pastured areas. Gullies form along some cattle trails. Fencing and other means of controlling livestock traffic patterns help to prevent gullying and give gullies time to revegetate.

The Bates soil is well suited to dwellings without basements, but it is only moderately well suited to dwellings with basements because the depth to bedrock is a limitation. The rock is rippable and can be excavated.

Because of the depth to bedrock, the Bates soil is generally unsuited to septic tank absorption fields and is poorly suited to sewage lagoons. During the construction of sewage lagoons, fill material should be borrowed or the bedrock ripped. Sealing the bottom of the lagoon helps to prevent excessive seepage into fractures in the bedrock.

The Collinsville soil is generally unsuited to building site development because of the shallow depth to bedrock.

The land capability classification is IVe. The Bates soil is in the Loamy Upland range site, and the Collinsville soil is in the Shallow Sandstone range site.

Bo—Bates-Collinsville loams, 7 to 20 percent slopes. These strongly sloping, well drained soils are on uplands. The shallow Collinsville soil is on side slopes. The moderately deep Bates soil is on ridgetops. Individual areas are long and narrow or irregular in shape and range from 20 to 1,000 acres in size. They are about 45 percent Bates soil and 40 percent Collinsville soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Bates soil has a surface layer of very dark brown loam about 7 inches thick. The subsoil is about 18 inches thick. The upper part is dark brown, friable loam; the next part is dark yellowish brown, mottled, firm clay loam; and the lower part is dark brown, mottled, firm gravelly clay loam. Soft sandstone and sandy shale are at a depth of about 25 inches. In places the surface layer and subsoil have common sandstone fragments. In some small areas the lower part of the surface layer is grayish brown silt loam. In some areas the slope is more than 20 percent.

Typically, the Collinsville soil has a surface layer of very dark grayish brown loam about 6 inches thick. The substratum is dark brown fine sandy loam that has common small sandstone fragments. Sandstone bedrock is at a depth of about 14 inches. In places the surface layer has only a few sandstone fragments.

Included with these soils in mapping are small areas of the deep Dennis and moderately deep Eram soils. Dennis soils are on foot slopes, and Eram soils are on side slopes. Both of these included soils have a clayey subsoil. They make up about 15 percent of the map unit.

Permeability is moderate in the Bates soil and moderately rapid in the Collinsville soil. Available water capacity is moderate in the Bates soil and very low in the Collinsville soil. Surface runoff is rapid on both soils. The subsoil of the Bates soil and the substratum of the Collinsville soil typically are strongly acid to slightly acid. Root penetration is restricted by the bedrock at a depth of 20 to 40 inches in the Bates soil and 4 to 20 inches in the Collinsville soil. The shrink-swell potential is low in both soils.

Nearly all areas are used as range. Because of a severe hazard of water erosion and rocks that interfere with tillage, these soils are generally unsuited to cultivated crops. They are better suited to range. Droughtiness is a limitation if the Collinsville soil is used as range. Water erosion is a hazard on both soils if the range is overgrazed. Maintaining an adequate plant cover helps to prevent excessive soil loss, reduces the runoff rate, and conserves moisture. Gullies form along some cattle trails. Fencing and other means of controlling livestock patterns help to prevent gullying and give gullies time to revegetate.

The Bates soil is well suited to dwellings without basements, but it is only moderately well suited to dwellings with basements because the depth to bedrock is a limitation. The rock is rippable and can be excavated.

Because of the depth to bedrock, the Bates soil is generally unsuited to septic tank absorption fields and is poorly suited to sewage lagoons. During the construction of sewage lagoons, fill material should be borrowed or the bedrock ripped. Sealing the bottom of the lagoon helps to prevent excessive seepage into fractures in the bedrock.

The Collinsville soil is generally unsuited to building site development because of the shallow depth to bedrock.

The land capability classification is VIe. The Bates soil is in the Loamy Upland range site, and the Collinsville soil is in the Shallow Sandstone range site.

Ca—Catoosa silt loam, 0 to 2 percent slopes. This moderately deep, nearly level, well drained soil is on the broad tops of ridges in the uplands. Individual areas are irregular in shape and range from 20 to 500 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 10 inches thick. The subsoil is silty clay loam about 20 inches thick. The upper part is dark brown and firm, the next part is dark reddish brown and firm, and the lower part is dark reddish brown and very firm. Hard limestone bedrock is at a depth of about 30 inches. In places the depth to limestone bedrock is more than 40 inches.

Included with this soil in mapping are small areas of Apperson, Kenoma, Shidler, and Zaar soils. The deep, moderately well drained Apperson soils are along drainageways. The deep, moderately well drained Kenoma soils are in the higher convex areas. The shallow Shidler soils are along drainageways and along the rim of rocky ledges. The clayey, somewhat poorly drained Zaar soils are on foot slopes. Also included are small areas where rock crops out and small areas where limestone fragments are throughout the soil. Included areas make up 5 to 15 percent of the map unit.

Permeability and available water capacity are moderate in the Catoosa soil. Surface runoff is medium. The surface layer is friable, and tilth is good. Root penetration is restricted by the bedrock at a depth of 20 to 40 inches. Reaction ranges from strongly acid to neutral in the subsoil and varies widely in the surface layer as a result of local liming practices. The shrink-swell potential is moderate in the subsoil.

About three-fourths of the acreage is used for cultivated crops. The rest is used as range, pasture, or hayland. This soil is well suited to soybeans, grain sorghum, wheat, and legumes. Water erosion is a hazard if cultivated crops are grown. A system of conservation tillage that leaves all or part of the crop residue on the surface, terraces, grassed waterways, and contour farming help to prevent excessive soil loss. Returning crop residue to the soil improves tilth and fertility and increases the rate of water infiltration.

This soil is suited to range and pasture plants for hay or grazing. Water erosion is a hazard in overused areas and in areas where the pasture is becoming established. An adequate plant cover on the established pastures and mulch in the seeded areas help to prevent excessive soil loss, reduce the runoff rate, and conserve moisture. Applications of fertilizer are generally needed in the pastured areas.

Because of the shrink-swell potential and the depth to bedrock, this soil is only moderately well suited to dwellings without basements. It is generally unsuited to dwellings with basements because of the depth to bedrock. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material around the foundations help to prevent the structural damage caused by shrinking and swelling. The areas where the depth to bedrock is more than 40 inches can generally be used as sites for dwellings with basements.

This soil is poorly suited to septic tank absorption fields and sewage lagoons because of the depth to bedrock. The areas where the depth to bedrock is more than 40 inches are better sites for these uses.

The land capability classification is IIe, and the range site is Loamy Upland.

Dn—Dennis silt loam, 1 to 4 percent slopes. This deep, gently sloping, moderately well drained soil is on side slopes and foot slopes in the uplands. Individual areas are irregular in shape and range from 40 to 500 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 10 inches thick. The subsoil extends to a depth of more than 60 inches. The upper part is dark brown, firm silty clay loam, and the lower part is dark brown and yellowish brown, mottled, very firm silty clay. In some places the upper part of the subsoil is silty clay. In other places, the surface layer is darker and more clayey and the upper part of the subsoil is darker. In some eroded areas the silty clay part of the subsoil is at or near the surface.

Included with this soil in mapping are small areas of Bates soils, small areas of sodic soils, slick spots, and areas of soils that are less than 40 inches deep over shale. The moderately deep Bates soils have a loamy subsoil. They are on the upper side slopes. The slick spots are generally a few inches lower on the landscape than the Dennis soil. Also included, along some of the larger streams, are soils that are redder and less clayey than the Dennis soil. Included areas make up 5 to 10 percent of the map unit.

Permeability is slow in the Dennis soil, and available water capacity is high. Surface runoff is medium. The surface layer is friable, and tilth is good. A perched seasonal high water table is at a depth of about 2 to 3 feet in winter and in early spring. Reaction typically ranges from strongly acid to neutral in the subsoil and varies widely in the surface layer as a result of local liming practices. The shrink-swell potential is high in the subsoil.

About two-thirds of the acreage is used for cultivated crops. The rest is used mainly as range or pasture. This soil is well suited to soybeans, grain sorghum, wheat, legumes, and corn. Water erosion is a hazard if cultivated crops are grown. A system of conservation tillage that leaves all or part of the crop residue on the surface, terraces, grassed waterways, and contour farming help to prevent excessive soil loss. Returning crop residue to the soil improves tilth and fertility and increases the rate of water infiltration.

This soil is suited to range and pasture plants for hay or grazing. Water erosion is a hazard in overused areas and in areas where the pasture is becoming established. An adequate plant cover on the established pastures and mulch in the seeded areas help to prevent excessive soil loss, reduce the runoff rate, and conserve moisture. Applications of fertilizer are generally needed in the pastured areas. Gullies form along some cattle trails. Fencing and other means of controlling livestock traffic patterns help to prevent gullying and give gullies time to revegetate.

This soil is poorly suited to dwellings because the shrink-swell potential is a limitation. Also, the wetness is a limitation on sites for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material around the foundations help to prevent the structural damage caused by shrinking and swelling and by wetness.

Because of the slow permeability and the wetness, this soil is generally unsuited to septic tank absorption fields. It is only moderately well suited to sewage lagoons because of the slope. Some land shaping is generally needed to overcome the slope.

The land capability classification is IIe, and the range site is Loamy Upland.

Do—Dennis silt loam, 4 to 7 percent slopes. This deep, moderately sloping, moderately well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 15 to 200 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsoil extends to a depth of more than 60 inches. The upper part is dark brown, firm silty clay loam, and the lower part is brown and yellowish brown, mottled, very firm silty clay. In some places the upper part of the subsoil is silty clay. In other places, the surface layer is more clayey and the upper part of the subsoil is darker. In some eroded areas the silty clay part of the subsoil is at or near the surface.

Included with this soil in mapping are small areas of Bates, Eram, and Zaar soils. Also included are soils that are less than 40 inches deep over shale. The moderately deep Bates soils have a loamy subsoil. They are on ridgetops. The moderately deep Eram soils are on the upper side slopes. The somewhat poorly drained Zaar soils are on the lower side slopes. Included soils make up 5 to 10 percent of the map unit.

Permeability is slow in the Dennis soil, and available water capacity is high. Surface runoff is rapid. The surface layer is friable, and tilth is good. A perched seasonal high water table is at a depth of about 2 to 3 feet in winter and in early spring. Reaction typically ranges from strongly acid to neutral in the subsoil and varies widely in the surface layer as a result of local liming practices. The shrink-swell potential is high in the subsoil.

About half of the acreage is used for cultivated crops. The rest is used mainly as range or pasture. This soil is moderately well suited to soybeans, grain sorghum, wheat, and legumes. Water erosion is a hazard if cultivated crops are grown. A system of conservation tillage that leaves all or part of the crop residue on the surface, terraces, grassed waterways, and contour farming help to prevent excessive soil loss. Returning crop residue to the soil improves tilth and fertility and increases the rate of water infiltration.

This soil is suited to range and pasture plants for hay or grazing. Water erosion is a hazard in overused areas and in areas where the pasture is becoming established. An adequate plant cover on the established pastures and mulch in the seeded areas help to prevent excessive soil loss, reduce the runoff rate, and conserve moisture. Applications of fertilizer are generally needed in the pastured areas. Gullies form along some cattle trails. Fencing and other means of controlling livestock traffic patterns help to prevent gullying and give gullies time to revegetate.

This soil is poorly suited to dwellings because the shrink-swell potential is a limitation. Also, the wetness is a limitation on sites for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material around the foundations help to prevent the structural damage caused by shrinking and swelling and by wetness.

Because of the slow permeability and the wetness, this soil is generally unsuited to septic tank absorption fields. It is only moderately well suited to sewage lagoons because of the slope. Some land shaping is generally needed to overcome the slope.

The land capability classification is IIIe, and the range site is Loamy Upland.

Dp—Dennis silty clay loam, 2 to 5 percent slopes, eroded. This deep, moderately sloping, moderately well drained soil is on side slopes in the uplands. Sheet erosion has removed more than half of the original surface layer in most places. In a few places, the subsoil is exposed and some rills and shallow gullies have formed. The rills and gullies can be crossed by farm equipment. Individual areas are irregular in shape and range from 10 to 75 acres in size.

Typically, the surface layer is dark brown silty clay loam about 5 inches thick. The subsoil is very firm, mottled silty clay about 55 inches thick. It is brown in the upper part, dark yellowish brown in the next part, and yellowish brown in the lower part. In some areas the surface layer is more than 10 inches thick. In places the upper part of the subsoil is darker.

Included with this soil in mapping are small areas of soils that are less than 40 inches deep over shale. These soils are in the steeper areas. They make up less than 5 percent of the map unit.

Permeability is slow in the Dennis soil, and available water capacity is high. Surface runoff is medium. The surface layer is friable when moist and generally is cloddy when dry. Reaction typically ranges from strongly acid to neutral in the subsoil and varies widely in the surface layer as a result of local liming practices. A perched seasonal high water table is at a depth of about 2 to 3 feet in winter and in early spring. The shrink-swell potential is high in the subsoil.

About half of the acreage is used for cultivated crops. The rest is pasture or is abandoned cropland. This soil is poorly suited to wheat, soybeans, and grain sorghum. It is somewhat droughty. Crops tend to wilt during dry, hot periods because the soil absorbs and releases moisture slowly. Further water erosion is a hazard if cultivated crops are grown. A system of conservation tillage that leaves all or part of the crop residue on the surface, terraces, grassed waterways, and contour farming help to prevent excessive soil loss. Returning crop residue to the soil improves tilth and fertility and increases the rate of water infiltration.

This soil is suited to range and pasture plants for hay or grazing. Establishing pasture is difficult because of poor tilth. Further water erosion is a hazard in overused areas and in areas where the pasture is becoming established. An adequate plant cover on the established pastures and mulch in the seeded areas help to prevent excessive soil loss, reduce the runoff rate, and conserve moisture. Applications of fertilizer are generally needed in the pastured areas. Gullies form along some cattle trails. Fencing and other means of controlling livestock traffic patterns help to prevent gullying and give gullies time to revegetate.

This soil is poorly suited to dwellings because the shrink-swell potential is a limitation. Also, the wetness is a limitation on sites for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material around the foundations help to prevent the structural damage caused by shrinking and swelling and by wetness.

Because of the slow permeability and the wetness, this soil is generally unsuited to septic tank absorption fields. It is only moderately well suited to sewage lagoons because of the slope. Some land shaping is generally needed to overcome the slope.

The land capability classification is IIIe, and the range site is Loamy Upland.

Dw—Dennis-Dwight silt loams, 1 to 5 percent slopes. These deep, gently sloping, moderately well drained soils are on foot slopes in the uplands. The sodic Dwight soil is generally less sloping than the Dennis soil. Individual areas are irregular in shape and range from 20 to 200 acres in size. They are about 65 percent Dennis soil and 25 percent Dwight soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Dennis soil has a surface layer of very dark grayish brown silt loam about 10 inches thick. The subsoil extends to a depth of more than 60 inches. The upper part is dark brown, firm silty clay loam, and the lower part is dark brown and yellowish brown, mottled, very firm silty clay. In some places the subsoil is sandier. In other places the upper part of the subsoil is darker.

Typically, the Dwight soil has a surface layer of very dark grayish brown silt loam about 4 inches thick. The subsoil is very firm silty clay about 37 inches thick. It is black in the upper part, dark grayish brown and mottled in the next part, and dark brown and mottled in the lower part. The substratum to a depth of about 60 inches is brown, mottled silty clay. The subsoil and substratum have a moderate content of sodium.

Included with these soils in mapping are small areas of the well drained Bates soils. These included soils generally are on the higher parts of the landscape. They make up about 10 percent of the map unit.

Permeability is slow in the Dennis soil and very slow in the Dwight soil. Available water capacity is high in the Dennis soil and moderate in the Dwight soil. Surface runoff is medium on both soils. The content of sodium in the subsoil of the Dwight soil restricts the growth of most plants. The Dennis soil has a perched seasonal high water table at a depth of about 2 to 3 feet in winter and in early spring. Reaction typically ranges from strongly acid to neutral in the subsoil of the Dennis soil and from slightly acid to moderately alkaline in the subsoil of the Dwight soil. It varies widely in the surface layer of both soils as a result of local liming practices. The shrink-swell potential is high in the subsoil.

About three-fourths of the acreage is used as range. The rest is used mainly for cultivated crops. These soils are poorly suited to wheat, grain sorghum, and soybeans. Water erosion is a hazard if cultivated crops are grown. A system of conservation tillage that leaves all or part of the crop residue on the surface, terraces, grassed waterways, and contour farming help to prevent excessive soil loss. Droughtiness and excess sodium are concerns on the Dwight soil. This soil does not absorb moisture easily or release it readily to plants. Returning crop residue to the soil improves tilth and fertility and increases the rate of water infiltration.

These soils are suited to range. Water erosion is a hazard in overused areas. Maintaining an adequate plant cover helps to prevent excessive soil loss, reduces the runoff rate, and conserves moisture. Gullies form along some cattle trails. Fencing and other means of controlling livestock traffic patterns help to prevent gullying and give gullies time to revegetate.

These soils are poorly suited to dwellings because the shrink-swell potential is a limitation. Also, the wetness of the Dennis soil is a limitation on sites for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material around the foundations help to prevent the structural damage caused by shrinking and swelling and by wetness.

Because of the restricted permeability in both soils and the wetness of the Dennis soil, these soils are generally unsuited to septic tank absorption fields. They are only moderately well suited to sewage lagoons because of the slope. Some land shaping is generally needed to overcome the slope.

The land capability classification is IIIe. The Dennis soil is in the Loamy Upland range site, and the Dwight soil is in the Claypan range site.

Eb—Eram silt loam, 1 to 3 percent slopes. This moderately deep, gently sloping, moderately well drained soil is on side slopes and ridgetops in the uplands. Individual areas are irregular in shape and range from 20 to 300 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 9 inches thick. The subsoil is mottled, very firm silty clay about 23 inches thick. It is dark brown in the upper part and olive brown in the lower part. Soft shale is at a depth of about 32 inches. In some places the dark surface layer is thinner. In other places the depth to shale is more than 40 inches. In some small eroded areas, the silty clay subsoil is at or near the surface.

Included with this soil in mapping are small areas of Bates and Ringo soils. Bates soils have a loamy subsoil. They are on the upper side slopes. Ringo soils have a calcareous subsoil. They are on the steeper side slopes. Included soils make up 10 to 15 percent of the map unit.

Permeability is slow in the Eram soil, and available water capacity is low. Surface runoff is medium. The surface layer is friable, and tilth is fair. A perched seasonal high water table is at a depth of about 1 to 2 feet in winter and in early spring. Reaction ranges from strongly acid to neutral in the subsoil and varies widely in the surface layer as a result of local liming practices. Root penetration is restricted by the bedrock at a depth of 20 to 40 inches. The shrink-swell potential is high in the subsoil.

About half of the acreage is used for cultivated crops. The rest is used mainly as range or pasture. This soil is moderately well suited to soybeans, grain sorghum, wheat, and legumes. Water erosion is a hazard if cultivated crops are grown. A system of conservation tillage that leaves all or part of the crop residue on the surface, terraces, grassed waterways, and contour farming help to prevent excessive soil loss. Returning crop residue to the soil improves tilth and fertility and increases the rate of water infiltration.

This soil is suited to range and pasture plants for hay or grazing. Water erosion is a hazard in overused areas and in areas where the pasture is becoming established. An adequate plant cover on the established pastures and mulch in the seeded areas help to prevent excessive soil loss, reduce the runoff rate, and conserve moisture. Applications of fertilizer are generally needed in the pastured areas. Gullies form along some cattle trails. Fencing and other means of controlling livestock traffic patterns help to prevent gullying and give gullies time to revegetate.

This soil is poorly suited to dwellings because the shrink-swell potential is a limitation. Also, the wetness is a limitation on sites for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material around the foundations help to prevent the structural damage caused by shrinking and swelling and by wetness.

Because of the depth to bedrock, the wetness, and the slow permeability, this soil is generally unsuited to septic tank absorption fields. It is poorly suited to sewage lagoons because of the depth to bedrock. Suitable sites for lagoons are generally available in areas where the depth to bedrock is more than 40 inches.

The land capability classification is IIIe, and the range site is Clay Upland.

Ec—Eram silt loam, 3 to 7 percent slopes. This moderately deep, moderately sloping, moderately well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 15 to 200 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 9 inches thick. The subsoil is about 15 inches thick. The upper part is dark brown, firm silty clay loam, and the lower part is brown, mottled, very firm silty clay. Soft shale is at a depth of about 24 inches. In some places the dark surface layer is thinner. In other places the depth to shale is more than 40 inches. In some small eroded areas, the silty clay part of the subsoil is at or near the surface.

Included with this soil in mapping are small areas of Bates and Ringo soils and areas of deep soils that are below limestone escarpments and that may be calcareous. Bates soils have a loamy subsoil. They are on the upper side slopes. Ringo soils have calcareous subsoil. They on the steeper side slopes. Also included are a few areas of soils that are less than 20 inches deep over shale. These soils are on the upper side slopes. Included soils make up 5 to 15 percent of the map unit.

Permeability is slow in the Eram soil, and available water capacity is low. Surface runoff is rapid. The surface layer is friable, and tilth is fair. A perched seasonal high water table is at a depth of about 1 to 2 feet in winter and in early spring. Reaction ranges from strongly acid to neutral in the subsoil and varies widely in the surface layer as a result of local liming practices. Root penetration is restricted by the bedrock at a depth of 20 to 40 inches. The shrink-swell potential is high in the subsoil.

Most of the acreage is used as range. The rest is used for cultivated crops or pasture. This soil is poorly suited to cultivated crops. Water erosion is a hazard if cultivated crops are grown. Close-growing crops, such as wheat and legumes, provide the best protection against erosion. A system of conservation tillage that leaves all or part of the crop residue on the surface, terraces, grassed waterways, and contour farming help to prevent excessive soil loss. Soil depth should be considered when a terrace system is designed. If the bedrock is exposed during the construction of waterways or terrace channels, a layer of topsoil is needed. Returning crop residue to the soil improves tilth and fertility and increases the rate of water infiltration.

This soil is suited to range and pasture plants for hay or grazing. Water erosion is a hazard in overused areas and in areas where the pasture is becoming established. An adequate plant cover on the established pastures and mulch in the seeded areas help to prevent excessive soil loss, reduce the runoff rate, and conserve moisture. Applications of fertilizer are generally needed in the pastured areas. Gullies form along some cattle trails. Fencing and other means of controlling livestock traffic patterns help to prevent gullying and give gullies time to revegetate.

This soil is poorly suited to dwellings because the shrink-swell potential is a limitation. Also, the wetness is a limitation on sites for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material around the foundations help to prevent the damage caused by shrinking and swelling and by wetness.

Because of the depth to bedrock, the wetness, and the slow permeability, this soil is generally unsuited to septic tank absorption fields. It is poorly suited to sewage lagoons because of the depth to bedrock. Suitable sites for lagoons are generally available in areas where the depth to bedrock is more than 40 inches. Some land shaping may be needed to keep surface water away from the lagoon.

The land capability classification is IVe, and the range site is Clay Upland.

Ef—Eram silty clay loam, 3 to 7 percent slopes, eroded. This moderately deep, moderately sloping, moderately well drained soil is on low knolls and side slopes in the uplands. Sheet erosion has removed more than half of the original surface layer in most places. In a few places, the subsoil is exposed and some rills and gullies have formed. The rills and gullies can be crossed by farm equipment. Individual areas are irregular in shape or long and narrow and range from 10 to 100 acres in size.

Typically, the surface layer is dark brown silty clay loam about 4 inches thick. The subsoil is dark grayish brown, mottled, firm silty clay about 17 inches thick. Soft, clayey shale is at a depth of about 21 inches.

Included with this soil in mapping are small areas of Bates and Ringo soils. Bates soils have a loamy subsoil. They are on the upper side slopes. Ringo soils have a calcareous subsoil. They are on the steeper side slopes. Included soils make up 5 to 15 percent of the map unit.

Permeability is slow in the Eram soil, and available water capacity is low. Surface runoff is rapid. A perched seasonal high water table is at a depth of about 1 to 2 feet in winter and in early spring. Reaction is medium acid or slightly acid in the surface layer and ranges from strongly acid to neutral in the subsoil. Root penetration is restricted by the bedrock at a depth of 20 to 30 inches. The shrink-swell potential is high in the subsoil.

Almost all areas are used as range or pasture. Because of the hazard of further water erosion, this soil is generally not used for cultivated crops. It is better suited to range. Establishing pasture is difficult because of poor tilth. Erosion is a hazard in overused areas and in areas where the pasture is becoming established. An adequate plant cover on the established pastures and mulch in the seeded areas help to prevent excessive soil loss, reduce the runoff rate, and conserve moisture. Applications of fertilizer are generally needed in the pastured areas. Gullies form along some cattle trails. Fencing and other means of controlling livestock traffic patterns help to prevent gullying and give gullies time to revegetate. Land shaping commonly is needed in areas where gullies have formed.

This soil is poorly suited to dwellings because the shrink-swell potential is a limitation. Also, the wetness is a limitation on sites for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material around the foundations help to prevent the structural damage caused by shrinking and swelling and by wetness.

Because of the depth to bedrock, the wetness, and the slow permeability, this soil is generally unsuited to septic tank absorption fields. It is poorly suited to sewage lagoons because of the depth to bedrock. Suitable sites for lagoons are generally available in the included areas where the depth to bedrock is more than 40 inches. Some land shaping may be needed to keep surface water away from the lagoon.

The land capability classification is IVe, and the range site is Clay Upland.

Gr—Girard silty clay loam, frequently flooded. This moderately deep, nearly level, poorly drained soil is on narrow flood plains. Individual areas are long and narrow and range from 20 to 80 acres in size.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer also is black silty clay loam. It is about 5 inches thick. The subsoil is very firm silty clay about 12 inches thick. The upper part is black, and the lower part is very dark grayish brown. Hard, fractured limestone is at a depth of about 26 inches. In a few small areas, the soil is deep over limestone.

Included with this soil in mapping are small areas of the shallow Shidler soils. These soils are in landscape positions similar to those of the Girard soil. They make up about 5 percent of the map unit.

Permeability is slow in the Girard soil, and available water capacity is low. Surface runoff is slow. A seasonal high water table is within a depth of about 2 feet in winter and in early spring. Reaction is medium acid to neutral in the surface layer and typically is slightly acid to mildly alkaline in the subsoil. Root penetration is restricted by the bedrock at a depth of 20 to 40 inches. The shrink-swell potential is high in the subsoil.

All areas are used as range. Because of the wetness and the frequent flooding, this soil is generally unsuited to cultivated crops. It is better suited to range. No major problems affect the use of the soil as range. The flooding and the wetness can be problems, however, in the spring.

This soil is unsuited to building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is Vw, and the range site is Clay Lowland.

Iv—Ivan silt loam, occasionally flooded. This deep, nearly level, well drained soil is on flood plains. Individual areas are irregular in shape and range from 30 to more than 160 acres in size.

Typically, the surface layer is very dark grayish brown, calcareous silt loam about 9 inches thick. The subsurface layer is very dark grayish brown, calcareous silty clay loam about 15 inches thick. The next layer is dark brown, firm, calcareous silty clay loam about 16 inches thick. The substratum to a depth of about 60 inches is dark brown, calcareous silt loam. In places the soil is noncalcareous.

Permeability is moderate, and available water capacity is high. Surface runoff is slow. The surface layer is friable, and tilth is good. The soil generally is moderately alkaline throughout, but in places the surface layer is mildly alkaline. The shrink-swell potential is moderate below the surface layer.

Most areas are used for cultivated crops. A few small areas are used as woodland. This soil is well suited to corn, soybeans, wheat, grain sorghum, and alfalfa. The flooding can damage crops and can delay spring planting in some years. Terraces and conservation tillage on the adjacent uplands help to control flooding on this soil. Crop rotations help to control weeds, plant diseases, and insect carry-over.

This soil is suited to trees. It can produce commercial timber crops. Plant competition and flooding are management concerns. Tree cuttings and seedlings can be successfully established if competing vegetation is controlled by adequate site preparation, by controlled burning or spraying, and by selective cutting. Important species include bur oak, red oak, hackberry, black walnut, green ash, and pecan.

Fringe areas where cropland, grassland, and woodland are adjacent to each other provide habitat for many wildlife species, including deer, squirrel, racoon, bobwhite quail, and numerous songbirds. Good woodland and grassland management can increase the wildlife population.

This soil is generally unsuited to building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is IIw, and the range site is Loamy Lowland.

Ke—Kenoma silt loam, 1 to 3 percent slopes. This deep, gently sloping, moderately well drained soil is on the broad tops of ridges in the uplands. Individual areas are irregular in shape and range from 20 to 800 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 9 inches thick (fig. 7). The subsoil is very firm and extremely firm silty clay about 35 inches thick. The upper part is dark brown and mottled, and the lower part is brown. The substratum to a depth of about 60 inches is mixed yellowish brown and gray, very firm silty clay. In some areas the upper part of the subsoil is friable silty clay loam. In other areas the subsoil is grayer. In some small eroded areas, the silty clay subsoil is at or near the surface.

Included with this soil in mapping are small areas of Catoosa, Dwight, and Olpe soils. The moderately deep Catoosa soils are lower on the landscape than the Kenoma soil. Dwight soils are affected by sodium salts. They are in the more nearly level areas. Olpe soils have a gravelly subsoil. They are in rolling areas. Included soils make up 5 to 15 percent of the map unit.

Permeability is very slow in the Kenoma soil, and available water capacity is high. Surface runoff is medium. The surface layer is friable, and tilth is good. Reaction typically ranges from medium acid to mildly alkaline in the subsoil and varies widely in the surface layer as a result of local liming practices. The shrink-swell potential is high in the subsoil.

About three-fourths of the acreage is used for cultivated crops. The rest is used as range or pasture. This soil is moderately well suited to soybeans, grain sorghum, wheat, and legumes. Water erosion is a hazard if cultivated crops are grown. Because of the dense, clayey subsoil, both seasonal wetness and seasonal droughtiness are limitations. A system of conservation tillage that leaves all or part of the crop residue on the surface, terraces, grassed waterways, and contour farming help to prevent excessive soil loss. Returning crop residue to the soil improves tilth and fertility and increases the rate of water infiltration.

This soil is suited to range and pasture plants for hay or grazing. Water erosion is a hazard in overused areas and in areas where the pasture is becoming established. An adequate plant cover on the established pastures

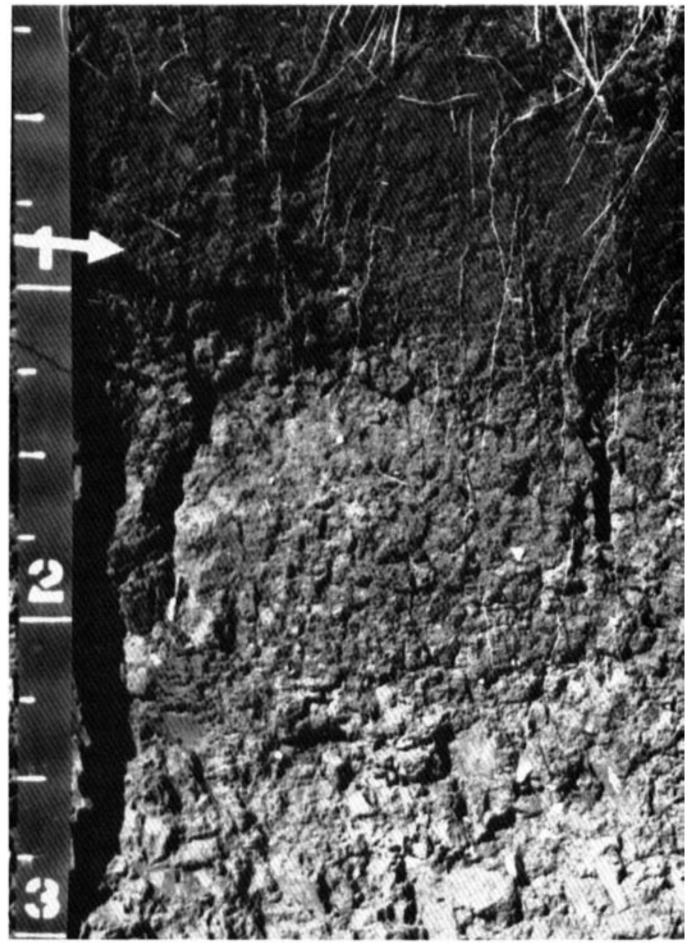


Figure 7.—Profile of Kenoma silt loam, 1 to 3 percent slopes. The dark surface layer is about 9 inches thick. Depth is marked in feet.

and mulch in the seeded areas help to prevent excessive soil loss, reduce the runoff rate, and conserve moisture. Applications of fertilizer are generally needed in the pastured areas. Gullies form along some cattle trails. Fencing and other means of controlling livestock traffic patterns help to prevent gullying and give gullies time to revegetate.

This soil is poorly suited to dwellings because the shrink-swell potential is a limitation. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable course textured material around the foundations help to prevent the structural damage caused by shrinking and swelling.

Because of the very slow permeability, this soil is generally unsuited to septic tank absorption fields. It is moderately well suited to sewage lagoons because of the slope. Some land shaping may be needed to overcome the slope.

The land capability classification is IIIe, and the range site is Clay Upland.

Ko—Kenoma-Olpe silt loams, 2 to 7 percent slopes. These deep, moderately sloping soils are on uplands. The moderately well drained Kenoma soil is on foot slopes. The well drained Olpe soil is on ridgetops and the upper side slopes. Individual areas are irregular in shape and range from 20 to 160 acres in size. They are about 50 percent Kenoma soil and 35 percent Olpe soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Kenoma soil has a surface layer of very dark grayish brown silt loam about 8 inches thick. The subsoil is very firm and extremely firm silty clay about 38 inches thick. The upper part is dark brown and mottled, the next part is mixed dark yellowish brown and reddish brown, and the lower part is olive brown. Soft shale is at a depth of about 46 inches.

Typically, the Olpe soil has a surface layer of very dark grayish brown silt loam about 8 inches thick. The subsoil extends to a depth of more than 60 inches. In sequence downward, it is dark brown, firm silty clay loam; dark reddish brown, very firm very gravelly and extremely gravelly silty clay; brown, mottled, very firm extremely gravelly silty clay; and yellowish brown, very firm gravelly silty clay (fig. 8).

Included with these soils in mapping are small areas of the moderately deep Eram soils and small areas of gravelly soils that are underlain by limestone bedrock at a depth of 10 to 20 inches. Also included are limestone outcrops. Included areas are in positions on the landscape similar to those of the Olpe soil. They make up about 15 percent of the map unit.

Permeability is very slow in Kenoma soil and slow in Olpe soil. Surface runoff is medium on the Kenoma soil and rapid on the Olpe soil. Available water capacity is high in the Kenoma soil and low in the Olpe soil. The surface layer of both soils is friable, and tilth is good. Reaction typically ranges from medium acid to mildly alkaline in the subsoil and varies widely in the surface layer as a result of local liming practices. The shrink-swell potential is high in the subsoil of the Kenoma soil and moderate in the subsoil of the Olpe soil.

Most areas are used as range. A few small areas are used for cultivated crops or pasture. These soils are

Figure 8.—Erratic gravel line and gravel pockets in the Olpe soil in an area of Kenoma-Olpe silt loams, 2 to 7 percent slopes.

poorly suited to cultivated crops. If cultivated crops are grown, water erosion is a hazard on both soils. Droughtiness is a limitation on the Olpe soil. Close-growing crops, such as wheat and legumes, provide the best protection against erosion. A system of conservation tillage that leaves all or part of the crop residue on the surface, terraces, grassed waterways, and contour farming help to prevent excessive soil loss. Returning crop residue to the soil improves tilth and fertility and increases the rate of water infiltration.

This soil is suited to range and pasture plants for hay or grazing. Water erosion is a hazard in overused areas and in areas where the pasture is becoming established. An adequate plant cover on the established pastures and mulch in the seeded areas help to prevent excessive soil loss, reduce the runoff rate, and conserve moisture. Applications of fertilizer are generally needed in the pastured areas. Gullies form along some cattle trails. Fencing and other means of controlling livestock traffic patterns help to prevent gullying and give gullies time to revegetate.

These soils are poorly suited to dwellings because the shrink-swell potential is a limitation. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material around the foundations help to prevent the structural damage caused by shrinking and swelling.

Because of the very slow or slow permeability, these soils are generally unsuited to septic tank absorption fields. They are only moderately well suited to sewage lagoons because of the slope of both soils and seepage in the Olpe soil. Some land shaping is needed to overcome the slope. Seepage can be controlled by sealing the floor and walls of the lagoon.

The land capability classification is IVe. The Kenoma soil is in the Clay Upland range site, and the Olpe soil is in the Loamy Upland range site.

La—Lanton silt loam, occasionally flooded. This deep, nearly level, somewhat poorly drained soil is on low terraces and flood plains along streams. Individual areas are long and narrow or irregular in shape and range from 40 to 200 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 7 inches thick. The subsurface layer is very dark gray, mottled, firm silty clay loam about 30 inches thick. The substratum to a depth of about 60 inches is dark gray, mottled silty clay. In some places the surface layer is silty clay loam. In other places the subsurface layer has no mottles.

Included with this soil in mapping are small areas of Mason and Osage soils. The well drained Mason soils are on the slightly higher terraces. The poorly drained Osage soils are in broad, slightly concave areas. They are more clayey throughout than the Lanton soil. Also included are small areas of soils that have a silt loam surface layer and a silty clay subsoil. These soils are in positions on the landscape similar to those of the Lanton soil. Included soils make up 5 to 10 percent of the map unit.

Permeability is slow in the Lanton soil, and available water capacity is high. Surface runoff is slow. A perched seasonal high water table is at a depth of about 1 to 2 feet in winter and in early spring. The surface layer is firm, and tilth is fair. Reaction is slightly acid or neutral in the subsurface layer and varies widely in the surface layer as a result of local liming practices. The shrink-swell potential is moderate in the substratum.

Most areas are used for cultivated crops. Some are used as range, pasture, or woodland. This soil is well suited to soybeans, grain sorghum, corn, wheat, and legumes. Flooding and prolonged wetness can damage crops and can delay spring planting in some years. Drainage ditches help to remove excess water. Terraces and conservation tillage on the adjacent uplands help to control flooding on this soil. Crop rotations help to control weeds, plant diseases, and insect carry-over.

This soil is suited to range and pasture plants for hay or grazing. Grazing when the soil is too wet causes surface compaction and poor tilth. Restricted use during wet periods helps to keep the soil in good condition. Applications of fertilizer are generally needed in the pastured areas.

This soil is suited to trees. Plant competition, seedling mortality, and the equipment limitation are management concerns. Tree cuttings and seedlings can be successfully established if competing vegetation is controlled by adequate site preparation, by controlled burning or spraying, and by selective cutting. Equipment should be used only during dry periods. Important species include green ash, hackberry, eastern cottonwood, bur oak, and walnut.

This soil is generally unsuited to building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is IIw, and the range site is Loamy Lowland.

Ma—Mason silt loam. This deep, nearly level, well drained soil is on stream terraces. It is subject to rare flooding, which lasts for very brief periods. Individual areas are long and narrow or irregular in shape and range from 40 to 200 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 9 inches thick. The subsurface layer is dark brown, friable silt loam about 5 inches thick. The subsoil to a depth of more than 60 inches is dark brown, firm silty clay loam. In places the soil is more sloping.

Included with this soil in mapping are small areas of Lanton and Osage soils. The somewhat poorly drained Lanton soils are in the slightly lower areas on the flood plains. The poorly drained Osage soils are in the lower, slightly concave areas on the flood plains. They are more clayey throughout than the Mason soil. Included soils make up 5 to 10 percent of the map unit.

Permeability is moderately slow in the Mason soil, and available water capacity is high. Surface runoff is slow. The surface layer is friable, and tilth is good. Reaction typically is slightly acid to strongly acid in the subsoil and varies widely in the surface layer as a result of local liming practices. The shrink-swell potential is moderate in the subsoil.

Most areas are used for cultivated crops. A few small areas are used as woodland or pasture. This soil is well suited to legumes, soybeans, grain sorghum, corn, and wheat. Minimizing tillage and leaving crop residue on the surface help to maintain tilth and fertility. Crop rotations help to control weeds, plant diseases, and insects.

This soil is suited to range and pasture plants for hay or grazing. No major hazards or limitations affect these uses.

This soil is suited to trees. Tree seeds, cuttings, and seedlings can be successfully established if competing vegetation is controlled by adequate site preparation, by controlled burning or spraying, and by selective cutting. The dominant species are hackberry, bur oak, green ash, black walnut, and American elm.

The wooded areas along streams add to the vegetative diversity of the county. The wildlife population can be increased by increasing the number of fringe areas where woodland joins cropland or grassland. These areas provide food and shelter for wildlife.

This soil is poorly suited to dwellings because of the flooding. The highest areas on the landscape should be selected as sites for buildings. Levees and dikes help to overcome the hazard of flooding.

This soil is well suited to sewage lagoons that are protected from floodwater. It is poorly suited to septic tank absorption fields because the moderately slow permeability restricts the absorption of effluent. Enlarging the absorption field helps to overcome this limitation.

This land capability classification is I, and the range site is Loamy Lowland.

Nd—Niotaze-Darnell complex, 4 to 30 percent slopes. These moderately sloping to moderately steep soils are on uplands. The moderately deep, somewhat poorly drained Niotaze soil is on the steeper, lower side slopes. The shallow, well drained Darnell soil is on the less sloping, upper side slopes. Individual areas are long and narrow or irregular in shape and range from 20 to 400 acres in size. They are about 45 percent Niotaze soil and 40 percent Darnell soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Niotaze soil has a surface layer of dark brown cobbly fine sandy loam about 5 inches thick. The subsurface layer is brown cobbly fine sandy loam about 4 inches thick. The subsoil is very firm silty clay about 27 inches thick. The upper part is yellowish red, and the lower part is dark brown and mottled. Silty shale is at a depth of about 36 inches.

Typically, the Darnell soil has a surface layer of dark brown fine sandy loam about 6 inches thick. The subsoil is dark yellowish brown, friable fine sandy loam about 11 inches thick. Soft sandstone is at a depth of about 17 inches. In places the depth to sandstone is less than 10 inches.

Included with these soils in mapping are small areas of Stephenville soils and sandstone outcrops. The moderately deep Stephenville soils are on ridgetops. Included areas make up about 15 percent of the map unit.

Permeability is slow in the Niotaze soil and moderately rapid in the Darnell soil. Available water capacity is low in the Niotaze soil and very low in the Darnell soil. Surface runoff is rapid on both soils. The Niotaze soil has a perched seasonal high water table at a depth of about 1 to 2 feet in winter and spring. Both soils typically are slightly acid to strongly acid throughout. Root penetration is restricted by bedrock at a depth of 20 to 40 inches in the Niotaze soil and 10 to 20 inches in the Darnell soil. The shrink-swell potential is high in the subsoil of the Niotaze soil and low in the Darnell soil.

Nearly all areas are used as range. Most are covered with oak and an understory of shrubs and grasses. Because of a severe hazard of water erosion on both soils and the shallow depth to bedrock in the Darnell soil, these soils are generally unsuited to cultivated crops. They are better suited to range. Water erosion is a hazard in overused areas, and additional invasion by woody plants is a concern in all areas. A good vegetative cover and ground mulch help to prevent excessive soil loss, reduce the runoff rate, and conserve moisture. The woody vegetation can be controlled by spraying or by selective cutting. Gullies form along some cattle trails. Fencing and other means of controlling livestock traffic patterns help to prevent gullying and give gullies time to revegetate.

The diverse vegetation of trees, shrubs, and grasses provides good habitat for many species of wildlife, including deer, quail, wild turkey, songbirds, and fur-bearing animals.

These soils are poorly suited to dwellings. The slope of both soils, the wetness and high shrink-swell potential of the Niotaze soil, and the shallow depth to bedrock in the Darnell soil are limitations. The less sloping parts of the landscape should be selected as sites for dwellings. The deeper soils should be selected as sites for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material around the foundations help to prevent the structural damage caused by shrinking and swelling and by wetness.

Mainly because of the slope and the depth to bedrock, these soils are generally unsuited to onsite sewage disposal. Some areas on the adjacent foot slopes are suitable sites.

The land capability classification is VIe. The Niotaze soil is in the Savannah range site, and the Darnell soil is in the Shallow Savannah range site.

Or—Osage silty clay loam, occasionally flooded. This deep, nearly level, poorly drained soil is on flood plains. Individual areas are irregular in shape and range from 40 to 400 acres in size.

Typically, the surface layer is very dark gray silty clay loam about 11 inches thick. The subsoil to a depth of more than 60 inches is black and very dark gray, extremely firm silty clay. In places the surface layer is silty clay.

Included with this soil in mapping are small areas of Lanton and Verdigris soils. Lanton soils are slightly higher on the landscape than the Osage soil and are mainly along the larger creeks. Verdigris soils are adjacent to stream channels. Both of these soils are less clayey than the Osage soil. They make up 5 to 10 percent of the map unit.

Permeability is very slow in the Osage soil, and available water capacity is moderate. Surface runoff is slow. A seasonal high water table is within a depth of about 1 foot in winter and in early spring. The surface layer is firm, and tilth is poor. Reaction typically is slightly acid to mildly alkaline in the subsoil and varies widely in the surface layer as a result of local liming practices. The shrink-swell potential is very high in the subsoil.

Most areas are used for cultivated crops. A few are used as pasture or woodland. This soil is well suited to legumes, soybeans, grain sorghum, corn, and wheat. The wetness and the flooding can delay farming and reduce yields. Field drainage ditches, a bedding system, or land leveling may be needed to remove excess surface water. Deep chiseling improves internal drainage and aeration. If the soil is tilled during the fall, a seedbed can be more easily prepared during the following spring. Returning crop residue to the soil improves tilth and fertility and increases the rate of infiltration. Crop rotations help to control weeds, plant diseases, and insect carry-over.

This soil is suited to range and pasture plants for hay or grazing. Grazing when the soil is too wet causes surface compaction and poor tilth. Restricted use during wet periods helps to keep the grassland in good condition. Applications of fertilizer are generally needed in the pastured areas.

This soil is suited to trees. Plant competition, seedling mortality and the equipment limitation are management concerns. Tree cuttings and seedlings can be successfully established if competing vegetation is controlled by adequate site preparation, by controlled burning or spraying, and by selective cutting. Equipment should be used only during dry periods.

This soil is generally unsuited to building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is IIw, and the range site is Clay Lowland.

Os—Osage silty clay, occasionally flooded. This deep, nearly level, poorly drained soil is on flood plains. Individual areas are long and narrow or irregular in shape and range from 40 to several hundred acres in size.

Typically, the surface layer is black silty clay about 7 inches thick. The subsurface layer also is black silty clay. It is about 9 inches thick. The subsoil to a depth of more than 60 inches is extremely firm silty clay. The upper part is black, and the lower part is very dark grayish brown. In places the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Lanton and Verdigris soils. Lanton soils are slightly higher on the landscape than the Osage soil and are mainly along the larger creeks. Verdigris soils are adjacent to stream channels. Both of these soils are less clayey than the Osage soil. They make up 5 to 10 percent of the map unit.

Permeability is very slow in the Osage soil, and available water capacity is moderate. Surface runoff is slow. A seasonal high water table is within a depth of about 1 foot in winter and in early spring. The surface layer is very firm, and tilth is poor. Reaction typically is from slightly acid to mildly alkaline in the subsoil and varies widely in the surface layer as a result of local liming practices. The shrink-swell potential is very high throughout the soil.

Most areas are used for cultivated crops. A few are used as pasture or woodland. This soil is moderately well suited to soybeans, grain sorghum, corn, and wheat. The wetness and the flooding can delay farming and reduce yields. Field drainage ditches, a bedding system, or land leveling may be needed to remove excess surface water. Deep chiseling improves internal drainage and aeration. If the soil is tilled during the fall, a seedbed can be more easily prepared during the following spring. Returning crop residue to the soil improves tilth and fertility and increases the rate of water infiltration. Crop rotations help to control weeds, plant diseases, and insect carry-over.

This soil is suited to range and pasture plants for hay or grazing. Grazing when the soil is too wet causes surface compaction and poor tilth. Restricted use during wet periods helps to keep the grassland in good condition. Applications of fertilizer are generally needed in the pastured areas.

This soil is suited to trees. Plant competition, seedling mortality, and the equipment limitation are management concerns. Tree cuttings and seedlings can be successfully established if competing vegetation is controlled by adequate site preparation, by controlled burning or spraying, and by selective cutting. Equipment should be used only during dry periods.

This soil is generally unsuited to building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is IIIw, and the range site is Clay Lowland.

Pe—Prue loam, 2 to 5 percent slopes. This deep, moderately sloping, moderately well drained soil is on foot slopes in the uplands. Individual areas are long and narrow or irregular in shape and range from 15 to 300 acres in size.

Typically, the surface layer is very dark brown loam about 11 inches thick. The subsoil extends to a depth of more than 60 inches. The upper part is very dark brown, friable clay loam; the next part is dark brown and dark yellowish brown, firm clay loam; and the lower part is brown and yellowish brown, mottled, very firm silty clay. In some places the subsoil is more clayey. In other places the depth to bedrock is less than 40 inches.

Included with this soil in mapping are small areas of Dwight and Stephenville soils. Dwight soils have a high content of sodium. They are on the lower foot slopes. Stephenville soils have a light colored subsurface layer. They are on ridgetops. Included soils make up 5 to 10 percent of the map unit.

Permeability is moderately slow in the Prue soil, and surface runoff is medium. Available water capacity is high. The surface layer is friable, and tilth is good. Reaction typically ranges from strongly acid to mildly alkaline in the subsoil and varies widely in the surface layer as a result of local liming practices. The shrink-swell potential is high in the lower part of the subsoil.

About half of the acreage is used for cultivated crops. The rest is used mainly as range. A few areas are used as pasture. This soil is moderately well suited to wheat, grain sorghum, and soybeans. Water erosion is a hazard if cultivated crops are grown. A system of conservation tillage that leaves all or part of the crop residue on the surface, terraces, grassed waterways, and contour farming help to prevent excessive soil loss. Returning crop residue to the soil improves tilth and fertility and increases the rate of water infiltration

This soil is suited to range and pasture plants for hay or grazing. Water erosion is a hazard in overused areas and in areas where the pasture is becoming established. An adequate plant cover on the established pastures and mulch in the seeded areas help to prevent excessive soil loss, reduce the runoff rate, and conserve moisture. Applications of the fertilizer are generally needed in the pastured areas. Gullies form along some cattle trails. Fencing and other means of controlling livestock traffic patterns help to prevent gullying and give gullies time to revegetate.

This soil is well suited to dwellings without basements. It is poorly suited to dwellings with basements because the shrink-swell potential is a limitation. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse material around the foundations help to prevent the structural damage caused by shrinking and swelling.

This soil is poorly suited to septic tank absorption fields and moderately well suited to sewage lagoons. The moderately slow permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field or installing two absorption fields that are used alternately helps to overcome this limitation. Seepage and slope are limitations on sites for sewage lagoons. Sealing the floor and walls of the lagoon helps to control seepage. If the less sloping areas are selected as sites for the lagoons, less leveling and banking will be needed during construction.

The land capability classification is IIIe, and the range site is Loamy Upland.

Pt—Pits, quarries. This map unit consists of areas from which soil and some of the underlying limestone gravel or shale have been removed. The underlying material has been quarried for use in road surfacing and in the manufacturing of cement, brick, and agricultural lime. Individual areas are irregular in shape and range from 10 to 300 acres in size.

A typical quarry is a pit surrounded by vertical walls 8 to 20 feet high. Small piles of rock, shale, and gravel are around the outer edge of some quarries.

This map unit is unsuited to cultivation and to most other uses. The surface is generally bare. Scattered trees, shrubs, and clumps of grass border the quarries. Some pits contain water for livestock, and a few are used for recreational purposes.

No land capability classification or range site is assigned.

Rn—Ringo silty clay loam, 15 to 35 percent slopes. This moderately deep, moderately steep and steep, moderately well drained soil is on side slopes in the uplands. Some areas have scattered limestone rocks on the surface. Individual areas are long and narrow and range from 40 to 400 acres in size.

Typically, the surface layer is black, calcareous silty clay loam about 11 inches thick. The subsoil is about 15 inches thick. It is calcareous. The upper part is very dark grayish brown and dark grayish brown, firm silty clay loam, and the lower part is grayish brown, very firm silty clay. Soft, calcareous shale is at a depth of about 26 inches.

Included with this soil in mapping are small areas of Eram and Shidler soils. Eram soils are noncalcareous. They are on the less sloping side slopes. The shallow Shidler soils are on ridgetops. Also included are soils that formed in noncalcareous shale. Included soils make up 5 to 15 percent of the map unit.

Permeability is very slow in the Ringo soil, and available water capacity is low. Surface runoff is very rapid. Reaction ranges from slightly acid to moderately alkaline throughout the profile. Root penetration is restricted by the bedrock at a depth of 20 to 40 inches. The shrink-swell potential is high in the subsoil.

Most areas are used as range. Because of a severe hazard of water erosion, this soil is generally unsuited to cultivated crops. It is better suited to range. Water erosion is a hazard in overused areas. A good vegetative cover and ground mulch help to prevent excessive soil loss, reduce the runoff rate, and conserve moisture. Gullies form along some cattle trails. Fencing and other means of controlling livestock traffic patterns help to prevent gullying and give gullies time to revegetate.

This soil is generally unsuited to building site development, mainly because of the slope. The less sloping adjacent soils are better sites for buildings and sanitary facilities.

The land capability classification is VIIe, and the range site is Clay Upland.

Rs—Ringo-Shidler silty clay loams, 3 to 15 percent slopes. These moderately sloping and strongly sloping soils are on uplands that generally are dissected by drainageways. The moderately deep, moderately well drained Ringo soil is on side slopes. The shallow, well drained Shidler soil is on ridgetops. Individual areas are irregular in shape and range from 20 to 400 acres in size. They are about 60 percent Ringo soil and 25 percent Shidler soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Ringo soil has a surface layer of black, calcareous silty clay loam about 11 inches thick. The subsoil is about 15 inches thick. It is calcareous. The upper part is very dark grayish brown and dark grayish brown, firm silty clay loam, and the lower part is grayish brown, very firm silty clay. Soft, calcareous shale is at a depth of about 26 inches.

Typically, the Shidler soil has a surface layer of very dark grayish brown silty clay loam about 10 inches thick. Hard limestone bedrock is at a depth of about 10 inches.

Included with these soils in mapping are small areas of Catoosa soils, soils that formed in noncalcareous shale, soils that have a subsoil of reddish silty clay, and soils that have a slope of more than 15 percent. The moderately deep Catoosa soils are higher on the landscape than the Shidler soil. Also included are areas where limestone crops out in narrow bands along hilltops. Included areas make up about 15 percent of the map unit.

Permeability is very slow in the Ringo soil and moderate in the Shidler soil. Available water capacity is low in the Ringo soil and very low in the Shidler soil. Surface runoff is rapid on the Ringo soil and medium on the Shidler soil. Reaction ranges from slightly acid to moderately alkaline throughout both soils. Root development is restricted by the bedrock at a depth of 20 to 40 inches in the Ringo soil and 4 to 20 inches in the Shidler soil. The shrink-swell potential is high in the subsoil of the Ringo soil and moderate in the Shidler soil.

Nearly all areas are used as range. Because of a severe hazard of water erosion on both soils and the shallow depth to bedrock in the Shidler soil, these soils are generally unsuited to cultivated crops. They are better suited to range. Water erosion is a hazard in overused areas, and the invasion of woody plants is a concern in all areas. A good vegetative cover and ground mulch help to prevent excessive soil loss, reduce the runoff rate, and conserve moisture. The woody vegetation can be controlled by spraying or by selective cutting. Gullies form along some cattle trails. Fencing and other means of controlling livestock traffic patterns help to prevent gullying and give gullies time to revegetate.

The Ringo soil is poorly suited to dwellings because the shrink-swell potential is a limitation. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material around the foundations help to prevent the damage caused by shrinking and swelling.

Because of the depth to bedrock and the slow permeability, the Ringo soil is generally unsuited to septic tank absorption fields. It is poorly suited to sewage lagoons because of the slope and the depth to bedrock. Some land shaping may be needed to keep surface water away from the lagoon.

Because of the depth to bedrock, the Shidler soil is generally unsuited to building site development.

The land capability classification is VIe. The Ringo soil is in the Clay Upland range site, and the Shidler soil is in the Shallow Limy range site.

Sc—Shidler-Catoosa complex, 1 to 8 percent slopes. These well drained soils are on the tops of ridges in the uplands. The shallow, moderately sloping Shidler soil is lower on the ridges than the moderately deep, gently sloping Catoosa soil. Individual areas are irregular in shape and range from 20 to more than 1,000 acres in size. They are about 70 percent Shidler soil and 20 percent Catoosa soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Shidler soil has a surface layer of very dark brown silty clay loam about 10 inches thick. Hard limestone bedrock is at a depth of about 10 inches.

Typically, the Catoosa soil has a surface layer of very dark brown silt loam about 8 inches thick. The subsoil is dark brown and dark reddish brown, firm silty clay loam about 18 inches thick. Hard limestone bedrock is at a depth of about 26 inches. In places the depth to bedrock is more than 40 inches.

Included with these soils in mapping are small areas of Apperson, Girard, and Ringo soils. Apperson and Girard soils have a clayey subsoil. They are generally along drainageways. Ringo soils are underlain by shale. They are mainly in strongly sloping to steep areas on side slopes below limestone ledges. Also included are areas where limestone crops out. Included areas make up about 10 percent of the map unit.

Permeability is moderate in the Shidler and Catoosa soils, and surface runoff is medium. Available water capacity is very low in the Shidler soil and moderate in the Catoosa soil. Root penetration is restricted by the bedrock at a depth of 4 to 20 inches in the Shidler soil and 20 to 40 inches in the Catoosa soil. Reaction ranges from slightly acid to moderately alkaline throughout the Shidler soil. It ranges from strongly acid to neutral in the subsoil of the Catoosa soil. The shrink-swell potential is moderate in both soils.

Most areas are used as range. Because of a severe hazard of water erosion on both soils and the shallow depth to bedrock in the Shidler soil, these soils are generally unsuited to cultivated crops. They are better suited to range. Water erosion is a hazard in overused areas, and the invasion of woody plants is a concern in all areas. A good vegetative cover and ground mulch help to prevent excessive soil loss, reduce the runoff rate, and conserve moisture. The woody vegetation can be controlled by spraying or by selective cutting. Gullies form along some cattle trails. Fencing and other means of controlling livestock traffic patterns help to prevent gullying and give gullies time to revegetate.

Because of the depth to bedrock, the Catoosa soil is generally unsuited to dwellings with basements. It is only moderately well suited to dwellings without basements because of the shrink-swell potential and the depth to bedrock. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material around the foundations help to prevent the structural damage caused by shrinking and swelling. Adding fill material helps to overcome the limited depth to bedrock.

The Catoosa soil is poorly suited to septic tank absorption fields and sewage lagoons because of the depth to bedrock. The deeper soils on the adjacent foot slopes are better sites for lagoons.

The Shidler soil is generally unsuited to building site development because of the shallow depth to bedrock.

The land capability classification is VIe. The Shidler soil is in the Shallow Limy range site, and the Catoosa soil is in the Loamy Upland range site.

Sf—Steedman gravelly silt loam, 4 to 25 percent slopes, stony. This moderately deep, moderately sloping to moderately steep, moderately well drained soil is on side slopes and ridgetops in the uplands. Numerous scattered sandstone rocks are on the surface. They are irregular in shape and range from 3 inches to 2 feet in diameter. They cover less than 1 percent of the surface and are 2 to 6 feet apart. Individual areas are irregular in shape and range from 15 to several hundred acres in size.

Typically, the surface layer is very dark grayish brown gravelly silt loam about 8 inches thick. The subsoil is dark brown and dark yellowish brown, very firm silty clay about 24 inches thick. Soft, clayey shale is at a depth of about 32 inches. In places the dark surface layer is thicker.

Included with this soil in mapping are small areas of Bates and Collinsville soils. These soils are in positions on the landscape similar to those of the Steedman soil. Bates soils have a loamy subsoil. Collinsville soils are shallow. Also included are small areas where fractured sandstone crops out. Included areas make up 5 to 10 percent of the map unit.

Permeability is slow in the Steedman soil, and available water capacity is low. Surface runoff is rapid. A perched seasonal high water table is at a depth of 0.5 to 1.0 foot in winter and in early spring. Root penetration is restricted by the bedrock at a depth of 20 to 40 inches. Reaction is slightly acid to strongly acid in the surface layer and typically ranges from medium acid to mildly alkaline in the subsoil. The shrink-swell potential is high in the subsoil.

Nearly all areas are used as range. Because water erosion is a severe hazard and the surface stones interfere with tillage, this soil is generally unsuited to cultivated crops. It is better suited to range. Water erosion is a hazard in overused areas, and the invasion of woody plants is a concern in all areas. A good vegetative cover and ground mulch help to prevent excessive soil loss, reduce the runoff rate, and conserve moisture. The woody vegetation can be controlled by spraying or by selective cutting. Gullies form along some cattle trails. Fencing and other means of controlling livestock traffic patterns help to prevent gullying and give gullies time to revegetate.

This soil is poorly suited to dwellings because the shrink-swell potential and the wetness are limitations. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material around the foundations help to prevent the structural damage caused by shrinking and swelling and by wetness.

Because of the depth to bedrock, the wetness, and the slow permeability, this soil is generally unsuited to septic tank absorption fields. It is poorly suited to sewage lagoons because of the depth to bedrock and the slope. The included areas where the depth to bedrock is more than 40 inches are better sites for lagoons. Some land shaping is needed to overcome the slope.

The land capability classification is VIe, and the range site is Loamy Upland.

Sm—Stephenville-Darnell fine sandy loams, 2 to 6 percent slopes. These moderately sloping, well drained soils are on the tops of ridges in the uplands. The moderately deep Stephenville soil is less sloping than the shallow Darnell soil and is higher on the landscape. Individual areas are irregular in shape and range from 50 to 200 acres in size. They are about 60 percent Stephenville soil and 30 percent Darnell soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Stephenville soil has a surface layer of very dark grayish brown fine sandy loam about 7 inches thick. The subsurface layer is dark yellowish brown fine sandy loam about 10 inches thick. The subsoil is reddish brown, friable sandy clay loam about 10 inches thick. Soft sandstone is at a depth of about 27 inches. In a few places the soil does not have a subsurface layer.

Typically, the Darnell soil has a surface layer of dark brown fine sandy loam about 6 inches thick. The subsoil is dark yellowish brown, friable fine sandy loam about 11 inches thick. Soft sandstone is at a depth of about 17 inches. In some places the depth to sandstone is less than 10 inches. In other places the soil has no subsoil.

Included with these soils in mapping are small areas of Niotaze and Prue soils. Niotaze soils have a clayey subsoil. They are on the steeper parts of the landscape. The deep Prue soils do not have a subsurface layer. They are on foot slopes and the lower side slopes. Also included are small areas where sandstone crops out. Included areas make up about 10 percent of the map unit.

Permeability is moderate in the Stephenville soil and moderately rapid in the Darnell soil. Available water capacity is low in the Stephenville soil and very low in the Darnell soil. Surface runoff is medium on both soils. Root penetration is restricted by the bedrock at a depth of 20 to 40 inches in the Stephenville soil and 10 to 20 inches in the Darnell soil. Both soils typically are slightly acid to strongly acid throughout. The shrink-swell potential is low.

Most areas are used as range. They are covered with oak and an understory of shrubs and grasses. A few small areas are used for orchards. Because of the hazard of water erosion on both soils and the shallow depth to bedrock in the Darnell soil, these soils are poorly suited to cultivated crops. They are better suited to range. Water erosion is a hazard in overused areas, and additional invasion by woody plants is a concern in all areas. A good vegetative cover and ground mulch help to prevent excessive soil loss, reduce the runoff rate, and conserve moisture. The woody vegetation can be controlled by spraying or by selective cutting. Gullies form along some cattle trails. Fencing and other means of controlling livestock traffic patterns help to prevent gullying and give gullies time to revegetate.

The Stephenville soil is well suited to dwellings without basements, but it is only moderately well suited to dwellings with basements because the depth to bedrock is a limitation. The rock is rippable and can be excavated.

Because of the depth to bedrock, the Stephenville soil is generally unsuited to septic tank absorption fields and is poorly suited to sewage lagoons. During the construction of lagoons, fill material should be borrowed or the bedrock ripped. Sealing the bottom of the lagoon helps to prevent excessive seepage into fractures in the bedrock. Some land shaping may be needed.

Because of the depth to bedrock, the Darnell soil is generally unsuited to onsite sewage disposal and is poorly suited to dwellings. The deeper Stephenville soil is better suited to building site development.

The land capability classification is IVe. The Stephenville soil is in the Savannah range site, and the Darnell soil is in the Shallow Savannah range site.

Sp—Stephenville-Darnell fine sandy loams, 6 to 20 percent slopes. These strongly sloping, well drained soils are on side slopes and the tops of ridges in the uplands. The moderately deep Stephenville soil is less sloping than the shallow Darnell soil and is higher on the landscape. Individual areas are irregular in shape and range from 40 to 160 acres in size. They are about 55 percent Stephenville soil and 35 percent Darnell soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Stephenville soil has a surface layer of very dark grayish brown fine sandy loam about 7 inches thick. The subsurface layer is dark yellowish brown fine sandy loam about 10 inches thick. The subsoil is reddish brown, friable sandy clay loam about 10 inches thick. Soft sandstone is at a depth of about 27 inches. In places the soil has no subsurface layer.

Typically, the Darnell soil has a surface layer of dark brown fine sandy loam about 6 inches thick. The subsoil is dark yellowish brown, friable fine sandy loam about 9 inches thick. Soft sandstone is at a depth of about 15 inches. In some places the depth to sandstone is less than 10 inches. In other places the soil has no subsoil.

Included with these soils in mapping are small areas of Niotaze and Prue soils. Niotaze soils have a clayey subsoil. They are on the steeper parts of the landscape. The deep Prue soils do not have a subsurface layer. They are on foot slopes and the lower side slopes. Also included are small areas where sandstone crops out. Included areas make up about 10 percent of the map unit.

Permeability is moderate in the Stephenville soil and moderately rapid in the Darnell soil. Available water capacity is low in the Stephenville soil and very low in the Darnell soil. Surface runoff is rapid on both soils. Root penetration is restricted by the bedrock at a depth of 20 to 40 inches in the Stephenville soil and 10 to 20 inches in the Darnell soil. Both soils typically are slightly acid to strongly acid throughout. The shrink-swell potential is low.

Nearly all areas are used as range. Most are covered with oak and an understory of shrubs and grasses. Because of a severe hazard of water erosion on both soils and the shallow depth to bedrock in the Darnell soil, these soils are generally unsuited to cultivated crops. They are better suited to range. Water erosion is a hazard in overused areas, and additional invasion by woody plants is a concern in all areas. A good vegetative cover and ground mulch help to prevent excessive soil loss, reduce the runoff rate, and conserve moisture. The woody vegetation can be controlled by spraying or by selective cutting. Gullies form along some cattle trails. Fencing and other means of controlling livestock traffic patterns help to prevent gullying and give gullies time to revegetate.

The Stephenville soil is moderately well suited to dwellings because the slope is a limitation. Also, the depth to bedrock is a limitation on sites for dwellings with basements. The rock is rippable and can be excavated. The less sloping parts of the landscape should be selected as sites for dwellings.

Because of the depth to bedrock, the Stephenville soil is generally unsuited to septic tank absorption fields. It is poorly suited to sewage lagoons because of the slope and the depth to bedrock. During the construction of lagoons, fill material should be borrowed or the bedrock ripped. Sealing the bottom of the lagoon helps to prevent excessive seepage into fractures in the bedrock. Some land shaping is needed to overcome the slope.

Because of the slope and the depth to bedrock, the Darnell soil is generally unsuited to onsite sewage disposal and is poorly suited to dwellings. The deeper Stephenville soil is better suited to building site development.

The land capability classification is VIe. The Stephenville soil is in the Savannah range site, and the Darnell soil is in the Shallow Savannah range site.

Vc—Verdigris silt loam, channeled. This deep, nearly level, moderately well drained soil is on narrow flood plains that are dissected by drainageways and meandering stream channels. It is frequently flooded for very brief periods. Individual areas are long and about 200 to 500 feet wide and range from 10 to 60 acres in size.

Typically, the surface layer is very dark brown silt loam about 10 inches thick. The subsurface layer also is very dark brown silt loam. It is about 20 inches thick. The next layer is dark brown, friable silt loam about 18 inches thick. The substratum to a depth of about 60 inches is brown silt loam. In some places the surface layer is silty clay loam, and in other places the subsurface layer and subsoil are mottled.

Included with this soil in mapping are small areas of the poorly drained Osage soils. These soils have a subsoil of silty clay. They are in swales and other concave areas. They make up 5 to 10 percent of the map unit.

Permeability is moderate in the Verdigris soil, and available water capacity is high. Surface runoff is slow. Reaction is medium acid to neutral throughout the profile. The shrink-swell potential is moderate below the surface layer.

Most areas are used as range. A few small areas are used as woodland. Because of the flooding and the meandering channels, this soil is generally unsuited to cultivated crops. It is better suited to range. Recurrent flooding, channeling, and deposition are hazards. Many areas of the range are overgrazed and are in poor condition because they are near watering facilities and shade trees, where cattle congregate. Properly located fences and salting and watering facilities help to distribute grazing more evenly.

This soil is suited to trees. Flooding limits the establishment and growth of trees. Tree seeds, cuttings, and seedlings grow well if competing vegetation is controlled or removed by adequate site preparation, by spraying, or by selective cutting. Important species include black walnut, pecan, bur oak, red oak, hackberry, eastern cottonwood, and green ash.

The wooded areas along streams add to the vegetative diversity of the county. The wildlife population can be increased by increasing the number of fringe areas where woodland joins cropland or range. These areas provide food and cover for wildlife.

This soil is unsuited to building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is Vw, and range site is Loamy Lowland.

Vf—Verdigris silt loam, occasionally flooded. This deep, nearly level, moderately well drained soil is on flood plains. In most areas it is occasionally flooded. In areas along the Verdigris River, however, it is less frequently flooded for several miles below the Toronto Reservoir, in the northern part of the county. Flooding also is less frequent for a few miles below watershed dams. Individual areas are long and narrow or irregular in shape and range from 15 to several hundred acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 14 inches thick. The next layer is dark brown, firm silty clay loam about 9 inches thick. The substratum to a depth of about 60 inches is dark brown silt clay loam. In some places the surface layer is silty clay loam. In other places the subsurface layer and subsoil are mottled. In some areas the substratum is calcareous. In a few areas the soil is stratified.

Included with this soil in mapping are small areas of the poorly drained Osage soils. These soils have a subsoil of silty clay. They are in swales and other concave areas. Also included are a few small areas of soils that are more sandy than the Verdigris soil. Included soils make up 5 to 10 percent of the map unit.

Permeability is moderate in the Verdigris soil, and available water capacity is high. Surface runoff is slow. The surface layer is friable, and tilth is good. Reaction is medium acid to neutral below the surface layer and varies widely in the surface layer as a result of local liming practices. The shrink-swell potential is moderate below the surface layer.

Most areas are cultivated. Narrow areas along streams are used as woodland, and a few small areas are used as pasture or range. This soil is well suited to legumes (fig. 9), soybeans, grain sorghum, corn, and wheat. The flooding can damage crops and can delay spring planting in some years. Terraces and conservation tillage on the adjacent uplands help to control flooding on this soil. Crop rotations help to control weeds, plant diseases, and insect carry-over.

This soil is suited to range and pasture plants for hay or grazing. Grazing when the soil is too wet causes surface compaction and poor tilth. Restricted use during wet periods helps to keep the grassland in good condition. Applications of fertilizer are generally needed in the pastured areas.

This soil is suited to trees. Flooding limits the establishment and growth of trees. Tree cuttings and seedlings grow well if competing vegetation is controlled by adequate site preparation, by spraying, or by selective cutting. Important species include black walnut, pecan, bur oak, hackberry, eastern cottonwood, and green ash.

Figure 9.—Alfalfa on Verdigris silt loam, occasionally flooded.

The wooded areas along streams add to the vegetative diversity of the county. The wildlife population can be increased by increasing the number of fringe areas where woodland joins cropland or range. These areas provide food and cover for wildlife.

This soil is generally unsuited to building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is IIw, and the range site is Loamy Lowland.

Wo—Woodson silt loam. This deep, nearly level, somewhat poorly drained soil is on the broad tops of ridges in the uplands. Individual areas are irregular in shape and range from 40 to more than 1,000 acres in size.

Typically, the surface layer is very dark gray silt loam about 8 inches thick. The subsoil is mottled, extremely firm and very firm silty clay about 42 inches thick (fig. 10). The upper part is very dark gray, and the lower part is gray. The substratum to a depth of about 60 inches is dark brown, mottled silty clay. In places the upper part of the subsoil is browner.

Included with this soil in mapping are small areas of the gently sloping Zaar soils. These soils have a clayey surface layer. They generally are on side slopes above the Woodson soil but also are in positions on the landscape similar to those of the Woodson soil. They make up 5 to 10 percent of the map unit.

Permeability is very slow in the Woodson soil, and available water capacity is high. Surface runoff is slow. A perched seasonal high water table is at a depth of about 0.5 foot to 2.0 feet in winter and spring. The surface layer is friable, and tilth is good. Reaction typically is medium acid to neutral in the subsoil and varies widely in the surface layer as a result of local liming practices. The shrink-swell potential is high in the subsoil.

Most areas are used for cultivated crops. Some are used as range or pasture. This soil is well suited to legumes, soybeans, grain sorghum, and wheat. The wetness often delays tillage in the spring. A surface drainage system is needed in some areas. Because the clayey subsoil does not release moisture readily to plants, crop yields are often reduced during periods of drought. Returning crop residue to the soil improves tilth, conserves moisture, and helps to maintain fertility.

This soil is suited to range and pasture plants for hay or grazing. Grazing when the soil is too wet causes surface compaction and poor tilth. Restricted use during wet periods helps to keep the grassland in good condition. Applications of fertilizer are generally needed in the pastured areas.

This soil is poorly suited to dwellings because the wetness and the shrink-swell potential are limitations. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material around the foundations help to prevent the structural damage caused by wetness and by shrinking and swelling.

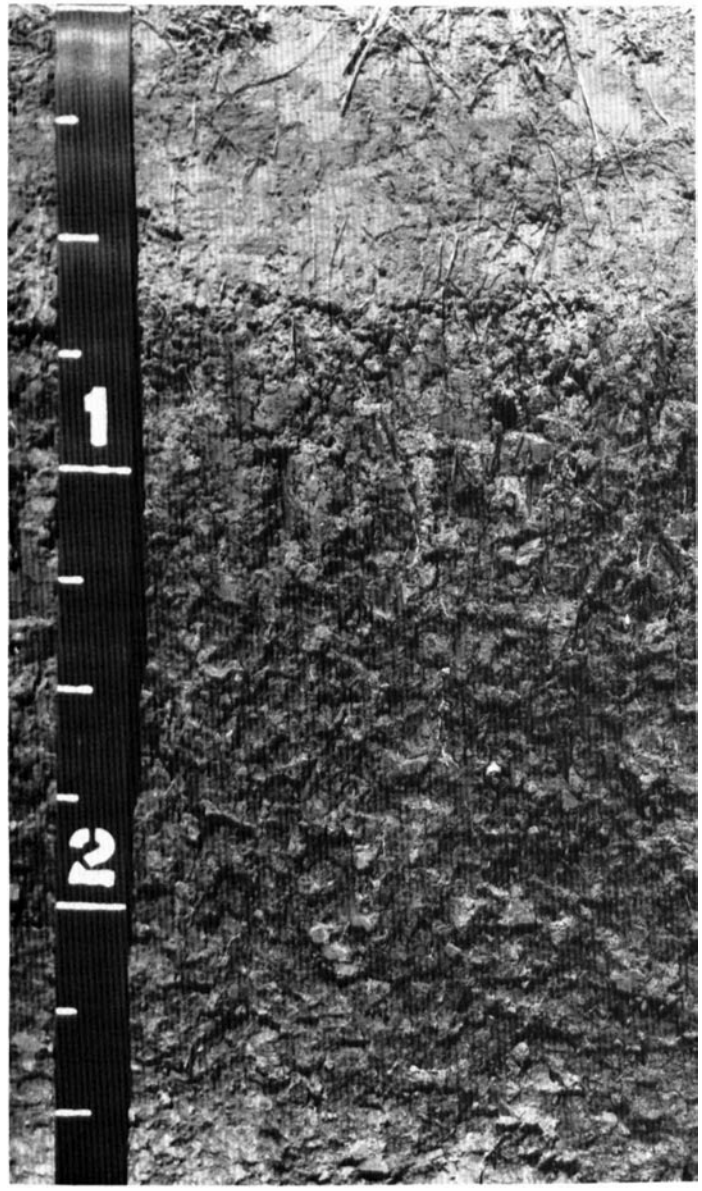


Figure 10.—Profile of Woodson silt loam, which has a dense, clayey subsoil. Depth is marked in feet.

Because of the very slow permeability and the wetness, this soil is generally unsuited to septic tank absorption fields. It is well suited to sewage lagoons.

The land capability classification is IIs, and the range site is Clay Upland.

Za—Zaar silty clay, 0 to 1 percent slopes. This deep, nearly level, somewhat poorly drained soil is on broad flats and toe slopes in the uplands. Individual areas are broad and irregular in shape and range from 50 to 700 acres in size.

Typically, the surface layer is black silty clay about 5 inches thick. The subsurface layer is black silty clay about 10 inches thick. The subsoil is mottled, extremely firm and very firm silty clay about 38 inches thick. It is very dark gray in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown silty clay. In some places the surface layer is silty clay. In other places the soil is underlain by limestone.

Included with this soil in mapping are small areas of Woodson soils. These soils have a surface layer of silt loam. They are in positions on the landscape similar to those of the Zaar soil. They make up 5 to 10 percent of the map unit.

Permeability is very slow in the Zaar soil, and available water capacity is high. Surface runoff is slow. A perched seasonal high water table is at a depth of about 1 to 2 feet in winter and in early spring. The surface layer is firm, and tilth is fair. The shrink-swell potential is high in the subsoil. Surface cracks are common during prolonged dry periods. Reaction typically is slightly acid to mildly alkaline in the subsoil and varies widely in the surface layer as a result of local liming practices.

Most areas are used for cultivated crops. The rest are used as range or pasture. This soil is moderately well suited to grain sorghum, soybeans, wheat, and legumes. The wetness often delays tillage in the spring. A surface drainage system is needed in some areas. Because the clayey subsoil does not release moisture readily to plants, crop yields are often reduced during periods of drought. Returning crop residue to the soil improves tilth, conserves moisture, and helps to maintain fertility.

This soil is suited to range and pasture plants for hay or grazing. Grazing when the soil is too wet causes surface compaction and poor tilth. Restricted use during wet periods helps to keep the grassland in good condition. Applications of fertilizer are generally needed in the pastured areas.

This soil is poorly suited to dwellings because the wetness and the shrink-swell potential are limitations. Properly designing and reinforcing foundations, installing foundations drains, and backfilling with suitable coarse textured material around the foundations help to prevent the structural damage caused by wetness and by shrinking and swelling.

Because of the very slow permeability and the wetness, this soil is generally unsuited to septic tank absorption fields. It is well suited to sewage lagoons.

The land capability classification is IIIw, and the range site is Clay Upland.

Zb—Zaar silty clay, 1 to 4 percent slopes. This deep, gently sloping, somewhat poorly drained soil is on foot slopes and along drainageways in the uplands. Individual areas are long and narrow or irregular in shape and range from 20 to 500 acres in size.

Typically, the surface layer is black silty clay about 10 inches thick. The subsoil is mottled, firm and very firm silty clay about 46 inches thick. The upper part is black, the next part is very dark gray, and the lower part is dark grayish brown. The substratum to a depth of about 60 inches is dark grayish brown, mottled silty clay. In some places the surface layer is silty clay loam. In other places the slope is more than 4 percent. In some areas the soil has a surface layer of silty clay loam and is underlain by limestone.

Included with this soil in mapping are small areas of Eram and Woodson soils. The moderately deep Eram soils are on the upper side slopes. Woodson soils have a surface layer of silt loam. They are on broad flats. They make up 5 to 15 percent of the map unit.

Permeability is very slow in the Zaar soil, and available water capacity is high. Surface runoff is medium. A perched seasonal high water table is at a depth of about 1 to 2 feet in winter and in early spring. The surface layer is firm, and tilth is fair. The shrink-swell potential is high in the subsoil. Surface cracks are common during prolonged dry periods. Reaction typically is slightly acid to mildly alkaline in the subsoil and varies widely in the surface layer as a result of local liming practices.

Most areas are used for cultivated crops. The rest are used as range or pasture. This soil is moderately well suited to legumes, soybeans, grain sorghum, corn, and wheat. Water erosion is a hazard if cultivated crops are grown. Because the clayey subsoil does not release moisture readily to plants, crop yields are often reduced during periods of drought. A system of conservation tillage that leaves all or part of the crop residue on the surface, terraces, grassed waterways, and contour farming help to prevent excessive soil loss. Returning crop residue to the soil improves tilth, conserves moisture, and helps to maintain fertility.

This soil is suited to range and pasture plants for hay or grazing. Water erosion is a hazard in overused areas and in areas where the pasture is becoming established. An adequate plant cover on the established pastures and mulch in the seeded areas help to prevent excessive soil loss, reduce the runoff rate, and conserve moisture. Grazing when the soil is too wet causes surface compaction and poor tilth. Restricted use during wet periods helps to keep the grassland in good condition. Applications of fertilizer are generally needed in the pastured areas. Gullies form along some cattle trails. Fencing and other means of controlling livestock traffic patterns help to prevent gullying and give gullies time to revegetate.

This soil is poorly suited to dwellings because the wetness and the shrink-swell potential are limitations. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material around the foundations help to prevent the structural damage caused by wetness and by shrinking and swelling.

Because of the very slow permeability and the wetness, this soil is generally unsuited to septic tank absorption fields. It is only moderately well suited to sewage lagoons because of the slope. Some land shaping is generally needed.

The land capability classification is IIIe, and the range site is Clay Upland.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 244,633 acres in the survey area, or more than 66 percent of the total acreage, meets the soil requirements for prime farmland. Scattered areas of this land are throughout the county, mainly in the Woodson-Kenoma-Dennis and Osage-Verdigris associations, which are described under the heading "General Soil Map Units." A smaller acreage of this land is in the Bates-Collinsville-Dennis and Steedman-Niotaze-Darnell associations. About 176,000 acres of the prime farmland is used for crops, mainly wheat, soybeans, grain sorghum, and alfalfa.

The map units in the survey area that are considered prime farmland are listed in table 5. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table qualify for prime farmland only in areas where this limitation has been overcome by drainage measures. The need for these measures is indicated after the map unit name in table 5. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

The soils in the survey area are assigned to various interpretive groups at the end of each map unit description and in some of the tables. The groups for each map unit also are shown in the section "Interpretive Groups," which follows the tables at the back of this survey.

Crops and Pasture

Jerry B. Lee, conservation agronomist, Soil Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

Crops

About 176,000 acres in Wilson County, or nearly 48 percent of the total acreage, is used for cultivated crops or hay. During the period 1971 to 1981, wheat was grown on about 32 percent of the cropland, soybeans on 23 percent, grain sorghum on 21 percent, alfalfa on 7 percent, corn on 4 percent, and pasture, oats, barley, and rye on 13 percent (*3*). The acreage used for soybeans increased compared to that of the previous 10-year period. The acreage of corn, alfalfa, and native hay decreased.

The crops are grown mainly on Apperson, Catoosa, Dennis, Kenoma, Osage, Verdigris, Woodson, and Zaar soils. A smaller acreage of Bates, Eram, Ivan, Lanton, Mason, and Prue soils also is used as cropland.

Crop production can be increased on most farms by applying the latest technology. This soil survey can facilitate the application of such technology. The main concerns in managing the soils in Wilson County are controlling water erosion, maintaining or improving fertility and tilth, and reducing wetness.

Water erosion is a hazard on about 58 percent of the cropland in the county. It occurs mainly on soils that have a slope of more than 1 or 2 percent. Examples are Bates, Dennis, Eram, Kenoma, and Prue soils.

Loss of the surface layer through erosion is damaging for two reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging on soils that have a clayey subsoil, such as Kenoma, Dennis, and Woodson soils. Secondly, erosion results in the pollution of streams by sediments, nutrients, and pesticides. Control of erosion minimizes this pollution and improves the quality of water.

Erosion-control practices provide a protective cover, reduce the runoff rate, and increase the rate of water infiltration. A cropping system that keeps a plant cover on the surface for extended periods helps to control erosion and preserves the productive capacity of the soils. Terraces and diversions help to control erosion by shortening the length of slopes and reducing the runoff rate. They are most practical on deep, well drained soils that have uniform slopes. Contour farming should generally be used in combination with terraces. It is best suited to soils that have smooth, uniform slopes and are suitable for terracing.

Plants on most of the arable soils in the county respond well to applications of nitrate and phosphate fertilizer. Most of the soils have a slightly acid or medium acid surface layer unless they have been limed. Applications of lime reduce the acidity of these soils. They can increase the production of legumes, such as alfalfa, and other crops that are more productive on neutral soils. On all soils the amount of fertilizer and lime to be applied should be based on the results of soil tests, on the needs of the crop, on the expected level of yields, and on the experience of farmers. The Cooperative Extension Service can help to determine the kinds and amounts of nutrients needed.

Organic matter is a storehouse of available plant nutrients. It increases the rate of water intake, helps to prevent surface crusting, helps to control erosion, and improves tilth. Most of the cropland in the county occurs as soils that have a silt loam surface layer. A surface crust forms during periods of intensive rainfall. When dry, the crusted surface is nearly impervious to water. As a result, the runoff rate is increased. A conservation tillage system that leaves all or part of the crop residue on the surface helps to prevent crusting, increases the rate of water infiltration, reduces the runoff rate, and helps to control erosion.

A drainage system is a management need on some of the soils on flood plains. Unless drained, some areas of the somewhat poorly drained Lanton and poorly drained Osage soils are so wet that crop yields are reduced. Surface drains or a bedding system can reduce the wetness.

Information about the design of erosion-control practices is available in the local office of the Soil Conservation Service. The latest information about growing crops can be obtained from the Cooperative Extension Service or the Soil Conservation Service.

Pasture

About 9 percent of the acreage in Wilson County is pastured. The pastured areas support mainly cool-season grasses, such as tall fescue and smooth bromegrass. They are throughout the county.

The main concerns in managing pasture are maintaining or improving the quality and quantity of forage, protecting the soil, and conserving water. Leaf development, root growth, forage regrowth, and food storage in roots are processes in the development and growth of grasses. All are essential if optimum yields of forage are to be maintained.

Proper stocking rates help to maintain a good stand of grasses. The number of livestock should be adjusted to the expected level of yields.

Delaying grazing in the spring until the soil is dry and firm helps to prevent the damage caused by trampling and compaction. Tall fescue and bromegrass should not be grazed during their midsummer dormancy. Rotation grazing helps to prevent depletion of a pasture by allowing the grasses to recover after periods of grazing. Maintaining an adequate ground cover during the periods of grazing helps to control erosion.

Problems with fescue toxicity resulted in the loss of many stands of fescue during a drought in 1980. This loss renewed interest in smooth bromegrass and other suitable cool-season grasses. Mixtures that include smooth bromegrass, alfalfa, and orchardgrass have been planted. If the pasture is well managed, the amount of forage provided by these mixtures of grasses and legumes is likely to be more than 2 animal-unit-months higher than that provided by pure stands of tall fescue or bromegrass.

Providing adequate supplies of water and salt at a variety of locations helps to distribute grazing evenly. Applying the proper kinds and amounts of fertilizer according to the results of soil tests, field observations, and the experience of farmers increases forage production. Mowing a pasture that has been grazed unevenly or has an excess of forage and spraying with herbicides help to control invading trees, brush, and broad-leaved weeds.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in the table.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units," in the yields table, and in the section "Interpretive Groups."

Rangeland

Steven L. Ekblad, range conservationist, Soil Conservation Service, helped prepare this section.

Range makes up about 33 percent of Wilson County. It is in areas throughout the county, on uplands and breaks where cultivation is not practical or is limited by soil characteristics. Of the 120,000 acres used as range in 1984, 90,000 acres was suited only to that use.

The native vegetation on range consists of a wide variety of grasses, grasslike plants, forbs, shrubs, and trees. The plants are generally suitable for grazing. Range receives no regular or frequent cultural treatment, but an understanding of management is needed to keep a site healthy and vigorous. Forage production and the composition of the plant community are determined by soils, climate, topography, and grazing management.

Most of the range in Wilson County is considered tall grass prairie. Prior to settlement, the western edge of the county was a savannah that supported scattered post oak and blackjack oak. Some areas supported thick oak motts. Because of the lack of fire and continued overgrazing, a heavy stand of the oaks has become established.

Most of the ranches are cow-calf enterprises, but some are yearling enterprises. Combinations of both enterprises permit greater flexibility in adjusting livestock numbers during periods of drought and during other periods.

Although native grasses are the major forage species, introduced species on cool-season pastures supplement the range forage during the fall, winter, and early spring. Producers who winter their livestock on native grass generally supplement the native forage with hay and protein concentrates.

Most of the forage production on range takes place in the spring and early summer. About 70 percent of the annual forage is produced in May, June, and July. During late summer and early fall, forage production and forage quality decline as the major species of tall grasses produce seed and rebuild root reserves.

Range Sites and Condition Classes

A range site is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

The plant community in an area that is characterized by at least 75 percent climax vegetation is relatively stable and is indicative of what the site is capable of producing. Climax vegetation reproduces itself and changes in composition very little as long as the environment remains unchanged. The climax vegetation consists of the plants that grew on the prairie when the region was first settled. It generally is the most productive combination of forage plants on a range site.

Range plants can respond to grazing pressure as decreasers, increasers, or invaders. Decreasers are plants in the climax vegetation that tend to decrease in a relative amount under close, continuous grazing. They are generally the tallest and most productive perennial grasses and forbs and are the most palatable to livestock.

Increasers are plants in the climax vegetation that increase in a relative amount as the extent of the more desirable plants is reduced by close grazing. They are generally shorter than decreasers and less palatable to livestock.

Invaders are plants that cannot compete with the climax plant community for moisture, nutrients, and light. They invade the site and grow along with increasers after the extent of the climax vegetation has been reduced by continuous heavy grazing. Invaders generally have little value for grazing.

Range condition is judged according to standards that apply to a particular range site. Four range condition classes are used to indicate the condition of the present vegetation on a range site in relation to the climax vegetation for that site. A range is in excellent condition if 76 to 100 percent of the vegetation is of the same kind as that in the climax stand; in good condition if the percentage is 51 to 75; in fair condition if the percentage is 26 to 50; and in poor condition if the percentage is 25 or less.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 7 shows, for each soil, the range site and the total potential annual production of vegetation in favorable, average, and unfavorable years. The potential annual production is the amount of vegetation that can be expected to grow annually on well managed range that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Yields are adjusted to a common percent of air-dry moisture content. The relationship of green weight to air-dry weight varies according to such factors as exposure, amount of shade, recent rains, and unseasonable dry periods.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, control of undesirable brush species, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Good range management keeps the range in excellent or good condition. Water is conserved, yields are improved, and the soils are protected. The main management concern is recognizing the changes in the plant cover that take place gradually and can be misinterpreted or overlooked. Growth resulting from heavy rainfall may lead to the conclusion that the range is in good condition when actually the cover is weedy and the long-term trend is toward lower production. On the other hand, some areas that have been closely grazed for a short period may have a degraded appearance that temporarily obscures the quality of the range and its ability to recover.

After years of prolonged overuse of range, seed sources of desirable vegetation may have been eliminated. Brush control, range seeding, fencing, and the development of watering facilities revitalize the stands of native plants. Thereafter, deferred grazing, proper grazing use, and a planned grazing system help to maintain or improve the range.

The soils in the survey area are assigned to the Claypan, Clay Lowland, Clay Upland, Loamy Lowland, Loamy Upland, Savannah, Shallow Limy, Shallow Sandstone, and Shallow Savannah range sites. These sites are described in the paragraphs that follow.

Claypan range site. This site is on uplands. The potential native vegetation is mixed prairie grasses. Typically, big bluestem makes up about 15 percent of the vegetation; little bluestem, 15 percent; sideoats grama, 15 percent; western wheatgrass, 15 percent; and switchgrass, 10 percent. Other grasses are indiangrass, tall dropseed, blue grama, and buffalograss. Forbs, such as dotted gayfeather, heath aster, slimflower scurfpea, western ragweed, Missouri goldenrod, and stiff goldenrod, make up about 10 percent of the vegetation.

Overgrazing on this site initially reduces the production of big bluestem, little bluestem, and switchgrass. As the production of these species is reduced, the amount of tall dropseed, western wheatgrass, and buffalograss increases. If overuse continues, Japanese brome, prairie threeawn, broomweed, tumble windmillgrass, and buffalograss become the dominant species.

Because of their accessibility, many areas of this range site are in poor condition. Maintaining the preferred species of grasses is difficult. A planned grazing system that includes proper stocking rates and periodic deferment of grazing during the growing season commonly can restore the site. Because of soil limitations, the site responds to grazing management more slowly than other range sites.

Clay Lowland range site. This site is mainly along the major drainageways in the uplands. The potential native vegetation is tall prairie grasses. Typically, prairie cordgrass makes up about 40 percent of the vegetation; switchgrass, 15 percent; big bluestem, 10 percent; and eastern gamagrass, 10 percent. Other grasses are indiangrass, Canada wildrye, Virginia wildrye, green muhly, and tall dropseed. Forbs, such as American licorice, Illinois bundleflower, Maximillian sunflower, sawtooth sunflower, wholeleaf rosinweed, and tall goldenrod, make up about 10 percent of the vegetation.

To maintain the climax vegetation, special grazing systems that provide periodic rest periods are essential. Continuous seasonal or yearlong grazing quickly reduces or eliminates the production of eastern gamagrass, Maximillian sunflower, sawtooth sunflower, and wholeleaf rosinweed. Overuse reduces the production of prairie cordgrass, big bluestem, switchgrass, and indiangrass. As the production of these species is reduced, the amount of tall dropseed, meadow dropseed, Baldwin ironweed, and buckbrush increases. If overuse continues, the extent of woody vegetation such as osageorange, green ash, pecan, bur oak, cottonwood, willow, and sycamore, increases.

The woody vegetation can dominate this site unless it is destroyed by fire or controlled by other means. Deferred grazing and rotation grazing in combination with controlled burning and selected herbicides can improve or maintain the site.

Clay Upland range site. The potential native vegetation on this site is tall prairie grasses. Typically, big bluestem makes up about 35 percent of the vegetation; little bluestem, 15 percent; indiangrass, 10 percent; switchgrass, 10 percent; and eastern gamagrass, 10 percent. Other grasses are tall dropseed, Florida paspalum, sideoats grama, and prairie junegrass. Forbs, such as catclaw sensitivebrier, pitcher sage, and slimflower scurfpea, make up about 10 percent of the vegetation.

Overgrazing on this site quickly reduces the production of big bluestem, indiangrass, little bluestem, and other desirable species. Under continuous heavy grazing, tall dropseed, Japanese brome, prairie threeawn, western ragweed, and other less palatable plants become the dominant species. Unless brush is controlled by fire or other means, woody species, such as eastern redcedar, buckbrush, and osageorange, can become the dominant vegetation on much of the site.

To maintain or improve the range condition, proper stocking rates, a planned grazing system, and controlled burning are essential. In areas that are severely overgrazed but have remnant stands of tall grasses, the original productivity can be restored by good management measures, such as proper stocking rates, a scheduled deferment of grazing during the growing season, and controlled burning. Range seeding generally is needed on abandoned cropland.

Loamy Lowland range site. This site is on terraces and flood plains that are subject to flooding and that receive runoff from the adjacent slopes. The potential native vegetation is tall prairie grasses. Typically, big bluestem makes up about 40 percent of the vegetation; eastern gamagrass, 15 percent; indiangrass, 10 percent; and switchgrass, 10 percent. Other grasses are prairie cordgrass, green muhly, tall dropseed, and Canada wildrye. Forbs, such as Maximillian sunflower, Illinois bundleflower, and wholeleaf rosinweed, make up about 10 percent of the vegetation.

Because of the extra moisture and the more deeply rooted plants, this site is a preferred grazing area. Overgrazing quickly reduces the production of big bluestem, eastern gamagrass, and the highly preferred forbs, such as Maximillian sunflower and wholeleaf rosinweed. Unless they are controlled by fire or herbicides, woody species can dominate the site.

To maintain or improve the range condition, a scheduled deferment of grazing during the growing season and controlled burning are necessary. In areas that have been severely overgrazed, the original productivity can be restored by proper stocking rates, a scheduled deferment of grazing during the growing season, and controlled burning.

Loamy Upland range site. The potential native vegetation on this site is tall prairie grasses. Typically, big bluestem makes up about 40 percent of the vegetation; little bluestem, 20 percent; eastern gamagrass, 10 percent; indiangrass, 10 percent; and switchgrass, 5 percent. Other grasses are Scribner panicum, sideoats grama, tall dropseed, and Canada wildrye. Forbs, such as catclaw sensitivebrier, pitcher sage, Missouri goldenrod, and Louisiana sagewart, make up about 10 percent of the vegetation. The site supports small amounts of Arkansas rose, ceanothus, and leadplant.

Overgrazing on this site quickly reduces the production of big bluestem, indiangrass, eastern gamagrass, little bluestem, and other desirable species. Under continuous heavy grazing, tall dropseed, Japanese brome, prairie threeawn, Baldwin ironweed, western ragweed, and other less palatable plants become the dominant species. Unless they are controlled by fire or other means, woody species, such as eastern redcedar, buckbrush, and osageorange, can become the dominant vegetation on much of the site.

To maintain or improve the range condition, proper stocking rates, a planned grazing system, and controlled burning are essential. In areas that have been severely overgrazed, the original productivity can be restored by proper stocking rates, scheduled deferment of grazing during the growing season, and controlled burning. Range seeding generally is needed on abandoned cropland.

Savannah range site. This site is on uplands. The potential native vegetation is tall savannah grasses. Typically, big bluestem makes up about 25 percent of the vegetation; little bluestem, 20 percent; indiangrass, 10 percent; and switchgrass, 10 percent. Woody species, mainly post oak and blackjack oak, make up about 15 percent, and forbs, such as catclaw sensitivebrier, roundhead lespedeza, and sessileleaf tickclover, make up about 10 percent.

Overgrazing reduces the extent of desirable grasses and increases the extent of post oak and blackjack oak. Unless the woody species are controlled by burning, continuous heavy grazing results in an overstory of oaks and an understory of buckbrush, shade-tolerant annuals, Scribner panicum, and sedges.

To maintain a good balance between the grasses and woody vegetation on this site, a high level of management is needed. Proper stocking rates, prescribed burning, and a planned grazing system are necessary to maintain or improve the range condition. Because of vigorous resprouting of the oak species after controlled burning, an approved herbicide may be necessary to improve areas that have dense stands of post oak and blackjack oak.

Shallow Limy range site. This site is on uplands. The potential native vegetation is tall prairie grasses. Typically, big bluestem makes up about 25 percent of the vegetation; sideoats grama, 20 percent; little bluestem, 10 percent; indiangrass, 10 percent; and switchgrass, 5 percent. Other grasses are Canada wildrye, Scribner panicum, and tall dropseed. Forbs, such as catclaw sensitivebrier, penstemon, dotted gayfeather, and compassplant, make up about 10 percent of the vegetation.

Because of the shallow depth to bedrock, this site is droughty and is easily overgrazed, especially in dry years, and severe overgrazing can result in excessive erosion and a complete loss of productivity. Overgrazing quickly reduces the production of big bluestem, little bluestem, sideoats grama, and the highly desirable forbs, such as catclaw sensitivebrier and compassplant. These plants are replaced by broomweed, prairie threeawn, Japanese brome, and tall dropseed if the site is continuously overgrazed and if woody species are not controlled by burning. Under these conditions, the extent of sumac, buckbrush, and eastern redcedar significantly increases.

To maintain or to improve the range condition, proper stocking rates, a scheduled deferment of grazing during the growing season, and controlled burning are necessary. In droughty years carefully adjusting the stocking rates can help to prevent the serious damage caused by overgrazing.

Shallow Sandstone range site. This site is on uplands. The potential native vegetation is mixed prairie grasses. Typically, big bluestem makes up about 25 percent of the vegetation; little bluestem, 25 percent; indiangrass, 10 percent; sideoats grama, 10 percent; and switchgrass, 5 percent. Other grasses are Canada wildrye, Scribner panicum, and blue grama. Forbs, such as roundhead lespedeza, compassplant, and pitcher sage, make up about 10 percent of the vegetation.

Overgrazing reduces the production of tall grasses and increases the production of broomsedge bluestem, prairie threeawn, and Japanese brome. Buckbrush, eastern redcedar, blackberry, and sumac can easily become established on this site.

To maintain or improve the range condition, proper stocking rates, a scheduled deferment of grazing during the growing season, and controlled burning are necessary. Because certain brush species on this site can withstand spring burning, an approved herbicide may be necessary.

Shallow Savannah range site. This site is on uplands. The potential native vegetation is tall savannah grasses. Typically, little bluestem makes up about 25 percent of the vegetation; big bluestem, 20 percent; indiangrass, 5 percent; and switchgrass, 5 percent. Other grasses are sideoats grama, Canada wildrye, purpletop, and Scribner panicum. Post oak, blackjack oak, and other trees and shrubs make up about 20 percent of the vegetation, and forbs, such as tickclover, roundhead lespedeza, and catclaw sensitivebrier, make up about 10 percent.

Unless the woody species are controlled by burning, overgrazing increases the extent of post oak and blackjack oak. In the early stages of the deterioration caused by overgrazing, the extent of tall dropseed, broomsedge bluestem, purpletop, and annual grasses increases rapidly. Continuous heavy grazing results in an overstory of oaks and an understory of shade-tolerant plants.

To maintain or improve the range condition, proper stocking rates, a scheduled deferment of grazing during the growing season, and controlled burning are essential. Because of vigorous resprouting of the oak species after controlled burning, an approved herbicide may be necessary to improve areas that have dense stands of post oak and blackjack oak.

Woodland Management and Productivity

Keith A. Ticknor, forester, Soil Conservation Service, helped prepare this section.

About 11,000 acres in Wilson County, or nearly 3 percent of the total acreage, is forested. The woodland occurs as irregular tracts and narrow bands along streams and rivers, as areas in the upland drainageways, and as some areas of upland soils that are underlain by sandstone.

The woodland is divided into three main forest cover types—post oak-blackjack oak (fig. 11), hackberry-American elm-green ash, and sycamore-oak-American elm. The post oak-blackjack oak type is in the upland areas of the Steedman-Niotaze-Darnell association, which is described under the heading "General Soil Map Units." Some tracts are nearly pure stands of post oak and blackjack oak. The most common associated species are other oaks, such as bur oak, chinkapin oak, and red oak, and hickory.

The hackberry-American elm-green ash and sycamore-oak-American elm cover types are in areas of the Osage-Verdigris association on bottom land. Some nearly pure stands of pecan are in areas of the sycamore-oak-American elm cover type. Associated species are numerous. They include mulberry, boxelder, black walnut, pecan, silver maple, Kentucky coffeetree, eastern cottonwood, hickory, bur oak, red oak, and honeylocust.

Many of the trees, especially the bottom-land species, have commercial value for wood products. Many of the soils have good potential for Christmas trees and for the trees used in the production of veneer, sawtimber, and other wood products. Only a small part of the woodland, however, is managed for commercial wood production. Most of the wooded areas are privately owned tracts making up only a small acreage of the farms. Most of the acreage is cropland that is unlikely to be converted to land used for commercial wood production. The soils on bottom land produce high-value hardwoods within a short period. In contrast, upland soils produce low-value trees over a long period.

Table 8 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for an indicator tree species. The number indicates the volume, in cubic meters per hectare per year, which the indicator species can produce. The number 1 indicates low potential productivity; 2 and 3, moderate; 4 and 5, moderately high; 6 to 8, high; 9 to 11, very high; and 12 to 39, extremely high. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *R* indicates steep slopes; *X*, stoniness or rockiness; *W*, excess water in or on the soil; *T*, toxic substances in the soil; *D*, restricted rooting depth; *C*, clay in the upper part of the soil; *S*, sandy texture; *F*, a high content of rock fragments in the soil; and *L*, low strength. The letter *A* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: R, X, W, T, D, C, S, F, and L.

In table 8, *slight*, *moderate*, and *severe* indicate the degree of the major soil limitations to be considered in management.

Figure 11.—An area of blackjack oaks adjacent to a pond.

Erosion hazard is the probability that damage will occur as a result of site preparation and cutting where the soil is exposed along roads, skid trails, fire lanes, and log-handling areas. Forests that have been burned or overgrazed are also subject to erosion. Ratings of the erosion hazard are based on the percent of the slope. A rating of *slight* indicates that no particular prevention measures are needed under ordinary conditions. A rating of *moderate* indicates that erosion-control measures are needed in certain silvicultural activities. A rating of *severe* indicates that special precautions are needed to control erosion in most silvicultural activities.

Equipment limitation reflects the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. The chief characteristics and conditions considered in the ratings are slope, stones on the surface, rock outcrops, soil wetness, and texture of the surface layer. A rating of *slight* indicates that under normal conditions the kind of equipment or season of use is not significantly restricted by soil factors. Soil wetness can restrict equipment use, but the wet period does not exceed 1 month. A rating of *moderate* indicates that equipment use is moderately restricted because of one or more soil factors. If the soil is wet, the wetness restricts equipment use for a period of 1 to 3 months. A rating of *severe* indicates that equipment use is severely restricted either as to the kind of equipment that can be used or the season of use. If the soil is wet, the wetness restricts equipment use for more than 3 months.

Seedling mortality refers to the death of naturally occurring or planted tree seedlings, as influenced by the kinds of soil, soil wetness, or topographic conditions. The factors used in rating the soils for seedling mortality are texture of the surface layer, depth to a seasonal high water table and the length of the period when the water table is high, rock fragments in the surface layer, effective rooting depth, and slope aspect. A rating of *slight* indicates that seedling mortality is not likely to be a problem under normal conditions. Expected mortality is less than 25 percent. A rating of *moderate* indicates that some problems from seedling mortality can be expected. Extra precautions are advisable. Expected mortality is 25 to 50 percent. A rating of *severe* indicates that seedling mortality is a serious problem. Extra precautions are important. Replanting may be necessary. Expected mortality is more than 50 percent.

Plant competition ratings indicate the degree to which undesirable species are expected to invade and grow when openings are made in the tree canopy. The main factors that affect plant competition are the depth to the water table and the available water capacity. A rating of *slight* indicates that competition from undesirable plants is not likely to prevent natural regeneration or suppress the more desirable species. Planted seedlings can become established without undue competition. A rating of *moderate* indicates that competition may delay the establishment of desirable species. Competition may hamper stand development, but it will not prevent the eventual development of fully stocked stands. A rating of *severe* indicates that competition can be expected to prevent regeneration unless precautionary measures are applied.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index* and as a *volume* number. The site index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

The *volume*, a number, is the yield likely to be produced by the most important trees. This number, expressed as cubic feet per acre per year, indicates the amount of fiber produced on a fully stocked, even-aged, unmanaged stand.

The first species listed under *common trees* for a soil is the indicator species for that soil. It is the dominant species on the soil and the one that determines the ordination class.

Trees to plant are those that are suitable for commercial wood production.

Windbreaks and Environmental Plantings

Keith A. Ticknor, forester, Soil Conservation Service, helped prepare this section.

Trees grow on most of the farmsteads in Wilson County. They were planted at various times by the landowners. Some of these are windbreaks, but most are environmental or ornamental plantings. Eastern redcedar is the most common species in the windbreaks. Other commonly planted species are Siberian elm, pecan, black walnut, lilac, green ash, Kentucky coffeetree, and hackberry.

A few windbreaks and many environmental plantings are planted each year. Tree planting is a continual need because old trees pass maturity and deteriorate, because some trees are destroyed by insects, disease, or storms, and because new plantings are needed on expanding farmsteads.

Many field windbreaks are established throughout the county. They are generally hedgerows of osageorange. They were planted as property lines and field boundaries, as living fences, and as a source of wood for posts. Many of these windbreaks are being removed because fields are being enlarged.

In order for windbreaks and environmental plantings to fulfill their intended purpose, the soils on the site should be suited to the trees or shrubs selected for planting. Permeability, available water capacity, fertility, soil depth, and texture greatly affect the growth rate.

Trees and shrubs can be easily established in the county, but the survival rate may be restricted, mainly by competition from weeds and grasses. The main management needs are proper site preparation before the trees and shrubs are planted and measures that control the competing weeds and grasses after the trees and shrubs are planted.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 9 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 9 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

Robert J. Higgins, biologist, Soil Conservation Service, helped prepare this section.

Wilson County has several areas of scenic, geologic, and historic interest. The rolling hills and broad bottom land along the Verdigris and Fall Rivers provide scenic views. Several watershed lakes, farm ponds, and the Fall and Verdigris Rivers provide opportunities for water sports.

The soils of the survey area are rated in table 10 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 10, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 10 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 13 and interpretations for dwellings without basements and for local roads and streets in table 12.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife Habitat

Robert J. Higgins, biologist, Soil Conservation Service, helped prepare this section.

The primary game species in Wilson County are bobwhite quail, white-tailed deer, wild turkey, cottontail rabbit, fox squirrel, prairie chicken, and several species of waterfowl. Hunting for prairie chickens is unique to this part of the state.

Nongame species are numerous because of the diverse habitat types in the county. Cropland, woodland, and grassland are intermixed throughout the county. This intermixture creates the desirable edge effect conducive to a variety of wildlife species. Establishing additional fringe areas generally increases the wildlife population.

Furbearers are sparse to common along the Verdigris and Fall Rivers and their tributaries. They are trapped on a limited basis.

A state fishing lake, several watershed lakes, stock water ponds, and the Fall and Verdigris Rivers and their tributaries provide good to excellent fishing. The species commonly caught are largemouth bass, bluegill, carp, channel cat, bullhead, and flathead catfish. Walleye and several other species also are caught in the Verdigris and Fall Rivers.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 11, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, grain sorghum, oats, and soybeans.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, switchgrass, indiangrass, grama, sunflowers, ragweed, and native legumes.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, hickory, hackberry, sycamore, cottonwood, black walnut, pecan, mulberry, ash, and willow. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, crabapple, plum, and fragrant sumac.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are eastern redcedar, pine, and juniper.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are plum, dogwood, buckbrush, gooseberry, blackberry, and sumac.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, cattails, indigobush, prairie cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, ponds, and lakes.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, mourning dove, meadowlark, field sparrow, and cottontail rabbit.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, owls, hawks, thrushes, woodpeckers, squirrels, opossum, raccoon, and white-tailed deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, red-winged blackbirds, muskrat, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include coyotes, jackrabbits, hawks, vultures, badgers, killdeer, and meadowlarks.

Technical assistance in planning wildlife areas and in determining the vegetation suitable for planting can be obtained from the local office of the Soil Conservation Service. Additional information and assistance can be obtained from the Kansas Fish and Game Commission and from the Cooperative Extension Service.

Engineering

John A. Eberwein, civil engineer, Soil Conservation Service, helped prepare this section.

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 12 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Sanitary Facilities

Table 13 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 13 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 13 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 13 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 14 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 14, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to

40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 15 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 19.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 16 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 12). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

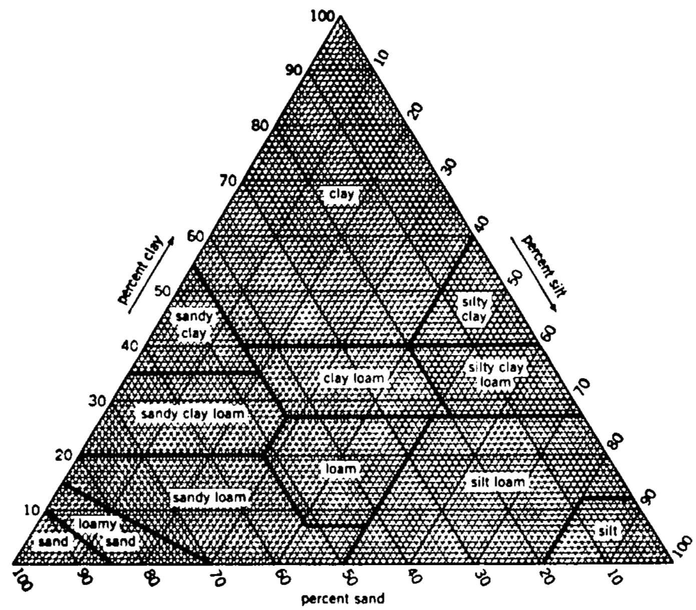


Figure 12.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 17 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 20 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 20 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 17, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 18 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 18 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 18 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 18. Only saturated zones within a depth of about 6 feet are indicated.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Engineering Index Test Data

Table 19 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are representative of the series described in the section "Soil Series and Their Morphology." The soil samples were tested by the Kansas Department of Transportation.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); and Moisture density, Method A—T 99 (AASHTO), D 698 (ASTM).

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*6*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 20 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udoll (*Ud*, meaning humid, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Argiudolls (*Argi*, meaning argillic horizon, plus *udoll*, the suborder of the Mollisols that has a udic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Argiudolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, siliceous, thermic Typic Argiudolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*5*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*6*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Apperson Series

The Apperson series consists of deep, moderately well drained, slowly permeable soils on uplands. These soils formed in material weathered from limestone. Slope ranges from 0 to 2 percent.

Apperson soils are similar to Eram and Zaar soils and are commonly adjacent to Catoosa, Girard, Shidler, and Zaar soils. Catoosa and Girard soils are moderately deep over limestone. Catoosa soils are on ridgetops, and Girard soils are along drainageways. Eram soils are moderately deep over shale. They are on side slopes. Shidler soils are shallow over limestone. They are generally lower on the landscape than the Apperson soils. Zaar soils do not have an argillic horizon. They are on broad flats and on toe slopes.

Typical pedon of Apperson silty clay loam, 0 to 2 percent slopes, 2,350 feet north and 330 feet west of the southeast corner of sec. 9, T. 29 S., R. 15 E.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; hard, firm; common fine roots; slightly acid; gradual smooth boundary.

BA—8 to 12 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; strong fine subangular blocky structure; hard, firm; few fine roots; neutral; gradual smooth boundary.

Bt1—12 to 23 inches; very dark grayish brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) dry; few fine faint dark brown (10YR 3/3) mottles; moderate medium blocky structure; very hard, very firm; few fine roots; few cracks filled with black (10YR 2/1) material; few distinct clay films on faces of peds; few black concretions; mildly alkaline; gradual smooth boundary.

Bt2—23 to 38 inches; dark brown (10YR 4/3) silty clay, brown (10YR 5/3) dry; few fine faint dark yellowish brown (10YR 4/4) mottles; moderate medium blocky structure; very hard, very firm; few distinct clay films on faces of peds; few black concretions and calcium carbonate concretions; moderately alkaline; diffuse smooth boundary.

BC—38 to 43 inches; dark yellowish brown (10YR 4/4) silty clay, yellowish brown (10YR 5/4) dry; few fine faint brown (10YR 4/3) mottles; weak medium blocky structure; very hard, very firm; common fine black concretions; moderately alkaline; abrupt irregular boundary.

R—43 inches; limestone bedrock.

The thickness of the solum and the depth to hard limestone range from 40 to 60 inches. The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1. It is medium acid or slightly acid unless it has been limed. The Bt horizon has hue of 10YR in the upper part and hue of 10YR or 2.5Y in the lower part. It has value of 3 or 4 (4 or 5 dry) and chroma of 1 to 3. It is mottled with shades of gray, brown, yellow, or red. This horizon is neutral to moderately alkaline. In some pedons the BC horizon is calcareous. In other pedons the content of limestone fragments less than 3 inches in diameter is less than 10 percent in this horizon.

Bates Series

The Bates series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from thinly bedded sandstone and interbedded sandy and silty shale. Slope ranges from 1 to 8 percent.

Bates soils are similar to Prue soils and are commonly adjacent to Collinsville, Dennis, Eram, and Prue soils. Collinsville soils are shallow over sandstone. They are on side slopes. Dennis and Eram soils have more clay in the subsoil than the Bates soils. Dennis soils are on foot slopes and the lower side slopes. Eram soils are in positions on the landscape similar to those of the Bates soils. The deep Prue soils are on foot slopes and the lower side slopes.

Typical pedon of Bates loam, 1 to 4 percent slopes, 100 feet north and 860 feet west of the southeast corner of sec. 21, T. 30 S., R. 17 E.

A—0 to 11 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable; few fine roots; slightly acid; gradual smooth boundary.

BA—11 to 15 inches; dark brown (10YR 4/3) loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; slightly hard, friable; few fine roots; slightly acid; gradual smooth boundary.

Bt—15 to 23 inches; dark yellowish brown (10YR 4/4) clay loam, yellowish brown (10YR 5/4) dry; few fine prominent reddish brown (5YR 4/4) mottles; moderate medium subangular blocky structure; hard, firm; few fine roots; few faint clay films on faces of peds; few sandstone fragments; medium acid; gradual smooth boundary.

BC—23 to 28 inches; dark brown (7.5YR 4/4) gravelly clay loam, brown (7.5YR 5/4) dry; common medium distinct yellowish red (5YR 4/6) mottles; weak medium blocky structure; hard, firm; few fine roots; about 25 percent small sandstone fragments and shale chips; medium acid; clear wavy boundary.

Cr—28 inches; soft, fine grained sandstone and sandy shale.

The thickness of the solum and the depth to bedrock range from 20 to 40 inches. The mollic epipedon ranges from 8 to 24 inches in thickness. Weathered sandstone fragments are throughout some pedons, but they make up less than 15 percent of the pedons.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 2 or 3. It is typically loam, but in some pedons it is silt loam or fine sandy loam. It is strongly acid to slightly acid unless it has been limed. The Bt horizon has hue of 10YR or 7.5YR, value of 3 to 5 (4 to 6 dry), and chroma of 3 to 5. It is strongly acid to slightly acid. It is clay loam, sandy clay loam, or loam. The content of clay in this horizon ranges from 18 to 35 percent. The content of weathered sandstone fragments in the lower part of this horizon ranges from 0 to 15 percent.

Catoosa Series

The Catoosa series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from limestone. Slope ranges from 0 to 2 percent.

Catoosa soils are commonly adjacent to Apperson, Bates, Kenoma, and Shidler soils. Apperson and Kenoma soils are deep and have more clay in the subsoil than the Catoosa soils. Apperson soils are on the slightly lower side slopes, mainly along the upper ends of drainageways. Kenoma soils are on broad ridgetops. Bates soils are moderately deep over sandstone. They are on ridgetops. Shidler soils are shallow over limestone. They are slightly lower on the landscape than the Catoosa soils.

Typical pedon of Catoosa silt loam, 0 to 2 percent slopes, 300 feet south and 2,400 feet west of the northeast corner of sec. 24, T. 27 S., R. 16 E.

A—0 to 10 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; strong fine granular structure; slightly hard, friable; many fine roots; slightly acid; gradual smooth boundary.

BA—10 to 16 inches; dark brown (7.5YR 3/2) silty clay loam, brown (7.5YR 4/2) dry; strong fine subangular blocky structure; hard, firm; common fine roots; neutral; gradual smooth boundary.

Bt1—16 to 20 inches; dark reddish brown (5YR 3/3) silty clay loam, reddish brown (5YR 4/3) dry; moderate medium subangular blocky structure; hard, firm; common fine roots; few faint clay films on faces of peds; few black concretions; neutral; gradual smooth boundary.

Bt2—20 to 30 inches; dark reddish brown (5YR 3/4) silty clay loam, dark reddish brown (5YR 3/4) dry; moderate medium subangular blocky structure; very hard, very firm; few fine roots; few faint clay films on faces of peds; few black concretions; neutral; abrupt wavy boundary.

R—30 inches; hard limestone bedrock.

The thickness of the solum and the depth to bedrock range from 20 to 40 inches. The mollic epipedon ranges from 10 to 20 inches in thickness.

The A horizon has hue of 10YR, 7.5YR, or 5YR, value of 2 or 3 (3 to 5 dry), and chroma of 2 or 3. It is slightly acid or medium acid unless it has been limed. The Bt horizon has hue of 5YR or 2.5YR, value of 3 or 4 (moist or dry), and chroma of 3 or 4. It ranges from strongly acid to neutral.

Collinsville Series

The Collinsville series consists of shallow, well drained, moderately rapidly permeable soils on uplands. These soils formed in material weathered from sandstone. Slope ranges from 3 to 20 percent.

Collinsville soils are commonly adjacent to Bates, Eram, and Steedman soils. Bates soils are moderately deep over sandstone. They are generally higher on the landscape than the Collinsville soils. Eram and Steedman soils are moderately deep over shale. They are generally lower on the landscape than the Collinville soils.

Typical pedon of Collinsville loam, in an area of Bates-Collinsville loams, 7 to 20 percent slopes, 350 feet west and 2,470 feet south of the northeast corner of sec. 29, T. 30 S., R. 17 E.

A—0 to 6 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable; many fine roots; few sandstone fragments less than 3 inches in diameter; medium acid; clear smooth boundary.

C—6 to 14 inches; dark brown (10YR 3/3) fine sandy loam, brown (10YR 4/3) dry; massive; slightly hard, friable; many fine roots; about 14 percent sandstone fragments less than 3 inches in diameter; strongly acid; abrupt wavy boundary.

R—14 inches; hard sandstone.

The thickness of the solum and the depth to sandstone range from 4 to 20 inches. Reaction typically is slightly acid to strongly acid throughout the profile. In some areas sandstone fragments are on the surface or make up as much as 35 percent of the A and C horizons.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 2 or 3. It is typically loam, but in some pedons it is fine sandy loam. The C horizon has hue of 10YR or 7.5YR, value of 3 or 4 (4 or 5 dry), and chroma of 3 or 4.

Darnell Series

The Darnell series consists of shallow, well drained, moderately rapidly permeable soils on uplands. These soils formed in material weathered from sandstone. Slope ranges from 2 to 15 percent.

Darnell soils are commonly adjacent to Niotaze, Steedman, and Stephenville soils. Niotaze and Steedman soils are moderately deep over shale. They are on slopes below the Darnell soils. Stephenville soils are moderately deep over sandstone. They are on slopes above the Darnell soils.

Typical pedon of Darnell fine sandy loam, in an area of Stephenville-Darnell fine sandy loams, 2 to 6 percent slopes, 240 feet north and 100 feet west of the southeast corner of sec. 35, T. 27 S., R. 13 E.

A—0 to 6 inches; dark brown (10YR 3/3) fine sandy loam, brown (10YR 5/3) dry; moderate fine granular structure; slightly hard, friable; many fine and medium roots; medium acid; gradual smooth boundary.

Bw—6 to 17 inches; dark yellowish brown (10YR 4/4) fine sandy loam, light yellowish brown (10YR 6/4) dry; weak fine granular structure; soft, friable; few fine and medium roots; strongly acid; abrupt wavy boundary.

Cr—17 inches; soft sandstone.

The thickness of the solum and the depth to sandstone bedrock range from 10 to 20 inches. Reaction typically is slightly acid to strongly acid throughout the profile.

The A horizon has hue of 7.5YR or 10YR, value of 3 or 4 (4 or 5 dry), and chroma of 2 to 4. The content of sandstone fragments more than 3 inches in diameter is less than 15 percent in this horizon. The Bw horizon has hue of 5YR, 7.5YR, or 10YR, value of 4 to 6 (5 to 7 dry), and chroma of 4 to 6. The content of sandstone fragments less than 3 inches in diameter is less than 20 percent in this horizon.

Dennis Series

The Dennis series consists of deep, moderately well drained, slowly permeable soils on uplands. These soils formed in material weathered from shale. Slope ranges from 1 to 7 percent.

Dennis soils are similar to Eram and Kenoma soils and are commonly adjacent to those soils and to Bates and Dwight soils. Bates soils are moderately deep over sandstone. They are on ridgetops. Dwight soils have a natric horizon. They are generally lower on the landscape than the Dennis soils. Eram soils are moderately deep over shale. They are on the upper side slopes. Kenoma soils do not have a BA horizon. They are on broad ridgetops.

Typical pedon of Dennis silt loam, 1 to 4 percent slopes, 250 feet north and 1,600 feet east of the southwest corner of sec. 17, T. 30 S., R. 14 E.

A—0 to 10 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; hard, friable; many fine roots; medium acid; gradual smooth boundary.

BA—10 to 16 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 4/3) dry; moderate fine subangular blocky structure; hard, firm; many fine roots; medium acid; gradual smooth boundary.

Bt1—16 to 23 inches; dark brown (10YR 4/3) silty clay, brown (10YR 5/3) dry; common fine prominent yellowish red (5YR 4/6) mottles; moderate medium subangular blocky structure; very hard, very firm; common fine roots; common distinct clay films on faces of peds; few black concretions; medium acid; gradual smooth boundary.

Bt2—23 to 42 inches; dark brown (10YR 4/3) and yellowish brown (10YR 5/6) silty clay, brown (10YR 5/3) and brownish yellow (10YR 6/6) dry; few fine faint grayish brown (10YR 5/2) mottles; moderate medium blocky structure; very hard, very firm; few black concretions; few fine roots; common distinct clay films on faces of peds; slightly acid; diffuse smooth boundary.

Bt3—42 to 60 inches; yellowish brown (10YR 5/6) silty clay, brownish yellow (10YR 6/6) dry; many coarse distinct light brownish gray (10YR 6/2) mottles; weak medium blocky structure; very hard, very firm; few faint clay films on faces of peds; few black concretions; neutral.

The solum is more than 60 inches thick. The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 2 or 3. It is typically silt loam, but in some pedons it is loam or silty clay loam. It is strongly acid or medium acid unless it has been limed. The BA horizon has hue of 10YR, value of 3 or 4 (4 or 5 dry), and chroma of 3 or 4. It is silty clay loam or clay loam. It is strongly acid or medium acid. The Bt horizon has hue of 10YR or 7.5YR, value of 4 or 5 (5 or 6 dry), and chroma of 3 to 6. It is silty clay loam, silty clay, or clay. It ranges from strongly acid to neutral.

Dennis silty clay loam, 2 to 5 percent slopes, eroded, does not have a mollic epipedon, which is definitive for the series. This difference, however, does not alter the usefulness or behavior of the soil.

Dwight Series

The Dwight series consists of deep, moderately well drained, very slowly permeable soils on uplands. These soils formed in clayey sediments. Slope ranges from 1 to 3 percent.

Dwight soils are similar to Kenoma and Woodson soils and are commonly adjacent to Bates, Dennis, Kenoma, and Woodson soils. The adjacent soils do not have a natric horizon and have a surface layer that is thicker than that of the Dwight soils. Kenoma and Woodson soils are in positions on the landscape similar to those of the Dwight soils. Bates and Dennis soils are generally higher on the landscape than the Dwight soils.

Typical pedon of Dwight silt loam, in an area of Dennis-Dwight silt loams, 1 to 5 percent slopes, 350 feet east and 1,400 feet south of the northwest corner of sec. 25, T. 30 S., R. 13 E.

A—0 to 4 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; slightly hard, friable; many roots; medium acid; abrupt smooth boundary.

Bt1—4 to 18 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate medium columnar structure parting to moderate coarse blocky; extremely hard, very firm; many roots;

common distinct clay films on faces of peds; mildly alkaline; gradual smooth boundary.

Bt2—18 to 32 inches; dark grayish brown (10YR 4/2) silty clay, grayish brown (10YR 5/2) dry; few fine distinct olive brown (2.5Y 4/4) mottles; moderate medium blocky structure; extremely hard, very firm; few roots; common distinct clay films on faces of peds; common salt streaks; moderately alkaline; gradual smooth boundary.

Bt3—32 to 41 inches; dark brown (10YR 4/3) silty clay, grayish brown (10YR 5/2) dry; few fine distinct olive brown (2.5Y 4/4) mottles; weak medium blocky structure; extremely hard, very firm; few faint clay films on faces of peds; few black concretions and carbonate concretions; moderately alkaline; gradual smooth boundary.

C—41 to 60 inches; brown (10YR 5/3) silty clay, pale brown (10YR 6/3) dry; common fine distinct olive brown (2.5Y 4/4) mottles; massive; extremely hard, very firm; few black concretions; moderately alkaline.

The thickness of the solum ranges from 30 to 55 inches. The depth to hard sandstone or shale ranges from 40 to more than 60 inches. The mollic epipedon ranges from 14 to 32 inches in thickness.

The A horizon has hue of 10YR, value of 2 or 3 (4 or 5 dry), and chroma of 1 or 2. It is medium acid to neutral. The Bt horizon has hue of 10YR, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 3. It is silty clay or clay. It ranges from slightly acid to moderately alkaline.

Eram Series

The Eram series consists of moderately deep, moderately well drained, slowly permeable soils on uplands. These soils formed in material weathered from shale. Slope ranges from 1 to 7 percent.

Eram soils are similar to Apperson and Dennis soils and are commonly adjacent to Bates, Dennis, Ringo, and Steedman soils. The deep Apperson soils are slightly higher on the landscape than the Eram soils. The deep Dennis soils are lower on the landscape than the Eram soils. Bates, Ringo, and Steedman soils are in positions on the landscape similar to those of the Eram soils. Bates soils are moderately deep over sandstone. Ringo soils have carbonates within 20 inches of the surface. Steedman soils do not have a mollic epipedon.

Typical pedon of Eram silt loam, 1 to 3 percent slopes, 1,200 feet south and 300 feet west of the northeast corner of sec. 18, T. 30 S., R. 14 E.

A—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable; common fine roots; slightly acid; gradual smooth boundary.

Bt—9 to 24 inches; dark brown (10YR 3/3) silty clay, brown (10YR 4/3) dry; few fine faint dark grayish brown (10YR 4/2) mottles; moderate medium blocky structure; extremely hard, very firm; few fine roots; common distinct clay films on faces of peds; few fine sandstone fragments; medium acid; gradual smooth boundary.

BC—24 to 32 inches; olive brown (2.5Y 4/4) silty clay, light olive brown (2.5Y 5/4) dry; few fine faint dark grayish brown (2.5Y 4/2) mottles; weak medium blocky structure; very hard, very firm; few fine roots; few fine shale chips; neutral; clear wavy boundary.

Cr—32 inches; soft shale.

The thickness of the solum and the depth to shale range from 20 to 40 inches. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 2 or 3. It is slightly acid or medium acid. It is typically silt loam, but in some pedons it is silty clay loam. The Bt horizon has hue of 5YR to 2.5Y, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 4. In pedons with value of 4 or 5 and chroma of 3 or 4, this horizon has mottles with value of 4 or more and chroma of 2 or less. It ranges from strongly acid to neutral. It is silty clay or silty clay loam. Seams of lime are in the lower part of the Bt horizon, and the Cr horizon is calcareous in some pedons.

Eram silty clay loam, 3 to 7 percent slopes, eroded, does not have a mollic epipedon, which is definitive for the series. This difference, however, does not alter the usefulness or behavior of the soil.

Girard Series

The Girard series consists of moderately deep, poorly drained, slowly permeable soils on flood plains. These soils formed in clayey alluvium. Slope is 0 to 1 percent.

Girard soils are commonly adjacent to Apperson and Shidler soils. The adjacent soils are on side slopes above the Girard soils. Apperson soils have an argillic horizon. Shidler soils are shallow over limestone.

Typical pedon of Girard silty clay loam, frequently flooded, 660 feet south and 330 feet east of the northwest corner of sec. 26, T. 27 S., R. 16 E.

A—0 to 9 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate coarse granular structure; hard, firm; many fine roots; neutral; gradual smooth boundary.

AB—9 to 14 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; very hard, firm; common fine roots; neutral; gradual smooth boundary.

Bg1—14 to 23 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate medium blocky structure; very hard, very firm; few fine roots; few brownish concretions; few limestone nodules; mildly alkaline; gradual smooth boundary.

Bg2—23 to 26 inches; very dark grayish brown (2.5Y 3/2) silty clay, dark grayish brown (2.5Y 4/2) dry; common fine distinct dark yellowish brown (10YR 4/4 and 3/4) mottles; weak medium blocky structure; extremely hard, very firm; few brownish concretions; mildly alkaline; abrupt smooth boundary.

R—26 inches; hard, fractured limestone.

The thickness of the solum and the depth to limestone range from 20 to 40 inches. The A and AB horizons have hue of 10YR or 2.5Y, value of 2 or 3 (3 to 5 dry), and chroma of 1. They are medium acid to neutral. The Bg horizon is slightly acid to mildly alkaline. The upper part of this horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 to 5 dry), and chroma of 1. The lower part has hue of 10YR or 2.5Y, value of 2 or 3 (3 to 5 dry), and chroma of 1 or 2. The texture of all horizons is silty clay loam, clay loam, or silty clay. The content of clay is more than 35 percent throughout the profile.

Ivan Series

The Ivan series consists of deep, well drained, moderately permeable soils on flood plains. These soils formed in silty alluvium. Slope ranges from 0 to 2 percent.

Ivan soils are similar to Mason and Verdigris soils and are commonly adjacent to Verdigris soils. Mason soils have an argillic horizon. They are on rarely flooded terraces. Verdigris soils are slightly higher on the landscape than the Ivan soils. They have no free carbonates in the 10- to 40-inch control section.

Typical pedon of Ivan silt loam, occasionally flooded, 400 feet east and 760 feet north of the southwest corner of sec. 7, T. 29 S., R. 14 E.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; slightly hard, friable; few fine roots; slight effervescence; moderately alkaline; gradual smooth boundary.

A—9 to 24 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular structure; hard, firm; few fine roots; slight effervescence; moderately alkaline; gradual smooth boundary.

AC—24 to 40 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 4/3) dry; weak fine subangular blocky structure; hard, firm; few fine roots; few fine wormholes and wormcasts; strong effervescence; moderately alkaline; gradual smooth boundary.

C—40 to 60 inches; dark brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; massive; slightly hard, friable; few fine roots; few fine wormholes and wormcasts; strong effervescence; moderately alkaline.

The solum ranges from 24 to 50 inches in thickness. The mollic epipedon ranges from 24 to more than 50 inches in thickness. The depth to lime is 0 to 10 inches.

The A and AC horizons have hue of 10YR or 7.5YR, value of 2 or 3 (4 or 5 dry), and chroma of 2 or 3. The C horizon has hue of 10YR or 7.5YR, value of 3 to 5 (5 to 7 dry), and chroma of 2 or 3.

Kenoma Series

The Kenoma series consists of deep, moderately well drained, very slowly permeable soils on uplands. These soils formed in silty and clayey old alluvium. Slope ranges from 1 to 3 percent.

Kenoma soils are similar to Dennis soils and are commonly adjacent to Catoosa, Dennis, Olpe, and Woodson soils. Dennis soils have a BA horizon. They are slightly lower on the landscape than the Kenoma soils. Catoosa and Woodson soils are less sloping than the Kenoma soils. Catoosa soils have less clay in the subsoil than the Kenoma soils. Woodson soils have chroma of 1 or less in the upper part of the solum. Olpe soils are generally more sloping than the Kenoma soils. The content of chert pebbles in their subsoil is more than 35 percent.

Typical pedon of Kenoma silt loam, 1 to 3 percent slopes, 1,700 feet south and 650 feet east of the northwest corner of sec. 11, T. 30 S., R. 16 E.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable; few fine roots; slightly acid; clear smooth boundary.

Bt1—9 to 19 inches; dark brown (10YR 3/3) silty clay, dark grayish brown (10YR 4/2) dry; few fine prominent dark reddish brown (5YR 3/3) mottles; moderate fine and medium blocky structure; very hard, very firm; few fine roots; common distinct clay films on faces of peds; few fine black concretions; slightly acid; gradual smooth boundary.

Bt2—19 to 25 inches; dark brown (10YR 4/3) silty clay, brown (10YR 5/3) dry; common medium distinct dark brown (7.5YR 4/4) mottles; moderate medium blocky structure; extremely hard, extremely firm; few fine roots; common distinct clay films on faces of peds; few black concretions; neutral; gradual smooth boundary.

Bt3—25 to 44 inches; brown (10YR 5/3) silty clay, yellowish brown (10YR 5/4) dry; weak medium blocky structure; extremely hard, extremely firm; few faint clay films on faces of peds; few black concretions; mildly alkaline; gradual smooth boundary.

C—44 to 60 inches; mixed yellowish brown (10YR 5/6) and gray (10YR 5/1) silty clay, brownish yellow (10YR 6/6) and gray (10YR 6/1) dry; massive; very hard, very firm; common gypsum crystals; mildly alkaline.

The thickness of the solum ranges from 30 to 60 inches. In some pedons limestone or shale is at a depth of 40 to 60 inches. In a few pedons the content of waterworn chert pebbles is as much as 20 percent.

The A horizon has hue of 10YR, value of 2 or 3 (4 or 5 dry), and chroma of 1 to 3. It is typically silt loam, but in a few pedons it is silty clay loam. It is strongly acid to slightly acid. The upper part of the Bt horizon has hue of 10YR or 7.5YR, value of 2 or 3 (4 or 5 dry), and chroma of 2 or 3. The lower part has value of 3 to 5 (4 to 6 dry) and chroma of 2 to 6. The Bt horizon is silty clay or clay in which the content of clay is 40 to 60 percent. It ranges from medium acid to mildly alkaline.

Lanton Series

The Lanton series consists of deep, somewhat poorly drained, slowly permeable soils on low terraces and flood plains along streams. These soils formed in silty and clayey alluvium. Slope ranges from 0 to 2 percent.

Lanton soils are commonly adjacent to Mason, Osage, and Verdigris soils. The well drained Mason soils are on stream terraces. They have an argillic horizon. Osage soils contain more clay than the Lanton soils. They are generally along the larger streams. The well drained Verdigris soils are generally adjacent to stream channels.

Typical pedon of Lanton silt loam, occasionally flooded, 2,300 feet east and 1,000 feet north of the southwest corner of sec. 3, T. 27 S., R. 15 E.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable; few fine roots; slightly acid; gradual smooth boundary.

A1—7 to 14 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; few fine distinct dark yellowish brown (10YR 3/4) mottles; moderate fine subangular blocky structure; hard, firm; few fine roots; slightly acid; gradual smooth boundary.

A2—14 to 37 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; common fine distinct dark yellowish brown (10YR 3/4) mottles; weak medium subangular blocky structure; hard, firm; slightly acid; gradual smooth boundary.

Cg—37 to 60 inches; dark gray (10YR 4/1) silty clay, gray (10YR 5/1) dry; common medium distinct dark yellowish brown (10YR 4/4) mottles; massive; very hard, very firm; few black concretions; neutral.

The solum is more than 40 inches thick. Reaction is slightly acid or neutral throughout the profile. The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 or 2. It is silt loam and silty clay loam. The C horizon has hue of 10YR, value of 3 or 4 (4 or 5 dry), and chroma of 1 or 2. It is commonly mottled with shades of red, brown, or gray. It is silty clay loam or silty clay.

Mason Series

The Mason series consists of deep, well drained, moderately slowly permeable soils on stream terraces. These soils formed in silty alluvium. Slope ranges from 0 to 2 percent.

Mason soils are similar to Verdigris and Ivan soils and are commonly adjacent to Lanton, Osage, and Verdigris soils. The similar and adjacent soils do not have an argillic horizon. They are slightly lower on the landscape than the Mason soils. Also, Osage soils are more clayey.

Typical pedon of Mason silt loam, 1,200 feet south and 2,500 feet east of the northwest corner of sec. 1, T. 27 S., R. 13 E.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable; few fine roots; neutral; gradual smooth boundary.

A—9 to 14 inches; dark brown (10YR 3/3) silt loam, brown (10YR 4/3) dry; moderate medium granular structure; slightly hard, friable; few fine roots; neutral; gradual smooth boundary.

Bt1—14 to 30 inches; dark brown (7.5YR 3/2) silty clay loam, brown (7.5YR 4/2) dry; moderate medium subangular blocky structure; hard, firm; few fine roots; few faint clay films on faces of peds; few black concretions; medium acid; gradual smooth boundary.

Bt2—30 to 60 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; hard, firm; few fine roots; few faint clay films on faces of peds; few black concretions; medium acid.

The solum ranges from 40 to more than 60 inches in thickness. The mollic epipedon is more than 20 inches thick.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 2 or 3. It is typically silt loam, but in some pedons it is silty clay loam. It is neutral to medium acid. The Bt horizon has hue of 10YR or 7.5YR, value of 2 to 4 (3 to 5 dry), and chroma of 2 or 3. In some pedons it is faintly mottled with shades of brown, gray, or red in the lower part. This horizon is slightly acid to strongly acid.

Niotaze Series

The Niotaze series consists of moderately deep, somewhat poorly drained, slowly permeable soils on uplands. These soils formed in material weathered from shale interbedded with sandstone. Slope ranges from 4 to 30 percent.

Niotaze soils are commonly adjacent to Collinsville, Darnell, and Stephenville soils. Collinsville and Darnell soils are shallow over sandstone. They are on side slopes above the Niotaze soils. Stephenville soils are less clayey in the subsoil than the Niotaze soils. They are on ridgetops.

Typical pedon of Niotaze cobbly fine sandy loam, in an area of Niotaze-Darnell complex, 4 to 30 percent slopes, 1,650 feet west and 200 feet north of the southeast corner of sec. 1, T. 27 S., R. 13 E.

A—0 to 5 inches; dark brown (10YR 3/3) cobbly fine sandy loam, brown (10YR 5/3) dry; moderate very fine granular structure; soft, friable; common fine roots; about 35 percent sandstone fragments; medium acid; clear smooth boundary.

E—5 to 9 inches; brown (10YR 4/3) cobbly fine sandy loam, pale brown (10YR 6/3) dry; moderate fine granular structure; slightly hard, friable; few fine roots; about 25 percent sandstone fragments; strongly acid; clear smooth boundary.

2Bt—9 to 24 inches; yellowish red (5YR 4/6) silty clay, yellowish red (5YR 5/6) dry; moderate fine and medium blocky structure; very hard, very firm; few fine roots; few faint clay films on faces of peds; strongly acid; gradual smooth boundary.

2BC—24 to 36 inches; dark brown (10YR 4/3) silty clay, brown (10YR 5/3) dry; many medium distinct yellowish red (5YR 5/6) and few fine faint light brownish gray (10YR 6/2) mottles; weak medium blocky structure; very hard, very firm; medium acid; gradual wavy boundary.

2Cr—36 inches; silty shale.

The depth to shale ranges from 20 to 40 inches. The A and E horizons are medium acid or strongly acid. The A horizon has hue of 10YR, value of 2 to 4 (4 to 6 dry), and chroma of 1 to 3. The E horizon has hue of 10YR or 7.5YR, value of 3 to 5 (5 to 7 dry), and chroma of 2 or 3. The B horizon has hue of 2.5YR to 2.5Y, value of 3 to 5 (4 to 6 dry), and chroma of 3 to 6. It is silty clay or silty clay loam. It is slightly acid to strongly acid.

Olpe Series

The Olpe series consists of deep, well drained, slowly permeable soils on uplands. These soils formed in gravelly old alluvium. Slope ranges from 2 to 7 percent.

Olpe soils are adjacent to Eram and Kenoma soils. The adjacent soils do not have chert pebbles. Eram soils are on the upper side slopes. Kenoma soils are on foot slopes or in the less sloping areas above the Olpe soils.

Typical pedon of Olpe silt loam, in an area of Kenoma-Olpe silt loams, 2 to 7 percent slopes, 600 feet south and 20 feet west of the northeast corner of sec. 19, T. 28 S., R. 15 E.

A—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable; many fine roots; few pebbles; slightly acid; gradual wavy boundary.

BA—8 to 16 inches; dark brown (7.5YR 3/2) silty clay loam, brown (7.5YR 4/2) dry; moderate fine subangular blocky structure; hard, firm; many fine roots; about 5 percent rounded chert pebbles; slightly acid; gradual smooth boundary.

Bt1—16 to 22 inches; dark reddish brown (5YR 3/4) very gravelly silty clay, reddish brown (5YR 4/4) dry; moderate medium subangular blocky structure; very hard, very firm; few fine roots; common distinct clay films on faces of peds; about 60 percent rounded chert pebbles; neutral; gradual wavy boundary.

Bt2—22 to 46 inches; dark reddish brown (5YR 3/4) extremely gravelly silty clay, reddish brown (5YR 4/4) dry; moderate medium blocky structure; very hard, very firm; few fine roots; common distinct clay films on faces of peds; about 70 percent rounded chert pebbles; neutral; gradual smooth boundary.

Bt3—46 to 56 inches; brown (7.5YR 5/4) extremely gravelly silty clay, light brown (7.5YR 6/4) dry; many prominent coarse yellowish red (5YR 4/6) mottles; weak medium blocky structure; very hard, very firm; few fine roots; few faint clay films on faces of peds; about 70 percent rounded chert pebbles; slightly acid; gradual smooth boundary.

BC—56 to 60 inches; yellowish brown (10YR 5/6) gravelly silty clay, brownish yellow (10YR 6/6) dry; weak medium subangular blocky structure; very hard, very firm; about 20 percent rounded chert pebbles; slightly acid.

The solum is more than 60 inches thick. The mollic epipedon ranges from 10 to 20 inches in thickness.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 to 3. It is typically silt loam, but in some pedons it is gravelly silt loam. It is strongly acid to slightly acid unless it has been limed. The Bt horizon has hue of 2.5YR to 7.5YR, value of 3 to 5 (4 to 6 dry), and chroma of 4 to 6. It is medium acid to neutral. The content of gravel ranges from 40 to 80 percent in the upper part of this horizon and from 30 to 70 percent in the lower part.

Osage Series

The Osage series consists of deep, poorly drained, very slowly permeable soils on flood plains. These soils formed in clayey alluvium. Slope is 0 to 1 percent.

Osage soils are similar to Zaar soils and are commonly adjacent to Lanton, Mason, and Verdigris soils. The somewhat poorly drained Zaar soils are in the uplands. Lanton, Mason, and Verdigris soils contain less clay in the control section than the Osage soils. Lanton soils generally are along the smaller streams. Mason soils are on stream terraces. Verdigris soils are adjacent to stream channels.

Typical pedon of Osage silty clay, occasionally flooded, 2,520 feet south and 300 feet west of the northeast corner of sec. 31, T. 30 S., R. 16 E.

Ap—0 to 7 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; strong medium granular structure; very hard, very firm; few fine roots; neutral; clear smooth boundary.

A—7 to 16 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate fine blocky structure; extremely hard, extremely firm; few fine roots; mildly alkaline; gradual smooth boundary.

Bg1—16 to 45 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate medium blocky structure; extremely hard, extremely firm; few fine roots; mildly alkaline; gradual smooth boundary.

Bg2—45 to 60 inches; very dark grayish brown (2.5Y 3/2) silty clay, dark grayish brown (2.5Y 4/2) dry; common fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium blocky structure; extremely hard, extremely firm; mildly alkaline.

The solum is more than 40 inches thick. The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. It is silty clay or silty clay loam. It ranges from strongly acid to mildly alkaline. The Bg horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. In some pedons it has mottles with higher value and chroma. It is slightly acid to mildly alkaline.

Prue Series

The Prue series consists of deep, moderately well drained, moderately slowly permeable soils on uplands. These soils formed in material weathered from sandy shale and sandstone. Slope ranges from 2 to 5 percent.

Prue soils are similar to Bates soils and are commonly adjacent to Bates, Darnell, Dennis, and Stephenville soils. Bates, Darnell, and Stephenville soils are on ridgetops. Bates and Stephenville soils are moderately deep over sandstone. Darnell soils are shallow over sandstone. Dennis soils have more clay in the subsoil than the Prue soils. They are in positions on the landscape similar to those of the Prue soils.

Typical pedon of Prue loam, 2 to 5 percent slopes, 2,000 feet east and 1,340 feet north of the southwest corner of sec. 6, T. 28 S., R. 14 E.

A—0 to 11 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; moderate very fine granular structure; slightly hard, friable; many fine roots; medium acid; gradual smooth boundary.

BA—11 to 17 inches; very dark brown (10YR 2/2) clay loam, very dark grayish brown (10YR 3/2) dry; moderate fine granular structure; slightly hard, friable; many fine roots; slightly acid; gradual smooth boundary.

Bt1—17 to 27 inches; dark brown (10YR 3/3) clay loam, brown (10YR 4/3) dry; moderate fine subangular blocky structure; hard, firm; few fine roots; few faint clay films on faces of peds; few fine sandstone fragments; slightly acid; gradual smooth boundary.

Bt2—27 to 38 inches; dark yellowish brown (10YR 4/4) clay loam, yellowish brown (10YR 5/4) dry; few fine faint brown (10YR 5/3) mottles; moderate fine subangular blocky structure; hard, firm; few fine roots; common distinct clay films on faces of peds; few fine sandstone fragments; slightly acid; gradual smooth boundary.

2Bt3—38 to 50 inches; coarsely mottled brown (10YR 5/3) and yellowish brown (10YR 5/6) silty clay, pale brown (10YR 6/3) and brownish yellow (10YR 6/6) dry; weak medium blocky structure; very firm, very hard; common distinct clay films on faces of peds; slightly acid; gradual smooth boundary.

2Bt4—50 to 60 inches; brown (10YR 5/3) silty clay, pale brown (10YR 6/3) dry; common coarse distinct strong brown (7.5YR 5/6) mottles; weak medium blocky structure; very hard, very firm; few faint clay films on faces of peds; mildly alkaline.

The thickness of the solum and the depth to bedrock are more than 60 inches. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 2. It is slightly acid to strongly acid unless it has been limed. The Bt horizon has hue of 10YR, value of 3 to 5, and chroma of 3 or 4. It is typically clay loam, but in some pedons it is sandy clay loam. It is slightly acid to strongly acid. The 2Bt horizon is coarsely mottled with shades of brown and red. It is silty clay loam, clay loam, or silty clay. It is slightly acid to strongly acid in the upper part and ranges from strongly acid to mildly alkaline in the lower part.

Ringo Series

The Ringo series consists of moderately deep, moderately well drained, very slowly permeable soils on uplands. These soils formed in material weathered from shale. Slope ranges from 3 to 35 percent.

Ringo soils are commonly adjacent to Catoosa, Eram, and Shidler soils. Eram soils have a loamy surface layer. They are in positions on the landscape similar to those of the Ringo soils. Catoosa and Shidler soils are underlain by limestone. They are on ridgetops.

Typical pedon of Ringo silty clay loam, in an area of Ringo-Shidler silty clay loams, 3 to 15 percent slopes, 1,500 feet north and 250 feet east of the southwest corner of sec. 17, T. 28 S., R. 17 E.

A—0 to 11 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; strong fine granular structure; hard, firm; many fine roots; few fine accumulations of carbonate; weak effervescence; mildly alkaline; gradual smooth boundary.
BA—11 to 14 inches; very dark grayish brown (2.5Y 3/2) silty clay loam, dark grayish brown (2.5Y 4/2) dry; moderate medium granular structure; hard, firm; many fine roots; common fine accumulations of carbonate; strong effervescence; moderately alkaline; gradual smooth boundary.
Bw1—14 to 21 inches; dark grayish brown (2.5Y 4/2) silty clay loam, grayish brown (2.5Y 5/2) dry; moderate fine subangular blocky structure; hard, firm; common fine roots; many fine and medium accumulations of carbonate; strong effervescence; moderately alkaline; gradual smooth boundary.
Bw2—21 to 26 inches; grayish brown (2.5Y 5/2) silty clay, light brownish gray (2.5Y 6/2) dry; weak medium blocky structure; very hard, very firm; common medium light olive brown (2.5Y 5/4) fragments of soft shale; few fine accumulations of carbonate; strong effervescence; moderately alkaline; clear wavy boundary.
Cr—26 inches; soft, calcareous shale.

The thickness of the solum and the depth to shale range from 20 to 40 inches. The mollic epipedon ranges from 8 to 20 inches in thickness. Reaction ranges from slightly acid to moderately alkaline throughout the profile.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. It is typically silty clay loam, but in some pedons it is silty clay. The Bw horizon has hue of 10YR or 2.5Y, value of 4 or 5 (5 or 6 dry), and chroma of 2 to 4.

Shidler Series

The Shidler series consists of shallow, well drained, moderately permeable soils on uplands. These soils formed in material weathered from limestone. Slope ranges from 1 to 8 percent.

Shidler soils are commonly adjacent to Apperson, Catoosa, Ringo, and Zaar soils. The deep Apperson and Zaar soils have a clayey subsoil. Apperson soils are generally higher on the landscape than the Shidler soils. Zaar soils are on foot slopes. Catoosa soils are moderately deep over limestone. They are generally higher on the landscape than the Shidler soils. Ringo soils are moderately deep over shale. They are on side slopes.

Typical pedon of Shidler silty clay loam, in an area of Shidler-Catoosa complex, 1 to 8 percent slopes, 150 feet north and 300 feet east of the southwest corner of sec. 8, T. 27 S., R. 17 E.

A—0 to 10 inches; very dark brown (10YR 2/2) silty clay loam, very dark grayish brown (10YR 3/2) dry; moderate fine granular structure; slightly hard, friable; many fine roots; about 14 percent limestone fragments; slightly acid; abrupt wavy boundary.
R—10 inches; hard limestone.

The thickness of the solum and the depth to hard limestone range from 4 to 20 inches. The A horizon has hue of 5YR, 7.5YR, or 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 to 3. It ranges from slightly acid to moderately alkaline. It is typically silty clay loam, but in some pedons it is silt loam. The content of thin, flat limestone fragments that are 3 to 15 inches in size along the longer axis is less than 20 percent.

Steedman Series

The Steedman series consists of moderately deep, moderately well drained, slowly permeable soils on uplands. These soils formed in shale residuum. Slope ranges from 4 to 25 percent.

Steedman soils are similar to Eram soils and are commonly adjacent to Bates, Collinsville, Dennis, Eram, and Niotaze soils. Eram and Niotaze soils are generally lower on the landscape than the Steedman soils. Eram soils have a mollic epipedon, and Niotaze soils have an E horizon. Bates soils are less clayey in the subsoil than the Steedman soils. They are on ridgetops. Collinsville soils are shallow over sandstone. They are on the upper side slopes. The deep Dennis soils have a mollic epipedon. They are on foot slopes and the lower side slopes.

Typical pedon of Steedman gravelly silt loam, 4 to 25 percent slopes, stony, 1,700 feet east and 100 feet north of the southwest corner of sec. 23, T. 29 S., R. 13 E.

A—0 to 8 inches; very dark grayish brown (10YR 3/2) gravelly silt loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable; about 25 percent gravel-sized sandstone fragments; many fine roots; slightly acid; clear smooth boundary.
Bt1—8 to 26 inches; dark brown (7.5Y 4/4) silty clay, brown (7.5YR 5/4) dry; moderate medium blocky structure; very hard, very firm; common fine roots; few faint clay films on faces of peds; medium acid; gradual smooth boundary.
Bt2—26 to 32 inches; dark yellowish brown (10YR 4/4) silty clay, yellowish brown (10YR 5/4) dry; few fine faint strong brown (7.5YR 4/6) mottles; weak medium blocky structure; very hard, very firm; few fine roots; few faint clay films on faces of peds; few fine black concretions; neutral; clear smooth boundary.
Cr—32 inches; soft, clayey shale.

The thickness of the solum and the depth to shale range from 20 to 40 inches. Some pedons do not have sandstone fragments in the solum.

The A horizon has hue of 10YR or 7.5YR, value of 3 or 4 (4 or 5 dry), and chroma of 2 or 3. It is typically gravelly silt loam, but the range includes silt loam, stony loam, and loam. This horizon is slightly acid to strongly acid. The Bt horizon has hue of 5YR, 7.5YR, or 10YR, value of 4 or 5 (5 or 6 dry), and chroma of 2 to 5. It is clay or silty clay. It ranges from medium acid to mildly alkaline.

Stephenville Series

The Stephenville series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from sandstone. Slope ranges from 2 to 6 percent.

Stephenville soils are commonly adjacent to Darnell and Niotaze soils. The adjacent soils are on side slopes below the Stephenville soils. Darnell soils do not have an argillic horizon and are shallow over sandstone. Niotaze soils are more clayey in the subsoil than the Stephenville soils.

Typical pedon of Stephenville fine sandy loam, in an area of Stephenville-Darnell fine sandy loams, 2 to 6 percent slopes, 120 feet north and 100 feet west of the southeast corner of sec. 35, T. 27 S., R. 13 E.

A—0 to 7 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; moderate very fine granular structure; slightly hard, friable; many fine roots; medium acid; gradual smooth boundary.

E—7 to 17 inches; dark yellowish brown (10YR 4/4) fine sandy loam, yellowish brown (10YR 5/4) dry; weak very fine granular structure; soft, very friable; few fine roots; strongly acid; gradual smooth boundary.

Bt—17 to 27 inches; reddish brown (5YR 4/4) sandy clay loam, reddish brown (5YR 5/4) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; moderate fine subangular blocky structure; slightly hard, friable; few fine roots; few faint clay films on faces of peds; strongly acid; abrupt wavy boundary.

Cr—27 inches; soft sandstone, which becomes harder with increasing depth.

The thickness of the solum and the depth to bedrock range from 20 to 40 inches. In some pedons scattered sandstone fragments are on the surface and throughout the solum.

The A horizon has hue of 7.5YR or 10YR, value of 3 to 5 (4 to 6 dry), and chroma of 2 or 3. It is typically fine sandy loam, but in some pedons it is loamy fine sand. The E horizon has hue of 7.5YR or 10YR, value of 4 to 6 (5 to 8 dry), and chroma of 2 to 4. The A and E horizons are strongly acid to slightly acid. The Bt horizon has hue of 2.5YR, 5YR, or 10YR, value of 4 or 5 (5 to 8 dry), and chroma of 4 to 8. It is strongly acid or medium acid.

Verdigris Series

The Verdigris series consists of deep, moderately well drained, moderately permeable soils on flood plains. These soils formed in silty alluvium. Slope ranges from 0 to 2 percent.

Verdigris soils are similar to Ivan and Mason soils and are commonly adjacent to Ivan, Lanton, Mason, and Osage soils. Ivan soils have free carbonates within 10 inches of the surface. They are slightly lower on the landscape than the Verdigris soils. Lanton soils have mottles within 16 inches of the surface. They are generally along the larger creeks. Mason soils have an argillic horizon. They are on stream terraces. Osage soils have more clay in the subsoil than the Verdigris soils. They are generally in broad, slightly concave areas a few hundred feet from stream channels.

Typical pedon of Verdigris silt loam, occasionally flooded, 2,000 feet south and 350 feet east of the northwest corner of sec. 25, T. 27 S., R. 14 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; slightly hard, firm; few fine roots; few fine pores; neutral; gradual smooth boundary.

A—8 to 22 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; hard, firm; few fine roots; few fine pores; neutral; gradual smooth boundary.

AC—22 to 31 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 4/3) dry; weak medium blocky structure; hard, firm; common fine pores; neutral; gradual smooth boundary.

C1—31 to 44 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 4/3) dry; massive; hard, firm; common fine pores; neutral; gradual smooth boundary.

C2—44 to 60 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 4/3) dry; massive; slightly hard, firm; few fine pores; neutral.

The solum and the mollic epipedon range from 24 to more than 50 inches in thickness. Reaction is medium acid to neutral to a depth of 50 inches or more.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 to 5 dry), and chroma of 1 to 3. It is typically silt loam, but in many pedons it is silty clay loam. The C horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 4. It is typically silty clay loam, but in some pedons it is silt loam.

Woodson Series

The Woodson series consists of deep, somewhat poorly drained, very slowly permeable soils on uplands. These soils generally formed in old alluvial sediments, but in many areas loess is in the upper part of the profile. Slope is 0 to 1 percent.

Woodson soils are commonly adjacent to Dwight, Kenoma, and Zaar soils. Dwight soils have a natric horizon. They are in positions on the landscape similar to those of the Woodson soils. Kenoma soils are more sloping than the Woodson soils. Also, they have a browner subsoil. Zaar soils have more clay in the surface layer than the Woodson soils. They are on broad flats and on toe slopes.

Typical pedon of Woodson silt loam, 1,320 feet south and 200 feet east of the northwest corner of sec. 3, T. 29 S., R. 14 E.

A—0 to 8 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; moderate fine granular structure; slightly hard, friable; few fine roots; slightly acid; abrupt smooth boundary.

Bt—8 to 28 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; moderate medium blocky structure; extremely hard, extremely firm; few fine roots; common distinct clay films on faces of peds; slightly acid; gradual smooth boundary.

BC—28 to 50 inches; gray (10YR 5/1) silty clay, light gray (10YR 6/1) dry; common coarse distinct brown (10YR 5/3) and few fine prominent reddish brown (5YR 4/3) mottles; weak medium blocky structure; very hard, very firm; few black concretions; slightly acid; gradual smooth boundary.

C—50 to 60 inches; dark brown (10YR 4/3) silty clay, brown (10YR 5/3) dry; many coarse faint dark yellowish brown (10YR 4/6) mottles and few fine distinct black (10YR 2/1) mottles and streaks; massive; very hard, very firm; few black concretions; medium acid.

The thickness of the solum ranges from 30 to 60 inches. The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1. It is typically silt loam, but in some pedons it is silty clay loam. It is medium acid or slightly acid unless it has been limed. The Bt horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 to 5 dry), and chroma of 1 and has few to many brownish or yellowish mottles. It is silty clay or clay. It is medium acid to neutral. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 to 3.

Zaar Series

The Zaar series consists of deep, somewhat poorly drained, very slowly permeable soils on uplands. These soils formed in clayey material weathered from shale. Slope ranges from 0 to 4 percent.

Zaar soils are similar to Apperson and Osage soils and are commonly adjacent to Apperson, Ringo, Shidler, and Woodson soils. The moderately well drained Apperson soils are mainly on ridgetops. They are underlain by limestone. The poorly drained Osage soils are on flood plains. The moderately deep Ringo soils have a calcareous subsoil. They generally are on the steeper side slopes above the Zaar soils. Shidler soils are shallow over limestone. They are on ridgetops. Woodson soils have an argillic horizon. They are in broad, nearly level areas below the Zaar soils.

Typical pedon of Zaar silty clay, 1 to 4 percent slopes, 990 feet west and 200 feet north of the southeast corner of sec. 13., T. 27 S., R. 16 E.

Ap—0 to 10 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate medium granular structure; very hard, very firm; few fine roots; slightly acid; clear smooth boundary.

Bw1—10 to 20 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; strong fine and medium blocky structure; very hard, very firm; few fine roots; few vertical streaks of darker material; few small black concretions; neutral; gradual smooth boundary.

Bw2—20 to 36 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium blocky structure; extremely hard, extremely firm; few vertical streaks of darker material; few small black concretions; mildly alkaline; gradual smooth boundary.

Bw3—36 to 46 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium blocky structure; extremely hard, extremely firm; few lime concretions; mildly alkaline; gradual smooth boundary.

BC—46 to 56 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; common fine distinct yellowish brown (10YR 5/6) mottles; weak medium blocky structure; few lime concretions; mildly alkaline; gradual smooth boundary.

C—56 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; few fine faint olive brown (2.5Y 4/4) mottles; massive; very hard, very firm; few lime concretions; mildly alkaline.

The solum is more than 40 inches thick. The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. It is typically silty clay, but in some pedons it is silty clay loam. It is medium acid to neutral unless it has been limed. The Bw horizon has hue of 10YR or 2.5Y. It has value of 2 to 4 (3 to 5 dry) and chroma of 1 to 3 in the upper part and value of 3 to 5 (4 to 6 dry) and chroma of 1 to 4 in the lower part. It is typically silty clay, but in some pedons it is clay. It is slightly acid to mildly alkaline.

Formation of the Soils

Soil forms through processes that act on deposited or accumulated geologic material. The characteristics of the soil at any given point are determined by the interaction of five factors of soil formation: 1) the physical and mineralogical composition of the parent material, 2) the climate under which the soil material has accumulated and has existed since accumulation, 3) the plant and animal life on and in the soil, 4) the relief, and 5) the length of time that the forces of soil formation have acted on the parent material. Each of these factors influences the formation of every soil, and each modifies the effects of the other four. The relative effects of the individual factors vary from place to place. The interactions among the factors are more complex for some soils than for others.

Parent Material

Parent material is the unconsolidated material in which soils form. It either is material weathered from rocks through freezing and thawing, abrasion, erosion, or chemical processes or is weathered material deposited by wind or water. The parent material affects texture, structure, color, natural fertility, and many other soil properties. Soils differ partly because of the various kinds of parent material. The texture of the parent material influences the rate of the downward movement of water and air and thus greatly affects soil formation. The composition of the parent material largely determines the mineralogical composition of the soil and, hence, its natural fertility.

Many of the soils in Wilson County formed in material weathered from Pennsylvanian limestone, sandstone, and shale. The other kinds of parent material are alluvial sediments and eolian and colluvial sediments.

Dennis, Eram, Ringo, and Steedman soils formed in material weathered from shale. Apperson, Catoosa, and Shidler soils formed in material weathered from limestone. Bates, Collinsville, Darnell, and Stephenville soils formed in material weathered from sandstone.

Alluvium is water-deposited material. Two types of alluvial sediments are evident in Wilson County—recent alluvium and old alluvium. The recent alluvium is in the stream valleys. Ivan, Lanton, Mason, Osage, and Verdigris soils formed in this material. Old alluvial sediments are on parts of the landscape that are now uplands. Kenoma, Olpe, and Woodson soils formed partly or entirely in these sediments.

Some soils formed in material derived from more than one source. The lower part of the Niotaze soils, for example, formed in material weathered from shale. In many areas, however, the upper part of these soils appears to be of sandstone origin. The upper part of Kenoma and Woodson soils may have been somewhat influenced by eolian or windblown sediments.

Climate

Climate is an active factor of soil formation. It directly influences soil formation by weathering the parent material. It indirectly affects soil formation through its effect on plants and animals.

The climate of Wilson County is typical continental. It is characterized by intermittent dry and moist periods, which can last for less than a year or for several years. The soil material dries to varying depths during dry periods. It slowly regains moisture during wet periods and can become so saturated that excess moisture penetrates the substratum. Because of the wetting and drying, some of the basic nutrients, and even clay particles, have been leached from the upper horizons in most of the soils.

Plant and Animal Life

Plants and animals have important effects on soil formation. Plants generally influence the content of nutrients and organic matter in the soil and the color of the surface layer. Earthworms, cicadas, and other burrowing animals help to keep the soil open and porous. Bacteria and fungi decompose the plants, thus releasing plant nutrients.

The tall and mid prairie grasses have had an influence on soil formation in Wilson County. As a result of these grasses, the upper part of a typical soil in the county is dark and is high in content of organic matter. The transitional part in many areas is slightly finer textured and somewhat lighter colored than the layer above. The underlying parent material generally is light in color. The soils that formed under a canopy of oaks in the western part of the county do not have a thick, dark surface layer and are more acid than the soils that formed under prairie grasses.

Relief

Relief, or lay of the land, influences the formation of soils through its effect on drainage, runoff, plant cover, and soil temperature. Although climate and plants are the most active factors of soil formation, relief also is important, mainly because it controls the movement of water on the surface and into the soil.

Runoff is more rapid on the steeper upland soils than on the less sloping soils. As a result, erosion is more extensive. Collinsville soils formed in old parent material, but relief has restricted their formation. Runoff is rapid on these moderately sloping and strongly sloping soils, and much of the soil material is removed as soon as a soil profile forms.

Time

The length of time needed for soil formation depends largely on the other factors of soil formation. As water moves downward through the soil, soluble material and fine particles are gradually leached from the surface layer to the subsoil. The amount of leaching depends on the amount of time that has elapsed and the amount of water that has penetrated the surface.

Differences in the length of time that the parent material has been exposed to the processes of soil formation are reflected in the degree of profile development. For example, the young Ivan and Verdigris soils, which formed in recent alluvium, show very little evidence of horizon development other than a slight darkening of the surface layer. In contrast, the older Kenoma and Woodson soils, which have been exposed to soil-forming processes for thousands of years, have well defined horizons.

References

(1) American Association of State Highway and Transportation Officials. 1982. Standard specifications for highway materials and methods of sampling and testing. Ed. 13, 2 vols., illus.

(2) American Society for Testing and Materials. 1985. Standard test method for classification of soils for engineering purposes. ASTM Stand. D 2487.

(3) Kansas State Board of Agriculture. 1983. 1982-1983. 66th biennial report and farm facts. 261 pp., illus.

(4) Kerr, J.A., J.T. Whetzel, and H.W. Higbee. 1927. Soil survey of Wilson County, Kansas. U.S. Dep. Agric., Bur. of Chem. and Soils, 29 pp., illus.

(5) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus.

(6) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.

(7) United States Department of Agriculture, Soil Conservation Service. National resources inventory. (Available in the State Office of the Soil Conservation Service at Salina, Kansas)

Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Argillic horizon. A subsoil horizon characterized by an accumulation of illuvial clay.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Bedding system. A drainage system made by plowing, grading, or otherwise shaping the surface of a flat field. It consists of a series of low ridges separated by shallow, parallel dead furrows.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Mollic epipedon. A thick, dark, humus-rich surface horizon (or horizons) that has high base saturation and pedogenic soil structure. It may include the upper part of the subsoil.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor, on the basis of how much the present plant community has departed from the potential.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Sodicity. The degree to which a soil is affected by exchangeable sodium. Sodicity is expressed as a sodium adsorption ratio (SAR) of a saturation extract, or the ratio of Na^+ to $Ca^{++} + Mg^{++}$. The degrees of sodicity are—

	SAR
Slight	less than 13:1
Moderate	13-30:1
Strong	more than 30:1

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0

Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1941-70 at Fredonia, Kansas)

Month	Temperature					Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	In	In	In		In
January----	44.3	21.8	33.1	73	-5	1.14	0.33	1.59	3	3.3
February---	50.3	26.2	38.3	78	1	1.13	.35	1.79	3	2.6
March------	58.0	32.7	45.4	87	8	2.13	1.17	3.65	4	2.8
April------	71.0	45.8	58.4	93	23	3.61	1.59	4.58	5	.0
May--------	78.8	55.1	67.0	94	33	4.84	3.09	6.50	7	.0
June-------	87.2	63.6	75.4	103	46	5.30	2.47	7.40	7	.0
July-------	92.8	67.3	80.1	107	50	2.93	1.59	7.79	6	.0
August-----	93.1	66.1	79.6	110	52	3.09	1.72	4.44	5	.0
September--	84.0	57.8	70.9	100	38	5.16	1.75	7.22	6	.0
October----	74.1	47.4	60.8	95	25	2.71	.94	5.63	5	.0
November---	58.8	34.4	46.6	81	10	1.67	.22	4.05	3	1.8
December---	47.3	25.6	36.5	70	-1	1.33	.68	2.26	3	2.5
Year-----	70.0	45.3	57.7	112	-6	35.04	25.35	44.85	57	13.0

TABLE 2.--FREEZE DATES IN SPRING AND FALL

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	Apr. 6	Apr. 16	Apr. 27
2 years in 10 later than--	Apr. 1	Apr. 11	Apr. 22
5 years in 10 later than--	Mar. 23	Apr. 1	Apr. 12
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 28	Oct. 20	Oct. 10
2 years in 10 earlier than--	Nov. 1	Oct. 25	Oct. 14
5 years in 10 earlier than--	Nov. 11	Nov. 3	Oct. 24

TABLE 3.--GROWING SEASON

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	210	195	174
8 years in 10	218	202	181
5 years in 10	233	216	195
2 years in 10	249	230	209
1 year in 10	257	237	217

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Ae	Apperson silty clay loam, 0 to 2 percent slopes	18,590	5.1
Ba	Bates loam, 1 to 4 percent slopes	10,890	3.0
Bc	Bates loam, 4 to 7 percent slopes	2,815	0.8
Bh	Bates-Collinsville loams, 3 to 7 percent slopes	4,755	1.3
Bo	Bates-Collinsville loams, 7 to 20 percent slopes	23,230	6.3
Ca	Catoosa silt loam, 0 to 2 percent slopes	23,605	6.4
Dn	Dennis silt loam, 1 to 4 percent slopes	21,730	5.9
Do	Dennis silt loam, 4 to 7 percent slopes	785	0.2
Dp	Dennis silty clay loam, 2 to 5 percent slopes, eroded	490	0.1
Dw	Dennis-Dwight silt loams, 1 to 5 percent slopes	6,430	1.7
Eb	Eram silt loam, 1 to 3 percent slopes	13,840	3.8
Ec	Eram silt loam, 3 to 7 percent slopes	9,015	2.5
Ef	Eram silty clay loam, 3 to 7 percent slopes, eroded	560	0.2
Gr	Girard silty clay loam, frequently flooded	420	0.1
Iv	Ivan silt loam, occasionally flooded	1,435	0.4
Ke	Kenoma silt loam, 1 to 3 percent slopes	33,968	9.2
Ko	Kenoma-Olpe silt loams, 2 to 7 percent slopes	2,695	0.7
La	Lanton silt loam, occasionally flooded	6,675	1.8
Ma	Mason silt loam	2,705	0.7
Nd	Niotaze-Darnell complex, 4 to 30 percent slopes	10,435	2.8
Or	Osage silty clay loam, occasionally flooded	9,865	2.7
Os	Osage silty clay, occasionally flooded	10,715	2.9
Pe	Prue loam, 2 to 5 percent slopes	4,040	1.1
Pt	Pits, quarries	1,085	0.3
Rn	Ringo silty clay loam, 15 to 35 percent slopes	6,685	1.8
Rs	Ringo-Shidler silty clay loams, 3 to 15 percent slopes	8,955	2.4
Sc	Shidler-Catoosa complex, 1 to 8 percent slopes	37,905	10.3
Sf	Steedman gravelly silt loam, 4 to 25 percent slopes, stony	6,740	1.8
Sm	Stephenville-Darnell fine sandy loams, 2 to 6 percent slopes	3,305	0.9
Sp	Stephenville-Darnell fine sandy loams, 6 to 20 percent slopes	1,765	0.5
Vc	Verdigris silt loam, channeled	5,755	1.6
Vf	Verdigris silt loam, occasionally flooded	25,400	6.9
Wo	Woodson silt loam	27,390	7.4
Za	Zaar silty clay, 0 to 1 percent slopes	5,320	1.5
Zb	Zaar silty clay, 1 to 4 percent slopes	17,945	4.9
	Water	120	*
	Total	368,058	100.0

* Less than 0.1 percent.

TABLE 5.--PRIME FARMLAND

(Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name)

Map symbol	Soil name
Ae	Apperson silty clay loam, 0 to 2 percent slopes
Ba	Bates loam, 1 to 4 percent slopes
Bc	Bates loam, 4 to 7 percent slopes
Ca	Catoosa silt loam, 0 to 2 percent slopes
Dn	Dennis silt loam, 1 to 4 percent slopes
Do	Dennis silt loam, 4 to 7 percent slopes
Eb	Eram silt loam, 1 to 3 percent slopes
Iv	Ivan silt loam, occasionally flooded
Ke	Kenoma silt loam, 1 to 3 percent slopes
La	Lanton silt loam, occasionally flooded (where drained)
Ma	Mason silt loam
Or	Osage silty clay loam, occasionally flooded (where drained)
Os	Osage silty clay, occasionally flooded (where drained)
Pe	Prue loam, 2 to 5 percent slopes
Vf	Verdigris silt loam, occasionally flooded
Wo	Woodson silt loam
Za	Zaar silty clay, 0 to 1 percent slopes
Zb	Zaar silty clay, 1 to 4 percent slopes

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE

(Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Land capability	Grain sorghum	Winter wheat	Soybeans	Corn	Alfalfa hay	Tall fescue	Smooth bromegrass
		Bu	Bu	Bu	Bu	Tons	AUM*	AUM*
Ae-------------- Apperson	IIe	62	38	28	60	4.0	4.0	4.5
Ba-------------- Bates	IIe	56	34	24	50	3.5	3.5	4.0
Bc-------------- Bates	IIIe	51	31	22	45	3.5	3.5	4.0
Bh-------------- Bates-Collinsville	IVe	41	25	15	30	---	2.5	2.5
Bo-------------- Bates-Collinsville	VIe	---	---	---	---	---	---	---
Ca-------------- Catoosa	IIe	62	39	25	54	3.5	3.5	4.0
Dn-------------- Dennis	IIe	64	36	30	62	4.0	4.0	4.5
Do-------------- Dennis	IIIe	59	32	26	58	4.0	4.0	4.5
Dp-------------- Dennis	IIIe	44	27	22	50	3.5	3.5	4.0
Dw-------------- Dennis-Dwight	IIIe	49	31	20	45	3.0	3.0	3.5
Eb-------------- Eram	IIIe	51	31	23	48	3.0	3.0	3.5
Ec-------------- Eram	IVe	45	28	19	40	3.0	3.0	3.5
Ef-------------- Eram	IVe	36	22	15	30	3.0	3.0	3.5
Gr-------------- Girard	Vw	---	---	---	---	---	2.5	2.5
Iv-------------- Ivan	IIw	65	40	36	80	5.5	5.5	6.5

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Grain sorghum	Winter wheat	Soybeans	Corn	Alfalfa hay	Tall fescue	Smooth bromegrass
		Bu	Bu	Bu	Bu	Tons	AUM*	AUM*
Ke--------------- Kenoma	IIIe	57	35	25	57	3.5	3.5	4.0
Ko--------------- Kenoma-Olpe	IVe	48	30	18	35	3.0	3.0	3.5
La--------------- Lanton	IIw	64	38	34	75	5.0	5.0	5.5
Ma--------------- Mason	I	74	46	36	83	5.5	5.5	6.5
Nd--------------- Niotaze-Darnell	VIe	---	---	---	---	---	---	---
Or--------------- Osage	IIw	57	29	32	75	4.5	4.5	4.0
Os--------------- Osage	IIIw	50	25	27	60	4.5	4.5	4.0
Pe--------------- Prue	IIIe	58	36	28	---	4.0	4.0	4.5
Pt**. Pits								
Rn--------------- Ringo	VIIe	---	---	---	---	---	---	---
Rs--------------- Ringo-Shidler	VIe	---	---	---	---	---	---	---
Sc--------------- Shidler-Catoosa	VIe	---	---	---	---	---	---	---
Sf--------------- Steedman	VIe	---	---	---	---	---	---	---
Sm--------------- Stephenville-Darnell	IVe	45	28	15	---	---	2.5	2.5
Sp--------------- Stephenville-Darnell	VIe	---	---	---	---	---	---	---
Vc--------------- Verdigris	Vw	---	---	---	---	5.5	5.5	6.5

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Grain sorghum	Winter wheat	Soybeans	Corn	Alfalfa hay	Tall fescue	Smooth bromegrass
		Bu	Bu	Bu	Bu	Tons	AUM*	AUM*
Vf-------------- Verdigris	IIw	70	41	36	80	---	---	---
Wo-------------- Woodson	IIs	58	36	26	65	3.5	3.5	4.0
Za-------------- Zaar	IIIw	51	31	38	62	4.0	4.0	4.0
Zb-------------- Zaar	IIIe	46	28	38	62	4.0	4.0	4.0

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--RANGELAND PRODUCTIVITY

(Only the soils that support rangeland vegetation suitable for grazing are listed)

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable Lb/acre	Average Lb/acre	Unfavorable Lb/acre
Ae: Apperson	Loamy Upland	6,000	4,000	3,000
Ba, Bc: Bates	Loamy Upland	6,500	5,000	4,000
Bh*, Bo*:				
Bates	Loamy Upland	6,500	5,000	4,000
Collinsville	Shallow Sandstone	4,000	3,000	2,000
Ca: Catoosa	Loamy Upland	6,500	4,500	3,000
Dn, Do, Dp: Dennis	Loamy Upland	6,500	5,000	4,000
Dw*:				
Dennis	Loamy Upland	6,500	5,000	4,000
Dwight	Claypan	4,500	3,500	2,500
Eb, Ec, Ef: Eram	Clay Upland	6,000	4,500	3,500
Gr: Girard	Clay Lowland	10,000	7,000	5,000
Iv: Ivan	Loamy Lowland	9,000	7,000	5,000
Ke: Kenoma	Clay Upland	6,000	4,500	3,000
Ko*:				
Kenoma	Clay Upland	6,000	4,500	3,000
Olpe	Loamy Upland	6,000	4,500	3,000
La: Lanton	Loamy Lowland	9,000	7,000	5,000
Ma: Mason	Loamy Lowland	9,000	7,000	6,000
Nd*:				
Niotaze	Savannah	5,000	3,800	3,000
Darnell	Shallow Savannah	3,200	2,100	1,400
Or, Os: Osage	Clay Lowland	10,000	7,000	5,000
Pe: Prue	Loamy Upland	6,500	5,000	4,000
Rn: Ringo	Clay Upland	6,000	4,500	3,000

See footnote at end of table.

TABLE 7.--RANGELAND PRODUCTIVITY--Continued

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
Rs*:				
Ringo	Clay Upland	6,000	4,500	3,000
Shidler	Shallow Limy	3,500	3,000	2,000
Sc*:				
Shidler	Shallow Limy	3,500	3,000	2,000
Catoosa	Loamy Upland	6,000	4,500	3,000
Sf Steedman	Loamy Upland	6,000	4,500	3,000
Sm*, Sp*:				
Stephenville	Savannah	4,500	3,300	2,500
Darnell	Shallow Savannah	3,200	2,100	1,400
Vc, Vf Verdigris	Loamy Lowland	10,000	8,500	6,000
Wo Woodson	Clay Upland	6,000	4,500	3,000
Za, Zb Zaar	Clay Upland	6,000	4,500	3,000

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--WOODLAND MANAGEMENT AND PRODUCTIVITY

(Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available)

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Plant competition	Potential productivity: Common trees	Potential productivity: Site index	Potential productivity: Volume*	Trees to plant
Iv-------------- Ivan	4A	Slight	Slight	Slight	Moderate	Green ash-----------	88	8	Black walnut, pecan, eastern cottonwood, green ash, hackberry, bur oak.
						Bur oak-------------	50	2	
						Black walnut--------	73	4	
						Hackberry-----------	74	4	
						Kentucky coffeetree-	---	---	
La-------------- Lanton	6W	Slight	Severe	Moderate	Severe	Eastern cottonwood--	85	6	Green ash, hackberry, eastern cottonwood, pecan, bur oak.
						Sweetgum------------	71	5	
						Loblolly pine-------	70	4	
						Pecan---------------	63	4	
Ma-------------- Mason	4A	Slight	Slight	Slight	Slight	Green ash-----------	75	6	Bur oak, green ash, black walnut, pecan, hackberry, American sycamore.
						Black walnut--------	69	4	
						Northern red oak----	65	3	
						Hackberry-----------	80	4	
						Eastern cottonwood--	90	7	
Nd**:									
Niotaze--------	1X	Moderate	Moderate	Slight	Slight	Post oak------------	30	1	Post oak, northern red oak, blackjack oak, black oak, bur oak.
						Blackjack oak-------	25	1	
						Northern red oak----	35	2	
Darnell--------	1D	Slight	Moderate	Moderate	Slight	Post oak------------	30	1	Northern red oak, black oak, post oak, blackjack oak.
						Blackjack oak-------	30	1	
						Eastern redcedar----	---	---	
Or-------------- Osage	6W	Slight	Moderate	Moderate	Severe	Green ash-----------	75	5	Pecan, green ash, hackberry, bur oak, eastern cottonwood.
						Pecan---------------	75	6	
						Eastern cottonwood--	80	6	
						Bur oak-------------	55	3	
Os-------------- Osage	6W	Slight	Moderate	Severe	Severe	Green ash-----------	75	5	Pecan, green ash, hackberry, bur oak, eastern cottonwood.
						Pecan---------------	75	6	
						Eastern cottonwood--	80	6	
						Bur oak-------------	55	3	
Sm**, Sp**:									
Stephenville---	2X	Slight	Slight	Slight	Slight	Post oak------------	35	2	Bur oak, northern red oak, black oak, post oak, blackjack oak.
						Blackjack oak-------	33	1	
						Bur oak-------------	---	---	
Darnell--------	1D	Slight	Moderate	Moderate	Slight	Post oak------------	30	1	Northern red oak, black oak, post oak, blackjack oak.
						Blackjack oak-------	30	1	
						Eastern redcedar----	---	---	

See footnotes at end of table.

TABLE 8.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Plant competition	Common trees	Site index	Volume*	
Vc, Vf Verdigris	4A	Slight	Slight	Slight	Slight	Green ash Eastern cottonwood Hackberry Black walnut Silver maple Bur oak	69 87 69 69 --- 56	5 7 4 4 --- 3	Eastern cottonwood, pecan, hackberry, black walnut, green ash, bur oak.

* Volume class is the yield in cubic feet per acre per year calculated at the age of culmination of mean annual increment for fully stocked natural stands.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
Ae: Apperson	Lilac, Peking cotoneaster.	Manchurian crabapple, Amur honeysuckle, Siberian peashrub.	Eastern redcedar, Austrian pine, hackberry, green ash, Russian-olive.	Honeylocust, Siberian elm.	---
Ba, Bc: Bates	Lilac, Peking cotoneaster, Amur honeysuckle, fragrant sumac.	---	Eastern redcedar, green ash, Austrian pine, bur oak, hackberry, Russian-olive.	Siberian elm, honeylocust.	---
Bh*, Bo*:					
Bates	Lilac, Peking cotoneaster, Amur honeysuckle, fragrant sumac.	---	Eastern redcedar, green ash, Austrian pine, bur oak, hackberry, Russian-olive.	Siberian elm, honeylocust.	---
Collinsville.					
Ca: Catoosa	Amur honeysuckle, fragrant sumac, Peking cotoneaster, lilac.	---	Bur oak, Russian-olive, hackberry, eastern redcedar, green ash, Austrian pine.	Honeylocust, Siberian elm.	---
Dn, Do, Dp: Dennis	American plum, fragrant sumac, Peking cotoneaster, lilac.	Manchurian crabapple.	Russian mulberry, hackberry, eastern redcedar, green ash.	Honeylocust, Austrian pine, Scotch pine.	---
Dw*:					
Dennis	American plum, fragrant sumac, Peking cotoneaster, lilac.	Manchurian crabapple.	Russian mulberry, hackberry, eastern redcedar, green ash.	Honeylocust, Austrian pine, Scotch pine.	---
Dwight	Lilac, silver buffaloberry, Tatarian honeysuckle, Siberian peashrub.	Eastern redcedar, Russian-olive, Siberian elm, green ash.	---	---	---
Eb, Ec, Ef: Eram	Lilac, Peking cotoneaster.	Manchurian crabapple, Amur honeysuckle, Siberian peashrub.	Eastern redcedar, hackberry, green ash, Austrian pine, Russian-olive.	Siberian elm, honeylocust.	---

See footnote at end of table.

TABLE 9.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
Gr: Girard	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Norway spruce, honeylocust, golden willow, green ash, northern red oak, silver maple.	Eastern cottonwood.
Iv: Ivan	---	American plum, lilac, Peking cotoneaster, Amur honeysuckle.	Eastern redcedar	Honeylocust, Austrian pine, eastern white pine, green ash, hackberry, bur oak.	Eastern cottonwood.
Ke: Kenoma	Peking cotoneaster, lilac, fragrant sumac.	Amur honeysuckle, Manchurian crabapple.	Green ash, hackberry, Austrian pine, Russian-olive, eastern redcedar.	Siberian elm, honeylocust.	---
Ko*:					
Kenoma	Peking cotoneaster, lilac, fragrant sumac.	Amur honeysuckle, Manchurian crabapple.	Green ash, hackberry, Austrian pine, Russian-olive, eastern redcedar.	Siberian elm, honeylocust.	---
Olpe	Fragrant sumac, Amur honeysuckle, lilac.	Autumn-olive	Bur oak, eastern redcedar, Russian-olive, hackberry, Austrian pine, green ash, honeylocust.	Siberian elm	---
La: Lanton	---	Amur honeysuckle, lilac, Amur maple, autumn-olive.	Eastern redcedar	Austrian pine, pin oak, green ash, hackberry, honeylocust, eastern white pine.	Eastern cottonwood.
Ma: Mason	---	American plum, Peking cotoneaster, lilac, Amur honeysuckle.	Eastern redcedar, hackberry.	Austrian pine, honeylocust, green ash, bur oak, eastern white pine.	Eastern cottonwood.
Nd*:					
Niotaze	Lilac, fragrant sumac, Peking cotoneaster, Amur honeysuckle.	---	Austrian pine, hackberry, green ash, bur oak, Russian-olive, eastern redcedar.	Honeylocust, Siberian elm.	---
Darnell.					
Or, Os: Osage	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Norway spruce, honeylocust, green ash, silver maple, golden willow, northern red oak.	Eastern cottonwood.

See footnote at end of table.

TABLE 9.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
Pe: Prue	---	Lilac, Amur honeysuckle, fragrant sumac, Amur maple.	Hackberry, eastern redcedar, green ash, bur oak, Russian-olive.	Austrian pine, Scotch pine, honeylocust.	---
Pt*. Pits					
Rn: Ringo	Lilac, Amur honeysuckle, Siberian peashrub, Peking cotoneaster.	Eastern redcedar, Manchurian crabapple.	Austrian pine, Russian-olive, hackberry, green ash, honeylocust.	Siberian elm	---
Rs*:					
Ringo	Lilac, Amur honeysuckle, Siberian peashrub, Peking cotoneaster.	Eastern redcedar, Manchurian crabapple.	Austrian pine, Russian-olive, hackberry, green ash, honeylocust.	Siberian elm	---
Shidler.					
Sc*:					
Shidler.					
Catoosa	Amur honeysuckle, fragrant sumac, Peking cotoneaster, lilac.	---	Bur oak, Russian-olive, hackberry, eastern redcedar, green ash, Austrian pine.	Honeylocust, Siberian elm.	---
Sf: Steedman	Lilac, Peking cotoneaster.	Amur honeysuckle, Siberian peashrub, Manchurian crabapple.	Eastern redcedar, hackberry, Austrian pine, green ash, Russian-olive.	Honeylocust, Siberian elm.	---
Sm*, Sp*:					
Stephenville	Amur honeysuckle, lilac, fragrant sumac, Peking cotoneaster.	---	Eastern redcedar, hackberry, Austrian pine, bur oak, Russian-olive.	Honeylocust, Siberian elm.	---
Darnell.					
Vc, Vf: Verdigris	---	Lilac, autumn-olive, Amur maple.	Eastern redcedar, bur oak.	Pin oak, Austrian pine, eastern white pine, honeylocust, hackberry, green ash.	Eastern cottonwood.
Wo: Woodson	Peking cotoneaster, lilac, fragrant sumac.	Manchurian crabapple, Amur honeysuckle.	Green ash, hackberry, eastern redcedar, Russian-olive.	Austrian pine, honeylocust, Siberian elm.	---
Za, Zb: Zaar	Peking cotoneaster, lilac, Amur honeysuckle, Siberian peashrub.	Eastern redcedar, Manchurian crabapple.	Austrian pine, Russian-olive, hackberry, green ash, honeylocust.	Siberian elm	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Ae-------------------- Apperson	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Severe: erodes easily.
Ba, Bc---------------- Bates	Slight---------------	Slight---------------	Moderate: slope, small stones, depth to rock.	Slight.
Bh*:				
Bates----------------	Slight---------------	Slight---------------	Moderate: slope, small stones, depth to rock.	Slight.
Collinsville---------	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight.
Bo*:				
Bates----------------	Slight---------------	Slight---------------	Moderate: slope, small stones, depth to rock.	Slight.
Collinsville---------	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Slight.
Ca-------------------- Catoosa	Slight---------------	Slight---------------	Slight---------------	Severe: erodes easily.
Dn, Do, Dp------------ Dennis	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Severe: erodes easily.
Dw*:				
Dennis---------------	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Severe: erodes easily.
Dwight---------------	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Eb, Ec, Ef------------ Eram	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
Gr-------------------- Girard	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.
Iv-------------------- Ivan	Severe: flooding.	Slight---------------	Moderate: flooding.	Slight.
Ke-------------------- Kenoma	Severe: percs slowly.	Severe: percs slowly.	Severe: percs slowly.	Slight.

See footnote at end of table.

TABLE 10.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Ko*:				
Kenoma	Severe: percs slowly.	Severe: percs slowly.	Severe: percs slowly.	Slight.
Olpe	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, small stones.	Severe: erodes easily.
La Lanton	Severe: flooding, wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.
Ma Mason	Severe: flooding.	Moderate: percs slowly.	Moderate: percs slowly.	Slight.
Nd*:				
Niotaze	Severe: slope, wetness.	Severe: slope.	Severe: large stones, slope, small stones.	Moderate: large stones, wetness, slope.
Darnell	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Slight.
Or Osage	Severe: flooding, wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.
Os Osage	Severe: flooding, wetness, percs slowly.	Severe: wetness, too clayey, percs slowly.	Severe: too clayey, wetness.	Severe: wetness, too clayey.
Pe Prue	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Severe: erodes easily.
Pt*. Pits				
Rn Ringo	Severe: slope, percs slowly.	Severe: slope, percs slowly.	Severe: slope, percs slowly.	Severe: slope.
Rs*:				
Ringo	Severe: percs slowly.	Severe: percs slowly.	Severe: slope, percs slowly.	Slight.
Shidler	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Slight.
Sc*:				
Shidler	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight.

See footnote at end of table.

TABLE 10.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Sc*:				
Catoosa	Slight	Slight	Moderate: slope, depth to rock.	Severe: erodes easily.
Sf Steedman	Severe: wetness.	Severe: wetness.	Severe: slope, small stones, wetness.	Severe: wetness.
Sm*:				
Stephenville	Slight	Slight	Moderate: slope, depth to rock.	Slight.
Darnell	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight.
Sp*:				
Stephenville	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Darnell	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Slight.
Vc Verdigris	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.
Vf Verdigris	Severe: flooding.	Slight	Moderate: flooding.	Slight.
Wo Woodson	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.
Za, Zb Zaar	Severe: wetness, percs slowly, too clayey.	Severe: too clayey, percs slowly.	Severe: too clayey, wetness.	Severe: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Ae----------------- Apperson	Good	Good	Fair	Good	Good	---	Poor	Poor	Good	Good	Poor	---
Ba, Bc------------- Bates	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Bh*, Bo*:												
Bates--------------	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Collinsville------	Very poor.	Poor	Poor	Very poor.	Very poor.	---	Very poor.	Very poor.	Poor	Very poor.	Very poor.	---
Ca----------------- Catoosa	Fair	Good	Good	Good	Good	---	Poor	Very poor.	Good	Good	Very poor.	---
Dn----------------- Dennis	Good	Good	Good	Good	Good	---	Poor	Poor	Good	Good	Poor	---
Do, Dp------------- Dennis	Good	Good	Good	Good	Good	---	Poor	Very poor.	Good	Good	Very poor.	---
Dw*:												
Dennis-------------	Good	Good	Good	Good	Good	---	Poor	Very poor.	Good	Good	Very poor.	---
Dwight-------------	Fair	Fair	Fair	---	---	Fair	Poor	Fair	Fair	---	Poor	Fair.
Eb----------------- Eram	Good	Good	Good	Good	Good	---	Poor	Very poor.	Good	Good	Very poor.	---
Ec, Ef------------- Eram	Fair	Good	Good	Good	Good	---	Very poor.	Very poor.	Good	Good	Very poor.	---
Gr----------------- Girard	Poor	Fair	Fair	Fair	Fair	Fair	Good	Fair	Fair	Fair	Fair	---
Iv----------------- Ivan	Good	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor	Good.
Ke----------------- Kenoma	Good	Good	Fair	Fair	Fair	Fair	Poor	Fair	Good	Fair	Poor	Fair.
Ko*:												
Kenoma-------------	Good	Good	Fair	Fair	Fair	Fair	Poor	Fair	Good	Fair	Poor	Fair.
Olpe---------------	Good	Good	Good	Fair	Fair	Good	Poor	Very poor.	Good	Fair	Very poor.	Good.
La----------------- Lanton	Fair	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good	---
Ma----------------- Mason	Good	Good	Good	Good	Good	---	Poor	Very poor.	Good	Good	Very poor.	---

See footnote at end of table.

TABLE 11.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Nd*:												
Niotaze	Poor	Fair	Good	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.	Fair.
Darnell	Poor	Poor	Fair	---	---	Fair	Very poor.	Very poor.	Poor	---	Very poor.	Fair.
Or Osage	Fair	Fair	Fair	Fair	Fair	---	Good	Good	Fair	Fair	Good	---
Os Osage	Fair	Fair	Fair	Fair	Fair	---	Poor	Good	Fair	Fair	Fair	---
Pe Prue	Good	Good	Good	Good	Good	---	Poor	Very poor.	Good	Good	Very poor.	---
Pt*. Pits												
Rn Ringo	Very poor.	Poor	Fair	Fair	Fair	Good	Poor	Very poor.	Fair	---	Very poor.	Fair.
Rs*:												
Ringo	Poor	Fair	Fair	Fair	Fair	Good	Poor	Very poor.	Fair	---	Very poor.	Fair.
Shidler	Very poor.	Very poor.	Poor	---	---	Poor	Very poor.	Very poor.	Very poor.	---	Very poor.	Poor.
Sc*:												
Shidler	Very poor.	Very poor.	Poor	---	---	Poor	Very poor.	Very poor.	Very poor.	---	Very poor.	Poor.
Catoosa	Fair	Good	Good	Good	Good	---	Poor	Very poor.	Good	Good	Very poor.	---
Sf Steedman	Fair	Good	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Sm*:												
Stephenville	Fair	Good	Good	---	---	Good	Poor	Very poor.	Good	---	Very poor.	Good.
Darnell	Poor	Poor	Fair	---	---	Fair	Very poor.	Very poor.	Poor	---	Very poor.	Fair.
Sp*:												
Stephenville	Fair	Good	Good	---	---	Good	Very poor.	Very poor.	Good	---	Very poor.	Good.
Darnell	Poor	Poor	Fair	---	---	Fair	Very poor.	Very poor.	Poor	---	Very poor.	Fair.
Vc Verdigris	Poor	Fair	Fair	Good	Good	Good	Poor	Fair	Fair	Good	Poor	Good.
Vf Verdigris	Good	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor	Good.

See footnote at end of table.

TABLE 11.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements								Potential as habitat for--			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Wo------------------ Woodson	Good	Good	Fair	Poor	Poor	Fair	Poor	Good	Fair	Fair	Fair	Fair.
Za, Zb-------------- Zaar	Fair	Fair	Fair	Good	Good	Good	Poor	Fair	Fair	Good	Poor	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Ae: Apperson	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Ba: Bates	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Slight	Slight.
Bc: Bates	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Moderate: slope.	Slight.
Bh*:					
Bates	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Moderate: slope.	Slight.
Collinsville	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Bo*:					
Bates	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Moderate: slope.	Slight.
Collinsville	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.
Ca: Catoosa	Severe: depth to rock.	Moderate: shrink-swell, depth to rock.	Severe: depth to rock.	Moderate: shrink-swell, depth to rock.	Moderate: shrink-swell, depth to rock.
Dn, Do, Dp: Dennis	Moderate: too clayey, wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Dw*:					
Dennis	Moderate: too clayey, wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Dwight	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Eb, Ec, Ef: Eram	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell, wetness.	Severe: low strength, shrink-swell.
Gr: Girard	Severe: depth to rock, wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, depth to rock.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, wetness, flooding.
Iv: Ivan	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.

See footnote at end of table.

TABLE 12.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Ke----------------- Kenoma	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Ko*:					
Kenoma-----------	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Olpe-------------	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell.
La----------------- Lanton	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding.
Ma----------------- Mason	Slight-----------	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength.
Nd*:					
Niotaze----------	Severe: wetness, slope.	Severe: wetness, shrink-swell, slope.	Severe: wetness, slope, shrink-swell.	Severe: wetness, shrink-swell, slope.	Severe: low strength, slope, shrink-swell.
Darnell----------	Severe: depth to rock.	Moderate: slope, depth to rock.	Severe: depth to rock.	Severe: slope.	Moderate: depth to rock, slope.
Or, Os------------ Osage	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.
Pe----------------- Prue	Moderate: too clayey.	Slight-----------	Severe: shrink-swell.	Slight------------	Slight.
Pt*. Pits					
Rn----------------- Ringo	Severe: slope.	Severe: shrink-swell, slope.	Severe: slope, shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, slope, shrink-swell.
Rs*:					
Ringo------------	Moderate: depth to rock, slope.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, shrink-swell.
Shidler----------	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Sc*:					
Shidler----------	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Catoosa----------	Severe: depth to rock.	Moderate: shrink-swell, depth to rock.	Severe: depth to rock.	Moderate: shrink-swell, depth to rock.	Moderate: shrink-swell, depth to rock.

See footnote at end of table.

TABLE 12.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Sf---------------- Steedman	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell, slope.	Severe: shrink-swell, low strength, wetness.
Sm*:					
Stephenville-----	Moderate: depth to rock.	Slight-----------	Moderate: depth to rock.	Moderate: slope.	Slight.
Darnell----------	Severe: depth to rock.	Moderate: depth to rock.	Severe: depth to rock.	Moderate: slope, depth to rock.	Moderate: depth to rock.
Sp*:					
Stephenville-----	Moderate: depth to rock, slope.	Moderate: slope.	Moderate: depth to rock, slope.	Severe: slope.	Moderate: slope.
Darnell----------	Severe: depth to rock.	Moderate: slope, depth to rock.	Severe: depth to rock.	Severe: slope.	Moderate: depth to rock, slope.
Vc, Vf------------ Verdigris	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
Wo---------------- Woodson	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, low strength, wetness.
Za, Zb------------ Zaar	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, shrink-swell.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "poor," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Ae: Apperson	Severe: wetness, percs slowly.	Severe: wetness.	Severe: depth to rock, wetness, too clayey.	Moderate: depth to rock, wetness.	Poor: too clayey, hard to pack.
Ba, Bc: Bates	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: depth to rock.
Bh*:					
Bates	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: depth to rock.
Collinsville	Severe: depth to rock.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: depth to rock.
Bo*:					
Bates	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: depth to rock.
Collinsville	Severe: depth to rock.	Severe: depth to rock, slope, seepage.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: depth to rock.
Ca: Catoosa	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim, thin layer.
Dn, Do, Dp: Dennis	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
Dw*:					
Dennis	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
Dwight	Severe: percs slowly.	Moderate: slope.	Severe: too clayey, excess sodium.	Slight	Poor: too clayey, hard to pack, excess sodium.
Eb, Ec, Ef: Eram	Severe: depth to rock, wetness, percs slowly.	Severe: depth to rock.	Severe: depth to rock, wetness, too clayey.	Severe: depth to rock, wetness.	Poor: depth to rock, too clayey, hard to pack.
Gr: Girard	Severe: flooding, depth to rock, wetness.	Severe: depth to rock, flooding, wetness.	Severe: flooding, depth to rock, wetness.	Severe: flooding, depth to rock, wetness.	Poor: depth to rock, too clayey, hard to pack.
Iv: Ivan	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.

See footnote at end of table.

TABLE 13.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Ke------------------- Kenoma	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight------------	Poor: too clayey, hard to pack.
Ko*:					
Kenoma---------------	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight------------	Poor: too clayey, hard to pack.
Olpe-----------------	Severe: percs slowly.	Moderate: seepage, slope.	Severe: too clayey.	Slight------------	Poor: too clayey, small stones.
La------------------- Lanton	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness, thin layer.
Ma------------------- Mason	Severe: percs slowly.	Severe: flooding.	Moderate: flooding, too clayey.	Moderate: flooding.	Fair: too clayey.
Nd*:					
Niotaze--------------	Severe: depth to rock, wetness, percs slowly.	Severe: depth to rock, slope, wetness.	Severe: depth to rock, wetness, slope.	Severe: depth to rock, wetness, slope.	Poor: depth to rock, too clayey, hard to pack.
Darnell--------------	Severe: depth to rock.	Severe: seepage, depth to rock, slope.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: area reclaim.
Or, Os--------------- Osage	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
Pe------------------- Prue	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight------------	Poor: thin layer.
Pt*. Pits					
Rn------------------- Ringo	Severe: depth to rock, percs slowly, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: depth to rock, hard to pack.
Rs*:					
Ringo----------------	Severe: depth to rock, percs slowly.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: depth to rock, hard to pack.
Shidler--------------	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim, hard to pack.

See footnote at end of table.

TABLE 13.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Sc*:					
Shidler	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim, hard to pack.
Catoosa	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim, thin layer.
Sf Steedman	Severe: depth to rock, wetness, percs slowly.	Severe: depth to rock, slope.	Severe: depth to rock, wetness, too clayey.	Severe: depth to rock, wetness.	Poor: depth to rock, too clayey, hard to pack.
Sm*:					
Stephenville	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Darnell	Severe: depth to rock.	Severe: seepage, depth to rock.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: area reclaim.
Sp*:					
Stephenville	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Darnell	Severe: depth to rock.	Severe: seepage, depth to rock, slope.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: area reclaim.
Vc, Vf Verdigris	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
Wo Woodson	Severe: percs slowly, wetness.	Slight	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey, wetness, hard to pack.
Za Zaar	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
Zb Zaar	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Ae Apperson	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Ba, Bc Bates	Poor: depth to rock.	Improbable: excess fines.	Improbable: excess fines.	Fair: depth to rock, small stones.
Bh*, Bo*:				
Bates	Poor: depth to rock.	Improbable: excess fines.	Improbable: excess fines.	Fair: depth to rock, small stones.
Collinsville	Poor: depth to rock.	Improbable: excess fines.	Improbable: excess fines.	Poor: large stones, depth to rock.
Ca Catoosa	Poor: area reclaim, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, thin layer, too clayey.
Dn, Do, Dp Dennis	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, thin layer.
Dw*:				
Dennis	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, thin layer.
Dwight	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Eb, Ec, Ef Eram	Poor: depth to rock, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
Gr Girard	Poor: depth to rock, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Iv Ivan	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Ke Kenoma	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.

See footnote at end of table.

TABLE 14.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Ko*:				
Kenoma	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Olpe	Fair: shrink-swell, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, small stones, area reclaim.
La: Lanton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, thin layer.
Ma: Mason	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Nd*:				
Niotaze	Poor: depth to rock, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
Darnell	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.
Or, Os: Osage	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
Pe: Prue	Fair: thin layer.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, thin layer.
Pt*. Pits				
Rn: Ringo	Poor: depth to rock, low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Rs*:				
Ringo	Poor: depth to rock, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: depth to rock, too clayey.
Shidler	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.
Sc*:				
Shidler	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.
Catoosa	Poor: area reclaim, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, thin layer, too clayey.

See footnote at end of table.

TABLE 14.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Sf-------------------- Steedman	Poor: depth to rock, shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
Sm*:				
Stephenville---------	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim.
Darnell--------------	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.
Sp*:				
Stephenville---------	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, slope.
Darnell--------------	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.
Vc, Vf---------------- Verdigris	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Wo-------------------- Woodson	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Za, Zb---------------- Zaar	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Ae: Apperson	Moderate: depth to rock.	Severe: hard to pack.	Percs slowly	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Erodes easily, percs slowly.
Ba: Bates	Moderate: seepage, depth to rock.	Severe: thin layer.	Deep to water	Depth to rock	Depth to rock	Depth to rock.
Bc: Bates	Moderate: seepage, depth to rock, slope.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Bh*:						
Bates	Moderate: seepage, depth to rock, slope.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Collinsville	Severe: depth to rock, seepage.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Depth to rock, large stones.	Depth to rock, large stones.
Bo*:						
Bates	Moderate: seepage, depth to rock, slope.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Collinsville	Severe: depth to rock, slope, seepage.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Slope, depth to rock, large stones.	Slope, depth to rock, large stones.
Ca: Catoosa	Moderate: seepage, depth to rock.	Severe: thin layer.	Deep to water	Depth to rock, rooting depth.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Dn: Dennis	Slight	Moderate: hard to pack, wetness.	Percs slowly	Wetness, percs slowly, rooting depth.	Erodes easily, wetness, percs slowly.	Erodes easily, rooting depth, percs slowly.
Do, Dp: Dennis	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, slope.	Wetness, percs slowly, rooting depth.	Erodes easily, wetness, percs slowly.	Erodes easily, rooting depth, percs slowly.
Dw*:						
Dennis	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, slope.	Wetness, percs slowly, rooting depth.	Erodes easily, wetness, percs slowly.	Erodes easily, rooting depth, percs slowly.
Dwight	Slight	Severe: excess sodium.	Deep to water	Percs slowly, erodes easily, excess sodium.	Erodes easily, percs slowly.	Excess sodium, erodes easily, percs slowly.

See footnote at end of table.

TABLE 15.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
Eb-----Eram	Moderate: depth to rock.	Moderate: thin layer, hard to pack, wetness.	Percs slowly, depth to rock.	Percs slowly, erodes easily, depth to rock.	Depth to rock, erodes easily, wetness.	Wetness, erodes easily, depth to rock.
Ec, Ef-----Eram	Moderate: depth to rock, slope.	Moderate: thin layer, hard to pack, wetness.	Percs slowly, depth to rock, slope.	Percs slowly, depth to rock, slope.	Depth to rock, erodes easily, wetness.	Wetness, erodes easily, depth to rock.
Gr-----Girard	Moderate: depth to rock.	Severe: hard to pack, wetness.	Percs slowly, depth to rock, flooding.	Wetness, percs slowly.	Depth to rock, erodes easily, wetness.	Wetness, erodes easily, depth to rock.
Iv-----Ivan	Moderate: seepage.	Moderate: piping.	Deep to water	Flooding-----	Favorable-----	Favorable.
Ke-----Kenoma	Slight-----	Severe: hard to pack.	Deep to water	Percs slowly, erodes easily.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Ko*:						
Kenoma-----	Moderate: slope.	Severe: hard to pack.	Deep to water	Percs slowly, slope, erodes easily.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Olpe-----	Moderate: slope.	Slight-----	Deep to water	Slope, droughty, percs slowly.	Erodes easily, percs slowly.	Erodes easily, droughty.
La-----Lanton	Slight-----	Severe: piping, wetness.	Percs slowly, flooding.	Wetness, percs slowly, erodes easily.	Erodes easily, wetness.	Wetness, erodes easily, percs slowly.
Ma-----Mason	Slight-----	Moderate: piping.	Deep to water	Erodes easily	Erodes easily	Erodes easily.
Nd*:						
Niotaze-----	Severe: slope.	Severe: thin layer.	Percs slowly, depth to rock, slope.	Wetness, droughty, percs slowly.	Slope, large stones, depth to rock.	Large stones, wetness, slope.
Darnell-----	Severe: depth to rock, slope, seepage.	Severe: piping, thin layer.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
Or-----Osage	Slight-----	Severe: hard to pack, wetness.	Percs slowly, flooding.	Wetness-----	Wetness, percs slowly.	Wetness, percs slowly.
Os-----Osage	Slight-----	Severe: hard to pack, wetness.	Percs slowly, flooding.	Wetness, droughty, slow intake.	Wetness, percs slowly.	Wetness, droughty, percs slowly.
Pe-----Prue	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope, erodes easily.	Erodes easily	Erodes easily.
Pt*. Pits						

See footnote at end of table.

TABLE 15.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
Rn: Ringo	Severe: slope.	Severe: thin layer.	Deep to water	Percs slowly, depth to rock.	Slope, depth to rock, percs slowly.	Slope, depth to rock, percs slowly.
Rs*:						
Ringo	Severe: slope.	Severe: thin layer.	Deep to water	Percs slowly, depth to rock.	Slope, depth to rock, percs slowly.	Slope, depth to rock, percs slowly.
Shidler	Severe: depth to rock.	Severe: thin layer, hard to pack.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Sc*:						
Shidler	Severe: depth to rock.	Severe: thin layer, hard to pack.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Catoosa	Moderate: seepage, depth to rock.	Severe: thin layer.	Deep to water	Depth to rock, rooting depth.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Sf: Steedman	Severe: slope.	Severe: wetness.	Percs slowly, depth to rock, slope.	Slope, percs slowly, depth to rock.	Slope, depth to rock, wetness.	Wetness, depth to rock, slope.
Sm*:						
Stephenville	Moderate: seepage, depth to rock, slope.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Darnell	Severe: depth to rock, seepage.	Severe: piping, thin layer.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Sp*:						
Stephenville	Severe: slope.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
Darnell	Severe: depth to rock, slope, seepage.	Severe: piping, thin layer.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
Vc, Vf: Verdigris	Moderate: seepage.	Moderate: piping.	Deep to water	Flooding	Favorable	Favorable.
Wo: Woodson	Slight	Severe: wetness.	Percs slowly	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, percs slowly.	Percs slowly, wetness, erodes easily.
Za, Zb: Zaar	Slight	Moderate: hard to pack, wetness.	Percs slowly	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Ae: Apperson	0-8	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	75-98	33-44	12-20
	8-12	Silty clay loam, silty clay.	CL, CH	A-7	0	100	100	95-100	80-99	41-70	20-40
	12-43	Silty clay	CL, CH	A-7	0	85-100	83-100	80-100	75-99	41-70	20-40
	43	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ba, Bc: Bates	0-11	Loam	ML, CL, CL-ML	A-4, A-6	0	90-100	85-100	80-100	55-90	20-40	3-15
	11-23	Loam, clay loam, sandy clay loam.	ML, CL, SC, SM	A-4, A-6, A-7	0	85-100	85-100	80-100	45-85	25-45	3-20
	23-28	Gravelly clay loam, gravelly loam, gravelly sandy clay loam.	SM-SC, SC	A-2, A-4, A-6	0-15	70-90	70-90	50-80	20-40	20-35	5-15
	28	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Bh*, Bo*: Bates	0-11	Loam	ML, CL, CL-ML	A-4, A-6	0	90-100	85-100	80-100	55-90	20-40	3-15
	11-23	Loam, clay loam, sandy clay loam.	ML, CL, SC, SM	A-4, A-6, A-7	0	85-100	85-100	80-100	45-85	25-45	3-20
	23-28	Gravelly clay loam, gravelly loam, gravelly sandy clay loam.	SM-SC, SC	A-2, A-4, A-6	0-15	70-90	70-90	50-80	20-40	20-35	5-15
	28	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Collinsville	0-6	Loam	ML, CL, CL-ML	A-4	0-15	85-100	85-100	75-95	55-85	22-30	2-10
	6-14	Fine sandy loam, loam, stony fine sandy loam.	SM, SC, ML, CL	A-4, A-2	0-45	55-100	55-100	50-95	20-85	<30	NP-10
	14	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ca: Catoosa	0-10	Silt loam	CL	A-4, A-6	0	100	100	96-100	65-97	30-37	8-14
	10-30	Silty clay loam, clay loam.	CL	A-6, A-7	0	85-100	85-100	85-100	70-98	33-48	12-22
	30	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Dn, Do: Dennis	0-10	Silt loam	ML, CL, CL-ML	A-4, A-6	0	100	100	96-100	65-97	20-37	1-15
	10-16	Silty clay loam, clay loam.	CL	A-6, A-7	0	98-100	98-100	94-100	75-98	33-48	13-25
	16-60	Clay, silty clay, silty clay loam.	CL, CH	A-7, A-6	0	98-100	98-100	94-100	75-98	37-65	15-35
Dp: Dennis	0-5	Silty clay loam	CL	A-6, A-7	0	100	98-100	94-100	75-98	33-48	13-25
	5-60	Clay, silty clay, silty clay loam.	CL, CH	A-7, A-6	0	98-100	98-100	94-100	75-98	37-65	15-35

See footnote at end of table.

TABLE 16.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Dw*:											
Dennis----------	0-10	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	96-100	65-97	20-37	1-15
	10-16	Silty clay loam, clay loam.	CL	A-6, A-7	0	98-100	98-100	94-100	75-98	33-48	13-25
	16-60	Clay, silty clay, silty clay loam.	CL, CH	A-7, A-6	0	98-100	98-100	94-100	75-98	37-65	15-35
Dwight----------	0-4	Silt loam--------	CL-ML, CL, ML	A-4, A-6	0	100	100	95-100	85-100	25-40	3-15
	4-41	Clay, silty clay	CH	A-7	0	100	100	95-100	90-100	50-70	25-40
	41-60	Clay, silty clay, silty clay loam.	CL, CH	A-7	0	100	100	95-100	85-100	45-60	25-40
Eb, Ec----------- Eram	0-9	Silt loam--------	CL	A-4, A-6	0	85-100	85-100	85-100	70-95	30-37	8-14
	9-32	Clay, silty clay, clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	90-100	80-98	37-65	15-35
	32	Weathered bedrock	---	---	---	---	---	---	---	---	---
Ef--------------- Eram	0-4	Silty clay loam	CL	A-6, A-7	0	85-100	85-100	85-100	70-95	33-48	12-25
	4-21	Clay, silty clay, clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	90-100	80-98	37-65	15-35
	21	Weathered bedrock	---	---	---	---	---	---	---	---	---
Gr--------------- Girard	0-14	Silty clay loam	CL, CH	A-7	0	100	100	95-100	85-100	40-55	25-35
	14-26	Silty clay, silty clay loam.	CL, CH	A-7	0	100	100	95-100	85-100	40-65	25-45
	26	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Iv--------------- Ivan	0-9	Silt loam--------	CL	A-4, A-6	0	95-100	95-100	90-100	70-100	25-40	7-20
	9-60	Silt loam, silty clay loam, loam.	CL	A-4, A-6, A-7	0	95-100	95-100	90-100	65-100	25-45	7-25
Ke--------------- Kenoma	0-9	Silt loam--------	CL, CL-ML, ML	A-4, A-6	0	85-100	85-100	85-100	85-100	25-40	3-18
	9-25	Silty clay, clay	CH	A-7	0	85-100	85-100	85-100	85-100	50-75	30-48
	25-60	Silty clay, silty clay loam.	CL, CH	A-7	0	85-100	85-100	75-100	75-95	45-65	25-44
Ko*:											
Kenoma----------	0-8	Silt loam--------	CL, CL-ML, ML	A-4, A-6	0	85-100	85-100	85-100	85-100	25-40	3-18
	8-25	Silty clay, clay	CH	A-7	0	85-100	85-100	85-100	85-100	50-75	30-48
	25-46	Silty clay, silty clay loam.	CL, CH	A-7	0	85-100	85-100	75-100	75-95	45-65	25-44
	46	Weathered bedrock	---	---	---	---	---	---	---	---	---
Olpe------------	0-16	Silt loam, silty clay loam.	CL	A-6, A-4	0	80-100	75-100	60-100	50-95	20-40	7-20
	16-56	Very gravelly silty clay, very gravelly clay, extremely gravelly silty clay.	GC, GP-GC	A-2, A-7	0	20-60	10-50	10-45	10-40	40-65	25-40
	56-60	Silty clay, clay, gravelly silty clay.	GC, CL, CH, SC	A-7	0	60-100	50-100	40-100	35-95	40-65	25-40

See footnote at end of table.

TABLE 16.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
La---------------- Lanton	0-7	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	95-100	90-100	80-95	25-38	6-15
	7-37	Silt loam, silty clay loam.	ML, CL	A-4, A-6	0	100	95-100	85-100	80-95	30-38	8-16
	37-60	Silty clay, silty clay loam.	MH, CH, CL	A-7	0	100	95-100	85-100	75-95	40-55	18-28
Ma---------------- Mason	0-14	Silt loam--------	ML, CL	A-4, A-6	0	100	100	96-100	65-98	30-37	8-13
	14-60	Silty clay loam, clay loam, silt loam.	CL	A-6, A-4, A-7	0	98-100	98-100	96-100	65-98	30-43	9-20
Nd*: Niotaze----------	0-9	Cobbly fine sandy loam.	SM, GM, GM-GC, SM-SC	A-2-4, A-4, A-1	25-50	50-75	50-75	35-60	15-45	<26	NP-7
	9-36	Silty clay, silty clay loam.	CH, CL	A-7-6, A-6	0	95-100	95-100	90-100	90-100	35-65	15-40
	36	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Darnell----------	0-6	Fine sandy loam	SM, SC, ML, CL	A-4, A-2	0-15	90-100	90-100	85-100	30-60	<30	NP-10
	6-17	Fine sandy loam, loam, gravelly fine sandy loam.	SM, SC, ML, CL	A-4, A-2	0-10	70-100	70-100	60-100	25-60	<30	NP-10
	17	Weathered bedrock	---	---	---	---	---	---	---	---	---
Or---------------- Osage	0-11	Silty clay loam	CL	A-7	0	100	100	100	95-100	40-50	20-30
	11-60	Silty clay, clay, silty clay loam.	CH, CL	A-7	0	100	100	100	95-100	40-80	20-50
Os---------------- Osage	0-7	Silty clay--------	CH	A-7	0	100	100	100	95-100	50-75	30-55
	7-60	Silty clay, clay, silty clay loam.	CH, CL	A-7	0	100	100	100	95-100	40-80	20-50
Pe---------------- Prue	0-11	Loam--------------	CL, ML, CL-ML	A-4	0	100	100	96-100	65-85	22-31	3-10
	11-17	Loam, clay loam, sandy clay loam.	CL, SC	A-4, A-6	0	100	100	90-100	36-85	25-35	7-15
	17-38	Sandy clay loam, clay loam.	CL, SC	A-4, A-6	0	95-100	95-100	90-100	36-85	25-35	7-15
	38-60	Silty clay, silty clay loam, clay loam.	CL, CH	A-6, A-7	0	70-100	70-100	65-100	65-99	35-60	15-35
Pt*. Pits											
Rn---------------- Ringo	0-11	Silty clay loam	CH, CL	A-7-6	0-5	90-100	90-100	85-100	85-100	40-60	20-35
	11-26	Silty clay loam, silty clay.	CH, CL	A-7-6	0-5	90-100	90-100	85-100	85-95	50-65	25-40
	26	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Rs*: Ringo------------	0-11	Silty clay loam	CH, CL	A-7-6	0-5	90-100	90-100	85-100	85-100	40-60	20-35
	11-26	Silty clay loam, silty clay.	CH, CL	A-7-6	0-5	90-100	90-100	85-100	85-95	50-65	25-40
	26	Unweathered bedrock.	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 16.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Rs*:											
Shidler	0-10	Silty clay loam	CL, CH	A-6, A-7	0-25	75-100	75-100	70-100	65-98	33-55	12-27
	10	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Sc*:											
Shidler	0-10	Silty clay loam	CL, CH	A-6, A-7	0-25	75-100	75-100	70-100	65-98	33-55	12-27
	10	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Catoosa	0-10	Silt loam	CL	A-4, A-6	0	100	100	96-100	65-97	30-37	8-14
	10-30	Silty clay loam, clay loam.	CL	A-6, A-7	0	85-100	85-100	85-100	70-98	33-48	12-22
	30	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Sf Steedman	0-8	Gravelly silt loam.	CL, SC, GC	A-4, A-6	0-25	65-80	60-75	55-75	40-75	30-37	8-14
	8-32	Clay, silty clay	CL, CH	A-7	0	98-100	95-100	95-100	90-99	41-70	20-40
	32	Weathered bedrock	---	---	---	---	---	---	---	---	---
Sm*, Sp*:											
Stephenville	0-17	Fine sandy loam	SM, SC, ML, CL	A-4	0-15	85-100	85-100	80-100	36-60	<30	NP-10
	17-27	Fine sandy loam, sandy clay loam.	SC, CL	A-4, A-6	0	100	98-100	90-100	36-65	20-37	7-16
	27	Weathered bedrock	---	---	---	---	---	---	---	---	---
Darnell	0-6	Fine sandy loam	SM, SC, ML, CL	A-4, A-2	0-15	90-100	90-100	85-100	30-60	<30	NP-10
	6-17	Fine sandy loam, loam, gravelly fine sandy loam.	SM, SC, ML, CL	A-4, A-2	0-10	70-100	70-100	60-100	25-60	<30	NP-10
	17	Weathered bedrock	---	---	---	---	---	---	---	---	---
Vc Verdigris	0-8	Silt loam	CL, CL-ML, ML	A-4, A-6	0	100	100	95-100	65-100	22-38	2-13
	8-60	Silt loam, silty clay loam.	CL	A-4, A-6, A-7	0	100	100	95-100	80-100	30-45	8-23
Vf Verdigris	0-8	Silt loam	CL, CL-ML, ML	A-4, A-6	0	100	100	95-100	65-100	22-38	2-13
	8-60	Silt loam, silty clay loam.	CL	A-4, A-6, A-7	0	100	100	95-100	80-100	30-45	8-23
Wo Woodson	0-8	Silt loam	CL, CL-ML	A-4, A-6	0	100	100	90-100	85-100	25-40	5-20
	8-28	Silty clay, clay	CH	A-7-6	0	100	95-100	95-100	90-100	50-65	30-45
	28-60	Silty clay, clay, silty clay loam.	CH, CL	A-7-6	0	100	95-100	95-100	90-100	45-65	20-40
Za, Zb Zaar	0-10	Silty clay	CH	A-7	0	100	100	95-100	90-100	50-70	25-40
	10-60	Silty clay, clay	CH	A-7	0	100	100	95-100	90-100	50-70	25-40

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
Ae------------ Apperson	0-8	27-35	1.30-1.60	0.2-0.6	0.16-0.20	5.6-6.5	<2	Moderate	0.37	3	7	1-3
	8-12	35-45	1.35-1.70	0.2-0.6	0.16-0.20	5.6-7.8	<2	High------	0.37			
	12-43	40-60	1.35-1.60	0.06-0.2	0.14-0.18	6.6-8.4	<2	High------	0.32			
	43	---	---	---	---	---	---	----------	----			
Ba, Bc---------- Bates	0-11	15-27	1.40-1.50	0.6-2.0	0.20-0.24	5.1-6.5	<2	Low-------	0.28	4	5	1-4
	11-23	18-35	1.50-1.60	0.6-2.0	0.15-0.19	5.1-6.5	<2	Low-------	0.28			
	23-28	18-30	1.40-1.50	0.6-2.0	0.14-0.16	5.1-6.5	<2	Low-------	0.20			
	28	---	---	---	---	---	---	----------	----			
Bh*, Bo*:												
Bates----------	0-11	15-27	1.40-1.50	0.6-2.0	0.20-0.24	5.1-6.5	<2	Low-------	0.28	4	5	1-4
	11-23	18-35	1.50-1.60	0.6-2.0	0.15-0.19	5.1-6.5	<2	Low-------	0.28			
	23-28	18-30	1.40-1.50	0.6-2.0	0.14-0.16	5.1-6.5	<2	Low-------	0.20			
	28	---	---	---	---	---	---	----------	----			
Collinsville----	0-6	7-20	1.30-1.55	2.0-6.0	0.13-0.20	5.1-6.5	<2	Low-------	0.32	1	5	1-3
	6-14	5-20	1.40-1.70	2.0-6.0	0.07-0.20	5.1-6.5	<2	Low-------	0.20			
	14	---	---	---	---	---	---	----------	----			
Ca------------ Catoosa	0-10	15-26	1.30-1.55	0.6-2.0	0.15-0.24	5.6-6.5	<2	Low-------	0.37	2	6	1-3
	10-30	27-39	1.45-1.70	0.6-2.0	0.15-0.22	5.1-7.3	<2	Moderate	0.32			
	30	---	---	---	---	---	---	----------	----			
Dn, Do---------- Dennis	0-10	10-27	1.30-1.55	0.6-2.0	0.15-0.20	5.1-6.0	<2	Low-------	0.43	5	6	1-3
	10-16	27-35	1.45-1.70	0.2-0.6	0.15-0.20	5.1-6.0	<2	Moderate	0.37			
	16-60	35-55	1.35-1.65	0.06-0.2	0.15-0.20	5.1-7.3	<2	High------	0.37			
Dp------------ Dennis	0-5	27-35	1.30-1.60	0.2-0.6	0.15-0.20	5.1-6.0	<2	Moderate	0.37	5	7	1-3
	5-60	35-55	1.35-1.65	0.06-0.2	0.15-0.20	5.1-7.3	<2	High------	0.37			
Dw*:												
Dennis----------	0-10	10-27	1.30-1.55	0.6-2.0	0.15-0.20	5.1-6.0	<2	Low-------	0.43	5	6	1-3
	10-16	27-35	1.45-1.70	0.2-0.6	0.15-0.20	5.1-6.0	<2	Moderate	0.37			
	16-60	35-55	1.35-1.65	0.06-0.2	0.15-0.20	5.1-7.3	<2	High------	0.37			
Dwight----------	0-4	18-27	1.20-1.35	0.6-2.0	0.21-0.24	5.6-7.3	<2	Low-------	0.43	3	6	2-4
	4-41	45-60	1.30-1.40	<0.06	0.10-0.14	6.1-8.4	<4	High------	0.32			
	41-60	35-50	1.30-1.40	0.06-0.2	0.09-0.16	6.6-8.4	<8	High------	0.32			
Eb, Ec---------- Eram	0-9	18-26	1.30-1.60	0.2-2.0	0.15-0.20	5.6-6.5	<2	Low-------	0.43	3	6	1-3
	9-32	35-55	1.35-1.65	0.06-0.2	0.10-0.18	5.1-7.3	<2	High------	0.37			
	32	---	---	---	---	---	---	----------	----			
Ef------------ Eram	0-4	27-40	1.30-1.60	0.2-0.6	0.15-0.20	5.6-6.5	<2	Moderate	0.37	3	7	1-3
	4-21	35-55	1.35-1.65	0.06-0.2	0.10-0.18	5.1-7.3	<2	High------	0.37			
	21	---	---	---	---	---	---	----------	----			
Gr------------ Girard	0-14	35-40	1.20-1.30	0.06-0.2	0.15-0.18	5.6-7.3	<2	High------	0.37	4	7	2-4
	14-26	35-55	1.35-1.50	0.06-0.2	0.10-0.18	6.1-7.8	<2	High------	0.37			
	26	---	---	---	---	---	---	----------	----			
Iv------------ Ivan	0-9	16-27	1.30-1.45	0.6-2.0	0.22-0.24	7.4-8.4	<2	Low-------	0.32	5	4L	2-4
	9-60	18-35	1.35-1.55	0.6-2.0	0.19-0.22	7.9-8.4	<2	Moderate	0.32			

See footnote at end of table.

TABLE 17.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea-bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
Ke	0-9	18-27	1.35-1.45	0.2-0.6	0.22-0.24	5.1-6.5	<2	Low	0.43	4	6	2-4
Kenoma	9-25	40-60	1.40-1.50	<0.06	0.10-0.15	5.1-7.8	<2	High	0.32			
	25-60	30-50	1.35-1.45	0.06-0.2	0.18-0.20	6.1-8.4	<4	High	0.32			
Ko*:												
Kenoma	0-8	18-27	1.35-1.45	0.2-0.6	0.22-0.24	5.1-6.5	<2	Low	0.43	4	6	2-4
	8-25	40-60	1.40-1.50	<0.06	0.10-0.15	5.1-7.8	<2	High	0.32			
	25-46	30-50	1.35-1.45	0.06-0.2	0.18-0.20	6.1-8.4	<4	High	0.32			
	46	---	---	---	---	---	---	---	---			
Olpe	0-16	15-30	1.25-1.35	0.6-2.0	0.05-0.07	5.1-6.5	<2	Low	0.43	3	6	---
	16-56	35-50	1.35-1.45	0.06-0.2	0.01-0.03	5.6-7.3	<2	Moderate	0.24			
	56-60	35-50	1.40-1.55	0.06-0.2	0.05-0.08	5.6-7.8	<2	High	0.24			
La	0-7	20-27	1.30-1.55	0.6-2.0	0.18-0.22	6.1-7.3	<2	Low	0.37	5	6	2-6
Lanton	7-37	20-35	1.40-1.60	0.2-0.6	0.17-0.22	6.1-7.3	<2	Low	0.43			
	37-60	30-50	1.40-1.60	0.06-0.2	0.12-0.18	6.1-7.3	<2	Moderate	0.32			
Ma	0-14	12-27	1.30-1.50	0.6-2.0	0.16-0.20	5.6-7.3	<2	Low	0.37	5	5	1-3
Mason	14-60	20-35	1.40-1.70	0.2-0.6	0.16-0.20	5.1-6.5	<2	Moderate	0.37			
Nd*:												
Niotaze	0-9	5-20	1.35-1.45	0.6-6.0	0.06-0.11	5.1-6.0	<2	Low	0.20	3	8	---
	9-36	35-55	1.35-1.45	0.06-0.2	0.10-0.20	5.1-6.5	<2	High	0.28			
	36	---	---	---	---	---	---	---	---			
Darnell	0-6	10-20	1.30-1.65	2.0-6.0	0.12-0.16	5.1-6.5	<2	Low	0.20	2	3	<1
	6-17	10-25	1.40-1.70	2.0-6.0	0.12-0.16	5.1-6.5	<2	Low	0.32			
	17	---	---	---	---	---	---	---	---			
Or	0-11	35-40	1.45-1.65	<0.06	0.21-0.23	5.1-7.3	<2	High	0.28	5	4	1-4
Osage	11-60	35-60	1.50-1.70	<0.06	0.08-0.12	6.1-7.8	<2	Very high	0.28			
Os	0-16	40-50	1.40-1.60	<0.06	0.12-0.14	5.1-7.8	<2	Very high	0.28	5	4	1-4
Osage	16-60	35-60	1.50-1.70	<0.06	0.08-0.12	6.1-7.8	<2	Very high	0.28			
Pe	0-11	18-27	1.30-1.55	0.6-2.0	0.15-0.20	5.1-6.5	<2	Low	0.37	5	6	.5-1
Prue	11-17	25-35	1.45-1.70	0.6-2.0	0.12-0.20	5.1-6.5	<2	Low	0.32			
	17-38	25-45	1.35-1.65	0.6-2.0	0.12-0.20	5.1-6.5	<2	Low	0.32			
	38-60	25-45	1.35-1.65	0.2-0.6	0.14-0.20	5.1-7.8	<2	High	0.32			
Pt*.												
Pits												
Rn	0-11	35-45	1.35-1.43	<0.06	0.12-0.18	6.1-8.4	<2	High	0.28	4	4	2-4
Ringo	11-26	35-50	1.35-1.50	<0.06	0.15-0.21	6.1-8.4	<2	High	----			
	26	---	---	---	---	---	---	---	----			
Rs*:												
Ringo	0-11	35-45	1.35-1.43	<0.06	0.12-0.18	6.1-8.4	<2	High	0.28	4	4	2-4
	11-26	35-50	1.35-1.50	<0.06	0.15-0.21	6.1-8.4	<2	High	----			
	26	---	---	---	---	---	---	---	----			
Shidler	0-10	27-35	1.30-1.60	0.6-2.0	0.18-0.22	6.1-8.4	<2	Moderate	0.32	1	7	1-5
	10	---	---	---	---	---	---	---	----			
Sc*:												
Shidler	0-10	27-35	1.30-1.60	0.6-2.0	0.18-0.22	6.1-8.4	<2	Moderate	0.32	1	7	1-5
	10	---	---	---	---	---	---	---	----			
Catoosa	0-10	15-26	1.30-1.55	0.6-2.0	0.15-0.24	5.6-6.5	<2	Low	0.37	2	6	1-3
	10-30	27-39	1.45-1.70	0.6-2.0	0.15-0.22	5.1-7.3	<2	Moderate	0.32			
	30	---	---	---	---	---	---	---	----			

See footnote at end of table.

TABLE 17.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
Sf---------------- Steedman	0-8	18-26	1.30-1.50	0.6-2.0	0.10-0.20	5.1-6.5	<2	Low--------	0.28	3	8	.5-3
	8-32	40-55	1.35-1.60	0.06-0.2	0.10-0.18	5.6-8.4	<2	High-------	0.32			
	32	---	---	---	---	---	---	----------	----			
Sm*, Sp*: Stephenville----	0-17	10-20	1.30-1.60	2.0-6.0	0.11-0.15	5.1-6.5	<2	Low--------	0.24	3	3	<1
	17-27	18-35	1.50-1.70	0.6-2.0	0.11-0.17	5.1-6.0	<2	Low--------	0.32			
	27	---	---	---	---	---	---	----------	----			
Darnell----------	0-6	10-20	1.30-1.65	2.0-6.0	0.12-0.16	5.1-6.5	<2	Low--------	0.20	2	5	<1
	6-17	10-25	1.40-1.70	2.0-6.0	0.12-0.16	5.1-6.5	<2	Low--------	0.32			
	17	---	---	---	---	---	---	----------	----			
Vc---------------- Verdigris	0-8	15-27	1.30-1.40	0.6-2.0	0.20-0.24	5.6-7.3	<2	Low--------	0.32	5	6	2-4
	8-60	18-35	1.40-1.45	0.6-2.0	0.17-0.22	5.6-7.3	<2	Moderate	0.32			
Vf---------------- Verdigris	0-8	15-27	1.30-1.40	0.6-2.0	0.20-0.24	5.6-7.3	<2	Low--------	0.32	5	6	2-4
	8-60	18-35	1.40-1.45	0.6-2.0	0.17-0.22	5.6-7.3	<2	Moderate	0.32			
Wo---------------- Woodson	0-8	18-27	1.25-1.45	0.2-0.6	0.22-0.24	5.6-6.5	<2	Low--------	0.43	4	6	1-4
	8-28	40-60	1.30-1.45	<0.06	0.12-0.15	5.6-7.3	<2	High-------	0.32			
	28-60	30-50	1.35-1.45	0.06-0.2	0.10-0.15	5.6-7.8	<2	High-------	0.32			
Za, Zb----------- Zaar	0-10	40-60	1.20-1.30	<0.06	0.12-0.14	5.6-7.3	<2	High-------	0.28	5	4	2-4
	10-60	40-60	1.35-1.50	<0.06	0.11-0.18	6.1-8.4	<2	High-------	0.28			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hard-ness	Uncoated steel	Concrete
					Ft			In			
Ae----------------- Apperson	C	None---------	---	---	1.5-2.0	Perched	Dec-Apr	40-60	Hard	High------	Low.
Ba, Bc------------ Bates	B	None---------	---	---	>6.0	---	---	20-40	Soft	Low-------	Moderate.
Bh*, Bo*:											
Bates------------	B	None---------	---	---	>6.0	---	---	20-40	Soft	Low-------	Moderate.
Collinsville-----	D	None---------	---	---	>6.0	---	---	4-20	Hard	Low-------	Moderate.
Ca----------------- Catoosa	B	None---------	---	---	>6.0	---	---	20-40	Hard	Moderate	Moderate.
Dn, Do, Dp--------- Dennis	C	None---------	---	---	2.0-3.0	Perched	Dec-Apr	>60	---	High------	Moderate.
Dw*:											
Dennis-----------	C	None---------	---	---	2.0-3.0	Perched	Dec-Apr	>60	---	High------	Moderate.
Dwight-----------	D	None---------	---	---	>6.0	---	---	>60	---	High------	Moderate.
Eb, Ec, Ef-------- Eram	C	None---------	---	---	1.0-2.0	Perched	Nov-Apr	20-40	Soft	High------	Moderate.
Gr----------------- Girard	D	Frequent----	Very brief to brief.	Nov-May	0-2.0	Apparent	Nov-May	20-40	Hard	High------	Low.
Iv----------------- Ivan	B	Occasional	Very brief	Dec-Jun	>6.0	---	---	>60	---	Low-------	Low.
Ke----------------- Kenoma	D	None---------	---	---	>6.0	---	---	>60	---	High------	Moderate.
Ko*:											
Kenoma-----------	D	None---------	---	---	>6.0	---	---	40-60	Hard	High------	Moderate.
Olpe-------------	C	None---------	---	---	>6.0	---	---	>60	---	High------	Moderate.
La----------------- Lanton	D	Occasional	Very brief	Jan-May	1.0-2.0	Perched	Dec-May	>60	---	High------	Low.
Ma----------------- Mason	B	Rare---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate.
Nd*:											
Niotaze----------	C	None---------	---	---	1.0-2.0	Perched	Nov-Jun	20-40	Soft	High------	Moderate.
Darnell----------	C	None---------	---	---	>6.0	---	---	10-20	Soft	Low-------	Moderate.
Or, Os------------ Osage	D	Occasional	Very brief to long.	Nov-May	0-1.0	Apparent	Nov-May	>60	---	High------	Moderate.
Pe----------------- Prue	B	None---------	---	---	>6.0	---	---	>60	---	High------	Moderate.

See footnote at end of table.

TABLE 18.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hard-ness	Uncoated steel	Concrete
					Ft			In			
Pt*. Pits											
Rn----------------- Ringo	D	None---------	---	---	>6.0	---	---	20-40	Soft	High------	Low.
Rs*:											
Ringo-------------	D	None---------	---	---	>6.0	---	---	20-40	Soft	High------	Low.
Shidler-----------	D	None---------	---	---	>6.0	---	---	4-20	Hard	Moderate	Low.
Sc*:											
Shidler-----------	D	None---------	---	---	>6.0	---	---	4-20	Hard	Moderate	Low.
Catoosa-----------	B	None---------	---	---	>6.0	---	---	20-40	Hard	Moderate	Moderate.
Sf----------------- Steedman	D	None---------	---	---	0.5-1.0	Perched	Nov-Mar	20-40	Soft	High------	Moderate.
Sm*, Sp*:											
Stephenville------	B	None---------	---	---	>6.0	---	---	20-40	Soft	Moderate	Moderate.
Darnell-----------	C	None---------	---	---	>6.0	---	---	10-20	Soft	Low-------	Moderate.
Vc----------------- Verdigris	B	Frequent-----	Very brief	Dec-Jun	>6.0	---	---	>60	---	Low-------	Low.
Vf----------------- Verdigris	B	Occasional	Very brief	Dec-Jun	>6.0	---	---	>60	---	Low-------	Low.
Wo----------------- Woodson	D	None---------	---	---	0.5-2.0	Perched	Dec-Apr	>60	---	High------	Moderate.
Za, Zb------------- Zaar	D	None---------	---	---	1.0-2.0	Perched	Dec-Apr	>60	---	High------	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 19.--ENGINEERING INDEX TEST DATA

(LL means liquid limit; PI, plasticity index; MD, maximum dry density; and OM, optimum moisture)

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution							LL	PI	Moisture density	
			Percentage passing sieve--				Percentage smaller than--						
	AASHTO	Unified	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			MD	OM
										Pct		Lb/ft3	Pct
Apperson silty clay loam:													
(S81KS-205-001)													
Ap----- 0 to 8	A-6	CL	100	100	98	94	71	36	25	38	15	98	21
Bt2---- 23 to 38	A-7	CH	100	100	98	95	75	49	37	56	28	93	26
Shidler silty clay loam:													
(S81KS-205-003)													
A------ 0 to 10	A-7	MH	100	100	98	88	47	26	17	57	20	83	29

TABLE 20.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Apperson	Fine, montmorillonitic, thermic Vertic Argiudolls
Bates	Fine-loamy, siliceous, thermic Typic Argiudolls
Catoosa	Fine-silty, mixed, thermic Typic Argiudolls
Collinsville	Loamy, siliceous, thermic Lithic Hapludolls
Darnell	Loamy, siliceous, thermic, shallow Udic Ustochrepts
Dennis	Fine, mixed, thermic Aquic Paleudolls
Dwight	Fine, montmorillonitic, mesic Typic Natrustolls
Eram	Fine, mixed, thermic Aquic Argiudolls
Girard	Fine, mixed, thermic Cumulic Haplaquolls
Ivan	Fine-silty, mixed, mesic Cumulic Hapludolls
Kenoma	Fine, montmorillonitic, thermic Vertic Argiudolls
Lanton	Fine-silty, mixed, thermic Cumulic Haplaquolls
Mason	Fine-silty, mixed, thermic Typic Argiudolls
Niotaze	Fine, montmorillonitic, thermic Aquic Paleustalfs
Olpe	Clayey-skeletal, montmorillonitic, thermic Typic Paleudolls
Osage	Fine, montmorillonitic, thermic Vertic Haplaquolls
Prue	Fine-loamy, siliceous, thermic Mollic Paleudalfs
Ringo	Fine, mixed, thermic Entic Hapludolls
Shidler	Loamy, mixed, thermic Lithic Haplustolls
Steedman	Fine, montmorillonitic, thermic Vertic Haplustalfs
Stephenville	Fine-loamy, siliceous, thermic Ultic Haplustalfs
Verdigris	Fine-silty, mixed, thermic Cumulic Hapludolls
Woodson	Fine, montmorillonitic, thermic Abruptic Argiaquolls
Zaar	Fine, montmorillonitic, thermic Vertic Hapludolls

INTERPRETIVE GROUPS

Map symbol	Map unit	Land capability*	Prime farmland*	Range site
Ae	Apperson silty clay loam, 0 to 2 percent slopes	IIe	Yes	Loamy Upland.
Ba	Bates loam, 1 to 4 percent slopes	IIe	Yes	Loamy Upland.
Bc	Bates loam, 4 to 7 percent slopes	IIIe	Yes	Loamy Upland.
Bh	Bates-Collinsville loams, 3 to 7 percent slopes	IVe	No	
	Bates			Loamy Upland.
	Collinsville			Shallow Sandstone.
Bo	Bates-Collinsville loams, 7 to 20 percent slopes	VIe	No	
	Bates			Loamy Upland.
	Collinsville			Shallow Sandstone.
Ca	Catoosa silt loam, 0 to 2 percent slopes	IIe	Yes	Loamy Upland.
Dn	Dennis silt loam, 1 to 4 percent slopes	IIe	Yes	Loamy Upland.
Do	Dennis silt loam, 4 to 7 percent slopes	IIIe	Yes	Loamy Upland.
Dp	Dennis silty clay loam, 2 to 5 percent slopes, eroded	IIIe	No	Loamy Upland.
Dw	Dennis-Dwight silt loams, 1 to 5 percent slopes	IIIe	No	
	Dennis			Loamy Upland.
	Dwight			Claypan.
Eb	Eram silt loam, 1 to 3 percent slopes	IIIe	Yes	Clay Upland.
Ec	Eram silt loam, 3 to 7 percent slopes	IVe	No	Clay Upland.
Ef	Eram silty clay loam, 3 to 7 percent slopes, eroded	IVe	No	Clay Upland.
Gr	Girard silty clay loam, frequently flooded	Vw	No	Clay Lowland.
Iv	Ivan silt loam, occasionally flooded	IIw	Yes	Loamy Lowland.
Ke	Kenoma silt loam, 1 to 3 percent slopes	IIIe	Yes	Clay Upland.
Ko	Kenoma-Olpe silt loams, 2 to 7 percent slopes	IVe	No	
	Kenoma			Clay Upland.
	Olpe			Loamy Upland.
La	Lanton silt loam, occasionally flooded	IIw	Yes	Loamy Lowland.
Ma	Mason silt loam	I	Yes	Loamy Lowland.
Nd	Niotaze-Darnell complex, 4 to 30 percent slopes	VIe	No	
	Niotaze			Savannah.
	Darnell			Shallow Savannah.
Or	Osage silty clay loam, occasionally flooded	IIw	Yes	Clay Lowland.
Os	Osage silty clay, occasionally flooded	IIIw	Yes	Clay Lowland.
Pe	Prue loam, 2 to 5 percent slopes	IIIe	Yes	Loamy Upland.
Pt	Pits, quarries.			
Rn	Ringo silty clay loam, 15 to 35 percent slopes	VIIe	No	Clay Upland.
Rs	Ringo-Shidler silty clay loams, 3 to 15 percent slopes	VIe	No	
	Ringo			Clay Upland.
	Shidler			Shallow Limy.
Sc	Shidler-Catoosa complex, 1 to 8 percent slopes	VIe	No	
	Shidler			Shallow Limy.
	Catoosa			Loamy Upland.
Sf	Steedman gravelly silt loam, 4 to 25 percent slopes, stony	VIe	No	Loamy Upland.
Sm	Stephenville-Darnell fine sandy loams, 2 to 6 percent slopes	IVe	No	
	Stephenville			Savannah.
	Darnell			Shallow Savannah.
Sp	Stephenville-Darnell fine sandy loams, 6 to 20 percent slopes	VIe	No	
	Stephenville			Savannah.
	Darnell			Shallow Savannah.
Vc	Verdigris silt loam, channeled	Vw	No	Loamy Lowland.
Vf	Verdigris silt loam, occasionally flooded	IIw	Yes	Loamy Lowland.
Wo	Woodson silt loam	IIs	Yes	Clay Upland.
Za	Zaar silty clay, 0 to 1 percent slopes	IIIw	Yes	Clay Upland.
Zb	Zaar silty clay, 1 to 4 percent slopes	IIIe	Yes	Clay Upland.

* A soil complex is treated as a single management unit in the land capability and prime farmland columns.

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