United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with
Kansas Agricultural
Experiment Station

Soil Survey of Labette County, Kansas

How To Use This Soil Survey

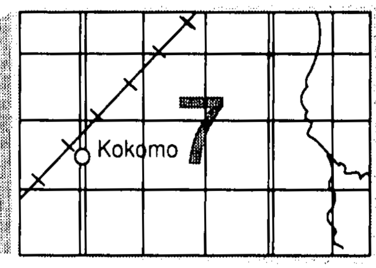
General Soil Map

The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

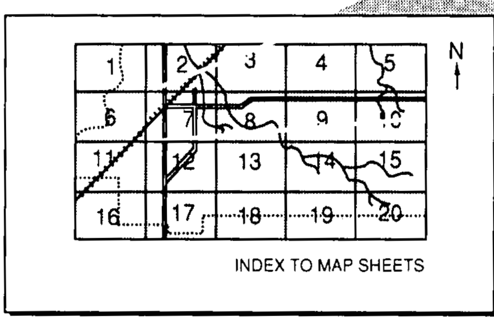
Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.



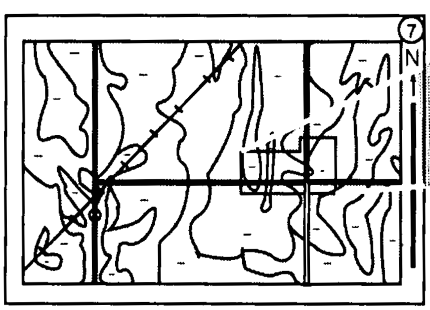
MAP SHEET

To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.

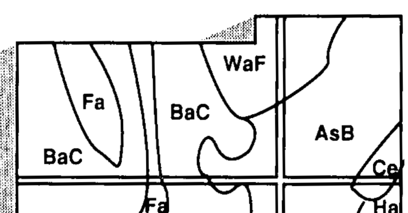


INDEX TO MAP SHEETS

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



MAP SHEET



AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

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.

Major fieldwork for this soil survey was completed in 1986. Soil names and descriptions were approved in 1987. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1986. 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 Labette 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.

All programs and services of the Soil Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

Cover: Cattle grazing in an area of Apperson silty clay loam, 1 to 3 percent slopes.

Contents

Issued July 1990

Index to Map Units

Summary of Tables

Foreword

This soil survey contains information that can be used in land-planning programs in Labette 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 Labette County, Kansas

By H. Dan Owens, Howard V. Cambell, Edward L. Fleming, Stephen P. Graber, and Deane W. Swanson, Soil Conservation Service

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

LABETTE COUNTY is in the southeastern part of Kansas (fig. 1). It has a total area of 417,984 acres, or about 653 square miles. In 1985, it had a population of 25,700. Parsons, the largest town, has a population of 13,052. Oswego, the county seat, has a population of 2,199. The county was organized in 1867.

Farming and related services are the most important enterprises in the county. Small industries also are important. The climate favors cash grain and livestock farming. The main crops are wheat, soybeans, grain sorghum, and tall fescue.

This soil survey updates the survey of Labette County published in 1926 *(4)*. It provides additional information and larger maps, which show the soils in greater detail.

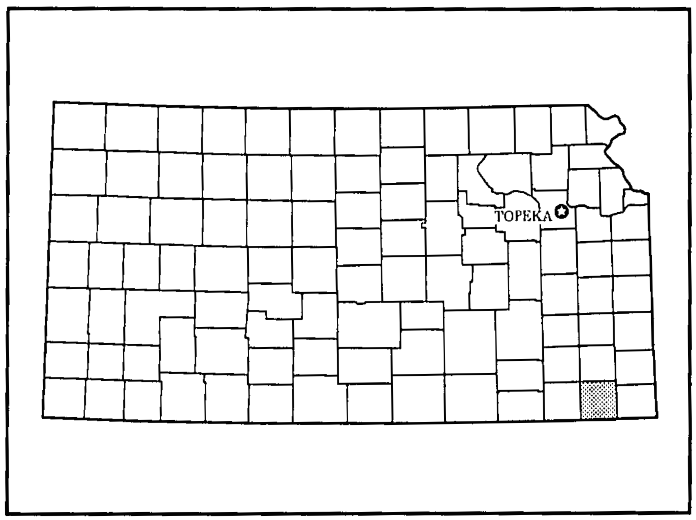


Figure 1.—Location of Labette County in Kansas.

General Nature of the County

This section gives general information concerning the county. It describes climate; physiography, drainage, and relief; water supply; and natural resources.

Climate

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

The climate in Labette 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. They provide a long growing season for crops. Spring and fall are relatively short.

Labette 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 causes 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. The muddiness delays planting and harvesting.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Parsons in the period 1951 to 1976. 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 37.1 degrees F, and the average daily minimum temperature is 26.8 degrees. The lowest temperature on record, which occurred at Oswego on February 13, 1905, is -30 degrees. In summer the average temperature is 79.0 degrees, and the average daily maximum temperature is 90.8 degrees. The highest recorded temperature, which occurred near Mound Valley on July 14, 1954, is 116 degrees.

The total annual precipitation is 38.5 inches. Of this, 25.37 inches, or about 66 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 20.24 inches. The heaviest 1-day rainfall during the period of record was 9.02 inches near Mound Valley on July 3, 1976. Tornadoes and severe thunderstorms strike occasionally. These storms are usually local in extent and of short duration, so that the risk of damage is small. Hail falls during warm periods. The hailstorms are infrequent, however, and are of local extent. They cause less crop damage in this county than in western Kansas.

The average seasonal snowfall is 11.7 inches. The highest recorded seasonal snowfall is 33.7 inches. On the average, 11 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 69 percent of the time possible in summer and 55 percent in winter. The prevailing wind is from the south. Average windspeed is highest, 11 miles per hour, in March and April.

Physiography, Drainage, and Relief

Labette County is in the Cherokee Prairie major land resource area. Generally, the uplands in this area include broad flats, broad gently sloping areas, low hills, and a few steep escarpments.

The eastern part of the county is drained by the Neosho River and its tributaries, and the western part is drained by tributaries of the Verdigris River (fig. 2). All of the streams flow in a southerly direction.

The highest elevation, in the northwestern part of the county, is about 1,000 feet above sea level. The lowest, in an area along the Neosho River in the southeastern part, is about 790 feet.

Water Supply

Generally, the quantity of underground water for domestic uses and for livestock is not adequate. Most wells are drilled in the alluvial deposits along drainageways. These are generally low-yielding wells that do not provide enough water for domestic uses.

The principal source of water for livestock is surface water impounded by dams on intermittent streams. The smaller streams and the ground water discharged by seeps and springs also are sources, but they can dry up during prolonged dry periods.

The water for farm uses is supplied mainly by rural water district supply lines but also by wells, ponds, and streams. The water for towns generally is drawn from lakes and streams.

Natural Resources

Soil is the most important natural resource in the county. Also important are coal, shale, limestone, oil, and gas. Limestone, coal, and shale are the most common minerals. They are mined for commercial uses. Limestone is used in the manufacture of cement and agricultural lime. Low-yielding oil and gas wells are throughout the county.

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

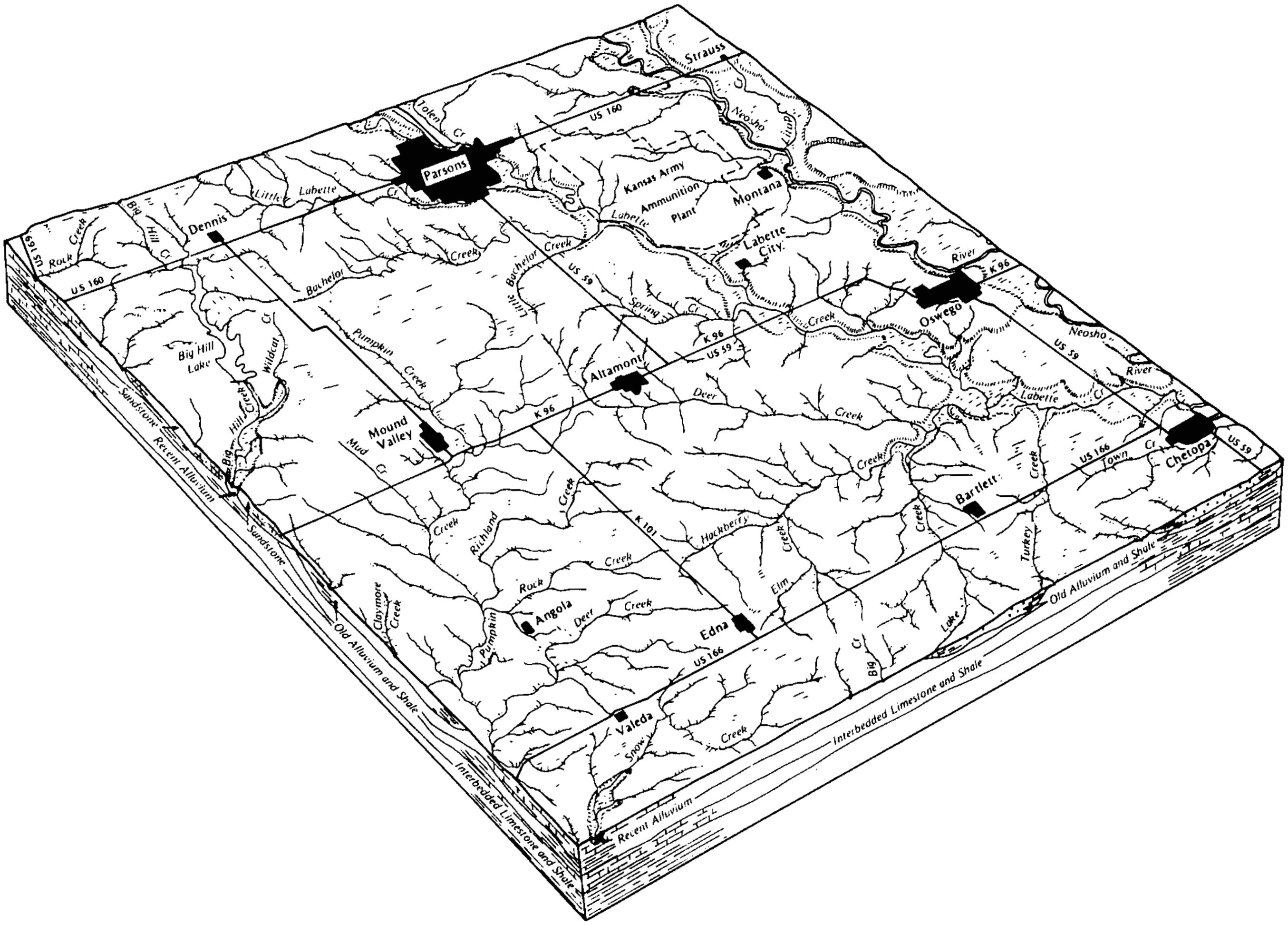


Figure 2.—Pattern of geology, relief, and drainage in Labette County.

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, soil reaction, 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 named and 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.

General Soil Map Units

The general soil map at the back of this publication shows 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.

Soil Descriptions

1. Cherokee-Dennis Association

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

This association is on broad flats and side slopes that are dissected by drainageways. Slopes range from 0 to 3 percent.

This association makes up about 5 percent of the county. It is about 68 percent Cherokee soils, 22 percent Dennis soils, and 10 percent minor soils (fig. 3).

The nearly level, somewhat poorly drained Cherokee soils formed in old alluvium on broad flats. Typically, the surface layer is dark grayish brown silt loam about 7 inches thick. The subsurface layer is grayish brown, mottled silt loam about 6 inches thick. The subsoil is mottled, very firm clay about 30 inches thick. The upper part is very dark gray, and the lower part is dark grayish brown. The substratum to a depth of about 60 inches is grayish brown, mottled silty clay loam.

The gently sloping, moderately well drained Dennis soils formed in material weathered from shale on 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, mottled, friable silty clay loam; the next part is brown, mottled, very firm silty clay; and the lower part is coarsely mottled strong brown and gray, very firm silty clay.

Minor in this association are the moderately well drained Verdigris soils on narrow flood plains along drainageways.

This association is used mainly for cultivated crops. Some areas are used as tame grass pasture. Soybeans, wheat, and grain sorghum are the main crops. Controlling water erosion and maintaining tilth and fertility are the main concerns in managing the cultivated areas. A surface drainage system is needed in some areas of the Cherokee soils. Increasing forage production is a concern in managing pasture.

2. Lanton-Osage-Hepler Association

Deep, nearly level, somewhat poorly drained and poorly drained soils that have a clayey subsoil or that are silty throughout; on flood plains

This association is on flood plains along the major streams in the county. The major soils are occasionally flooded. Slopes range from 0 to 2 percent.

This association makes up about 11 percent of the county. It is about 41 percent Lanton soils, 23 percent Osage soils, 21 percent Hepler soils, and 15 percent minor soils.

The somewhat poorly drained Lanton soils formed in silty and clayey alluvium. Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick.

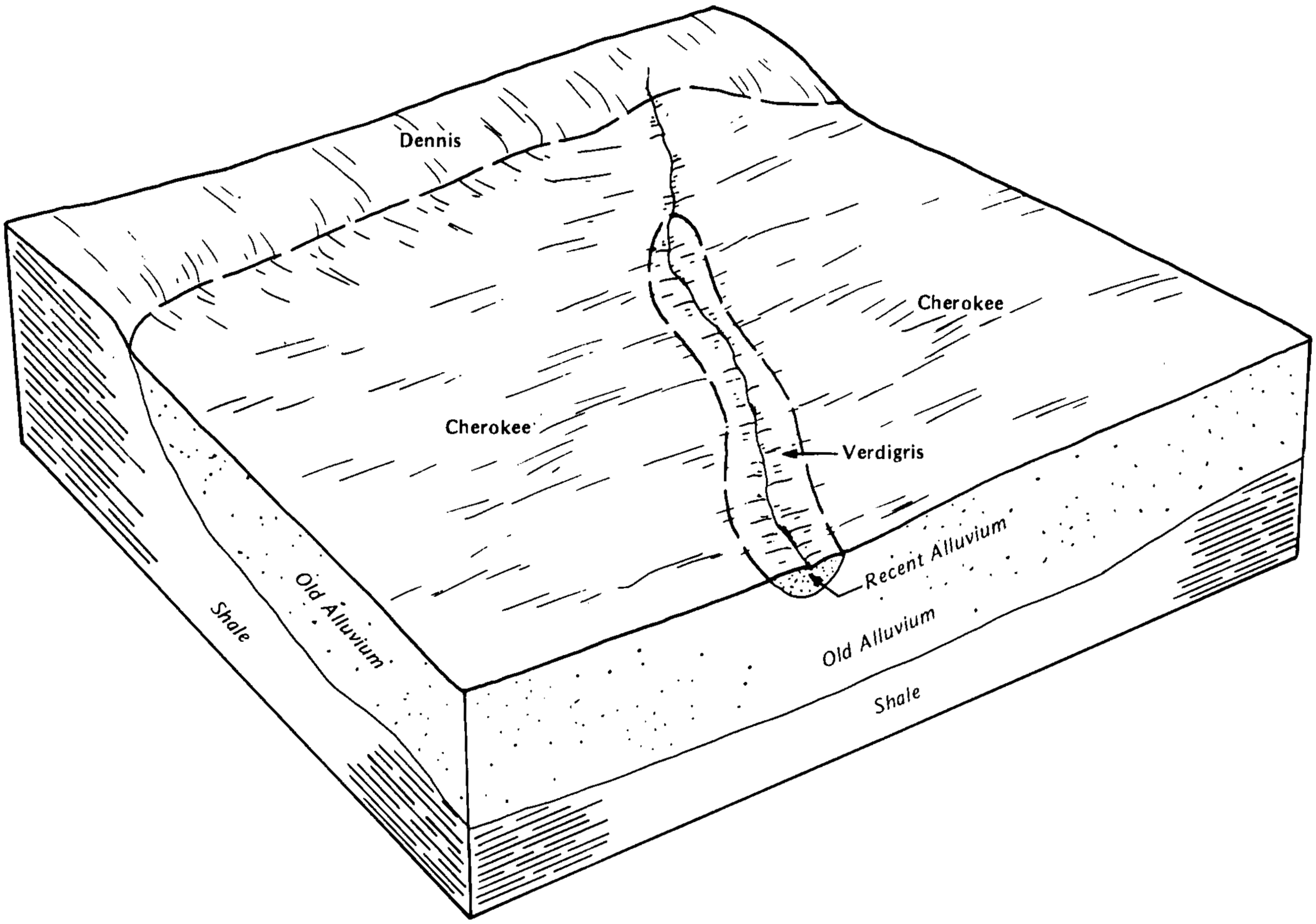


Figure 3.—Typical pattern of soils and parent material in the Cherokee-Dennis association.

The subsurface layer is mottled silty clay loam about 29 inches thick. The upper part is black, and the lower part is very dark gray. The substratum to a depth of about 60 inches is dark grayish brown, mottled silty clay.

The poorly drained Osage soils formed in clayey alluvium. Typically, the surface layer is very dark gray silty clay about 5 inches thick. The subsurface layer is silty clay about 12 inches thick. The upper part is black, and the lower part is very dark gray and mottled. The subsoil to a depth of about 60 inches is mottled, extremely firm clay. The upper part is very dark gray, and the lower part is dark gray.

The somewhat poorly drained Hepler soils formed in silty alluvium. Typically, the surface layer is very dark grayish brown silt loam about 9 inches thick. The subsurface layer is mottled silt loam about 15 inches thick. The upper part is dark grayish brown, and the lower part is grayish brown. The subsoil to a depth of more than 60 inches is dark grayish brown, mottled, firm silty clay loam.

Minor in this association are the moderately well drained Verdigris soils on the flood plains.

This association is used mainly for cultivated crops. A few areas are used as tame grass pasture. Hardwood trees grow along the stream channels. Wheat, grain sorghum, and soybeans are the main crops. Controlling flooding, maintaining fertility and tilth, and improving drainage are the main concerns in managing the cultivated areas.

3. Parsons-Kenoma-Dennis Association

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

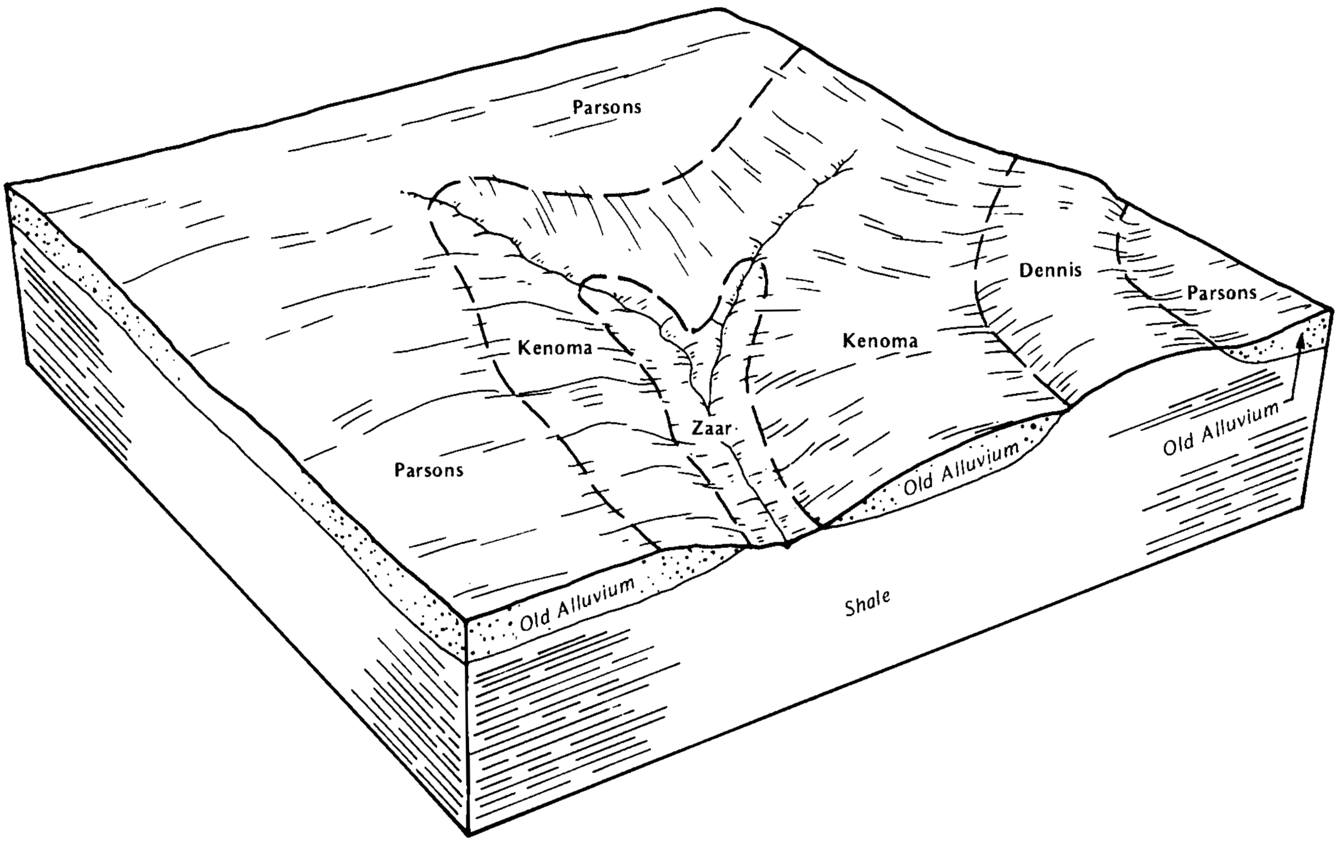


Figure 4.—Typical pattern of soils and parent material in the Parsons-Kenoma-Dennis association.

This association is on broad flats, ridges, and side slopes that are dissected by drainageways. Slopes range from 0 to 3 percent.

This association makes up about 28 percent of the county. It is about 42 percent Parsons soils, 28 percent Kenoma soils, 19 percent Dennis soils, and 11 percent minor soils (fig. 4).

The nearly level, somewhat poorly drained Parsons soils formed in old alluvium on broad flats. Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsurface layer is dark grayish brown, mottled silt loam about 5 inches thick. The subsoil to a depth of more than 60 inches is mottled, very firm silty clay. The upper part is very dark grayish brown, and the lower part is gray, yellowish brown, and yellowish red.

The gently sloping, moderately well drained Kenoma soils formed in old alluvium on broad ridgetops. Typically, the surface layer is very dark grayish brown silt loam about 6 inches thick. The subsurface layer also is very dark grayish brown silt loam. It is about 7 inches thick. The subsoil is mottled silty clay about 36 inches thick. The upper part is dark brown and very firm, and the lower part is dark yellowish brown and extremely firm. The substratum to a depth of about 60 inches is yellowish brown, mottled silty clay loam.

The gently sloping, moderately well drained Dennis soils formed in material weathered from shale on 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, mottled, friable silty clay loam; the next part is brown, mottled, very firm silty clay; and the lower part is coarsely mottled strong brown and gray, very firm silty clay.

Minor in this association are the Verdigris and Zaar soils. The moderately well drained Verdigris soils are on narrow flood plains along drainageways. The somewhat poorly drained Zaar soils are on foot slopes.

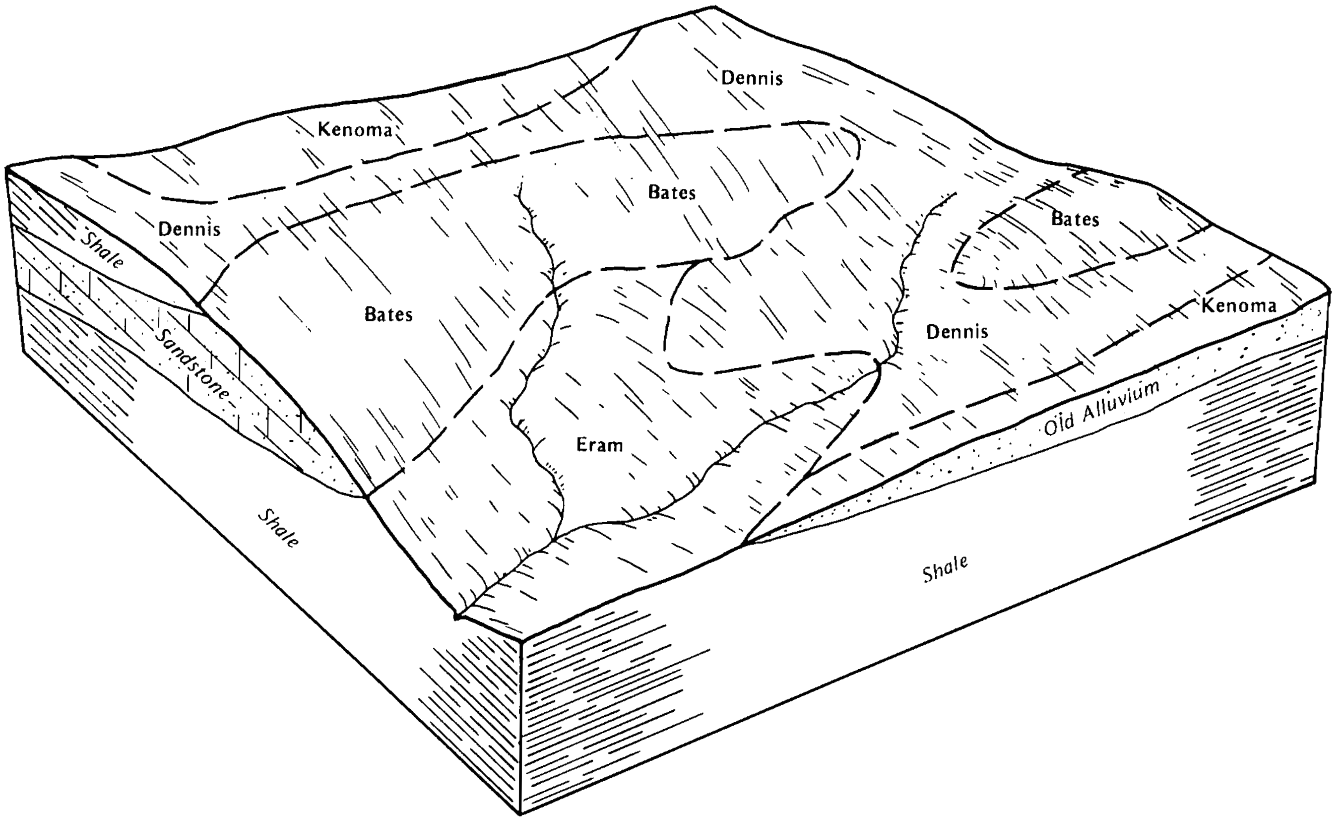


Figure 5.—Typical pattern of soils and parent material in the Bates-Dennis-Eram association.

This association is used mainly for cultivated crops. A few areas are used as tame grass pasture. Wheat, grain sorghum, and soybeans are the main crops. Controlling water erosion and maintaining tilth and fertility are the main concerns in managing the cultivated areas. A surface drainage system is needed in some areas of the Parsons soils.

4. Bates-Dennis-Eram Association

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

This association is on ridges and side slopes that are dissected by drainageways. Slopes range from 1 to 7 percent.

This association makes up about 13 percent of the county. It is about 31 percent Bates soils, 27 percent Dennis soils, 26 percent Eram soils, and 16 percent minor soils (fig. 5).

The moderately deep, well drained, gently sloping and moderately sloping Bates soils formed in material weathered from sandstone and sandy and silty shale on ridgetops and side slopes. Typically, the surface layer is very dark brown loam about 9 inches thick. The subsoil is about 21 inches thick. It is mottled. The upper part is dark brown, friable loam; the next part is brown, firm clay loam; and the lower part is dark yellowish brown, firm clay loam. Soft sandstone bedrock interbedded with sandy and silty shale is at a depth of about 30 inches.

The deep, moderately well drained, gently sloping Dennis soils formed in material weathered from shale on 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, mottled, friable silty clay loam; the next part is brown, mottled, very firm silty clay; and the lower part is coarsely mottled strong brown and gray, very firm silty clay.

The moderately deep, moderately well drained, gently sloping and moderately sloping Eram soils

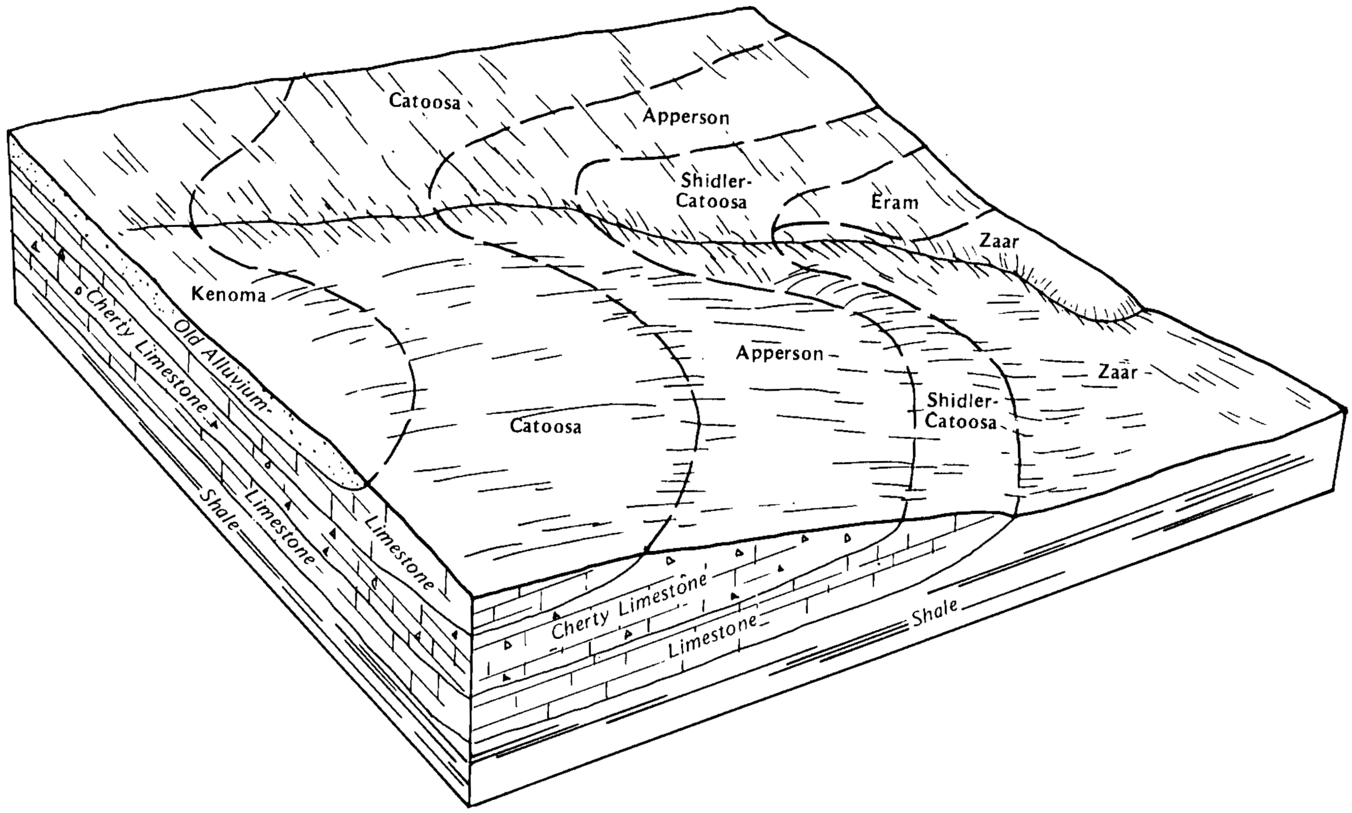


Figure 6.—Typical pattern of soils and parent material in the Catoosa-Apperson-Zaar association.

formed in material weathered from shale on side slopes. Typically, the surface layer is very dark grayish brown silty clay loam about 8 inches thick. The subsoil is mottled, very firm clay about 18 inches thick. The upper part is very dark grayish brown, and the lower part is dark grayish brown. Shale bedrock is at a depth of about 26 inches.

Minor in this association are the Collinsville, Kenoma, and Verdigris soils. The shallow Collinsville soils are on side slopes. The very slowly permeable Kenoma soils are on broad ridgetops. The moderately well drained Verdigris soils are on narrow flood plains along drainageways.

About 50 percent of this association is used for cultivated crops, and 50 percent is used as pasture, range, or woodland. Wheat, grain sorghum, and soybeans are the main crops. Controlling water erosion and maintaining tilth and fertility are the main concerns in managing the cultivated areas. Increasing forage production is a concern in managing tame grass pasture. Maintaining the growth and vigor of desirable grasses and forbs is the main concern in managing range.

5. Catoosa-Apperson-Zaar Association

Moderately deep and deep, nearly level and gently sloping, well drained to somewhat poorly drained soils that have a silty or dominantly clayey subsoil; on uplands

This association is on ridgetops, foot slopes, and side slopes that are dissected by drainageways. Slopes range from 0 to 3 percent.

This association makes up about 43 percent of the county. It is about 24 percent Catoosa soils, 21 percent Apperson soils, 18 percent Zaar soils, and 37 percent minor soils (fig. 6).

The moderately deep, well drained, nearly level Catoosa soils formed in material weathered from limestone on ridgetops. Typically, the surface soil is dark brown silt loam about 12 inches thick. The subsoil is dark reddish brown, firm silty clay loam about 26 inches thick. Limestone bedrock is at a depth of about 38 inches.

The deep, moderately well drained, gently sloping Apperson soils formed in material weathered from limestone on ridgetops and side slopes. Typically, the surface layer is black silty clay loam about 7 inches thick. The subsoil is about 42 inches thick. The upper part is very dark grayish brown, firm silty clay loam; the next part is very dark grayish brown and dark grayish brown, mottled, very firm silty clay; and the lower part is olive brown, mottled, very firm silty clay. Limestone bedrock is at a depth of about 49 inches.

The deep, somewhat poorly drained, nearly level Zaar soils formed in material weathered from shale on foot slopes. Typically, the surface layer is very dark gray silty clay about 7 inches thick. The subsurface layer is black silty clay about 10 inches thick. The subsoil is mottled, extremely firm clay about 37 inches thick. The upper part is black, and the lower part is dark grayish brown. The substratum to a depth of about 60 inches is yellowish brown, mottled clay.

Minor in this association are the Eram, Kenoma, Parsons, Shidler, and Verdigris soils. The moderately deep, moderately well drained Eram soils are on side slopes. The deep, gently sloping Kenoma soils are on broad ridgetops. The deep, somewhat poorly drained Parsons soils are on broad flats. The shallow, well drained, moderately sloping Shidler soils are on ridgetops. The deep, moderately well drained Verdigris soils are on flood plains along drainageways.

About 55 percent of this association is used for cultivated crops, and 45 percent is used as pasture or range. Wheat, grain sorghum, and soybeans are the main crops. Controlling water erosion, maintaining tilth and fertility, and improving drainage are the main concerns in managing the cultivated areas. Increasing forage production is a concern in managing tame grass pasture. Maintaining the growth and vigor of desirable grasses and forbs is the main concern in managing range.

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, Bates loam, 1 to 3 percent slopes, is a phase of the Bates 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. Bates-Collinsville complex, 4 to 15 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.

Soil Descriptions

Ae—Apperson silty clay loam, 1 to 3 percent slopes. This deep, gently sloping, moderately well drained soil is on ridgetops and side slopes in the uplands. Individual areas are irregular in shape and range from 10 to 300 acres in size.

Typically, the surface layer is black silty clay loam about 7 inches thick. The subsoil is about 42 inches thick. The upper part is very dark grayish brown, firm silty clay loam; the next part is very dark grayish brown and dark grayish brown, mottled, very firm silty clay; and the lower part is olive brown, mottled, very firm silty clay. Limestone bedrock is at a depth of about 49 inches. In some areas the surface layer is silt loam, and in other areas it is silty clay.

Included with this soil in mapping are small areas of Catoosa and Shidler soils. The moderately deep Catoosa soils are lower or higher on the landscape than the Apperson soil. The shallow Shidler soils are on the steeper side slopes. Also included are small areas where limestone bedrock crops out. Included areas make up 10 to 15 percent of the map unit.

Permeability is slow in the Apperson soil, and runoff is medium. Available water capacity is moderate. The shrink-swell potential is high in the subsoil. A perched seasonal high water table is at a depth of about 1.5 to 2.0 feet in winter and in early spring. The surface layer is firm and can be easily tilled only within a fairly narrow range in moisture content.

About 75 percent of the acreage is used for cultivated crops. The rest is used as range or tame grass pasture. This soil is well suited to grain sorghum, soybeans, wheat, and tall fescue. It is poorly suited to alfalfa because of the moderate available water capacity. Crop yields are adversely affected during dry periods because the clayey subsoil fails to release water readily to plants. Water erosion is a hazard if cultivated crops are grown. Terraces, grassed waterways, contour farming, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the rate of water infiltration.

This soil is suited to range and to tame grass pasture. The native vegetation is dominantly big bluestem, little bluestem, switchgrass, and indiangrass. If the range is heavily used throughout the growing season, these grasses are replaced by less desirable plants, such as broomsedge bluestem, Baldwin ironweed, and lanceleaf ragweed. Invasion of brushy plants, such as sumac, blackberry, and eastern redcedar, is a problem in some areas. Timely burning helps to control most of these plants. Water erosion is a hazard if the range is overused. An adequate plant cover helps to prevent excessive soil loss. Range seeding is needed to restore the productivity of abandoned cropland. A proper stocking rate, rotation grazing, a uniform distribution of grazing, and brush control help to keep the range productive. In the areas of tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and a timely season of use increase forage production.

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 depth to bedrock, the slope, and seepage. Sealing the lagoon helps to prevent seepage. If the less sloping areas are chosen as sites for lagoons, less cutting and filling will be needed during construction. Onsite investigation may identify areas of soils that are deeper to bedrock. Also, fill material can elevate the berms of the lagoon.

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

Be—Bates loam, 1 to 3 percent slopes. This moderately deep, gently sloping, well drained soil is on convex ridgetops, side slopes, and mounds 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 brown loam about 9 inches thick. The subsoil is about 21 inches thick. It is mottled. The upper part is dark brown, friable loam, and the lower part is brown and dark yellowish brown, firm clay loam. Soft sandstone bedrock interbedded with sandy and silty shale is at a depth of about 30 inches. In places the surface layer is cobbly loam.

Included with this soil in mapping are small areas of Collinsville and Dennis soils. The shallow Collinsville soils are generally more sloping than the Bates soil. The deep Dennis soils have a dominantly clayey subsoil. They are on side slopes. Included soils make up 10 to 15 percent of the map unit.

Permeability and available water capacity are moderate in the Bates soil. Runoff is medium. Root penetration is restricted by the bedrock at a depth of 20 to 40 inches. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas are used for cultivated crops. The rest are used as pasture. This soil is well suited to soybeans, grain sorghum, and wheat. It is poorly suited to alfalfa because of seasonal droughtiness. Water erosion is a hazard if cultivated crops are grown. Terraces, grassed waterways, contour farming, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the rate of water infiltration. Soil depth should be considered when a terrace system is designed. In a few areas where terraces have been built, the root zone is severely restricted because most of the soil overlying the bedrock has been removed.

This soil is suited to tame grass pasture. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates and rotation grazing help to keep the pasture in good condition. Applications of fertilizer and lime improve plant growth and vigor. The lime should be incorporated into the soil prior to seeding. Timely mowing for hay allows the plants to recover before the first frost.

This soil is well suited to dwellings. Because of the depth to bedrock, however, it is generally unsuited to septic tank absorption fields and sewage lagoons. Suitable sites for lagoons are commonly available in the nearby areas of more clayey soils on the lower side slopes.

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

Bf—Bates loam, 3 to 7 percent slopes. This moderately deep, moderately sloping, well drained soil is on convex ridgetops, side slopes, and knolls in the uplands. Individual areas are irregular in shape or long and narrow and range from 20 to 100 acres in size.

Typically, the surface layer is very dark brown loam about 7 inches thick. The subsoil is about 19 inches thick. The upper part is dark brown, friable loam, and the lower part is dark brown and dark yellowish brown, mottled, firm clay loam. Soft sandstone bedrock is at a depth of about 26 inches. In places the surface layer is cobbly loam.

Included with this soil in mapping are small areas of Collinsville and Dennis soils. The shallow Collinsville soils are generally more sloping than the Bates soil. The deep Dennis soils are on the lower side slopes. Included soils make up 10 to 15 percent of the map unit.

Permeability and available water capacity are moderate in the Bates soil. Runoff is medium. Root penetration is restricted by the bedrock at a depth of about 20 to 40 inches. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas are used for cultivated crops. The rest are used as pasture or range. This soil is moderately well suited to soybeans, grain sorghum, and wheat. It is poorly suited to alfalfa because of seasonal droughtiness. Water erosion is a hazard if cultivated crops are grown. Terraces, grassed waterways, contour farming, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the rate of water infiltration. Soil depth should be considered when a terrace system is designed. In a few areas where terraces have been built, the root zone is severely restricted because most of the soil overlying the bedrock has been removed.

This soil is suited to range and to tame grass pasture. The native vegetation is dominantly big bluestem, little bluestem, switchgrass, and indiangrass. If the range is heavily used throughout the growing season, these grasses are replaced by less desirable plants, such as broomsedge bluestem, Baldwin ironweed, and lanceleaf ragweed. Invasion of brushy plants, such as sumac, blackberry, and eastern redcedar, is a problem in some areas. Timely burning helps to control most of these plants. Water erosion is a hazard if the range is overused. An adequate plant cover helps to prevent excessive soil loss. Range seeding is needed to restore the productivity of abandoned cropland. A proper stocking rate, rotation grazing, a uniform distribution of grazing, and brush control help to keep the range productive.

In the areas of tame grass pasture, applications of fertilizer and lime, proper stocking rates, rotation grazing, and a timely season of use increase forage production. The lime should be incorporated into the soil prior to seeding. Timely mowing for hay allows the plants to recover before the first frost.

This soil is well suited to dwellings. Because of the depth to bedrock, however, it is generally unsuited to septic tank absorption fields and sewage lagoons. Suitable sites for lagoons are commonly available in the nearby areas of more clayey soils on the lower side slopes.

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

Bm—Bates-Collinsville complex, 4 to 15 percent slopes. These moderately sloping and 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 300 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 grayish brown loam about 8 inches thick. The subsoil is about 19 inches thick. The upper part is very dark grayish brown, friable loam, and the lower part is dark brown, mottled, firm clay loam. Soft sandstone bedrock is at a depth of about 27 inches. In places the surface layer is cobbly loam.

Typically, the Collinsville soil has a surface layer of very dark grayish brown fine sandy loam about 8 inches thick. The subsurface layer is dark brown fine sandy loam about 5 inches thick. Sandstone bedrock is at a depth of about 13 inches.

Included with these soils in mapping are small areas of Dennis and Eram soils. The deep Dennis soils are on the lower part of side slopes, and the moderately well drained Eram soils are on the upper part. Included soils 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. Runoff is medium on the Bates soil and rapid on the Collinsville soil. Root penetration is restricted by the bedrock at a depth of 20 to 40 inches in the Bates soil and about 4 to 20 inches in the Collinsville soil.

Most areas support native grasses and are used as range or hayland. A few areas are used as tame grass pasture. Because of the hazard of water erosion on both soils and the shallowness to bedrock in the Collinsville soil, these soils are generally unsuited to cultivated crops. They are better suited to range, pasture, and hay. The native vegetation is dominantly big bluestem, little bluestem, switchgrass, and indiangrass. If the range is heavily used throughout the growing season, the more desirable grasses and forbs are replaced by less productive mid and short grasses and by weeds and brush. After continued heavy grazing, the plant community is invaded by broomsedge bluestem, broomweed, eastern redcedar, sumac, and other less desirable vegetation. Water erosion is a hazard if the range is overused. An adequate plant cover helps to prevent excessive soil loss. A proper stocking rate, a uniform distribution of grazing, rotation grazing, and brush control help to keep the range productive.

If these soils are used for tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, a timely season of use, and brush control increase forage production. Forage production is low on abandoned cropland. It can be increased by seeding desirable grasses.

The Bates soil is well suited to dwellings. Because of the depth to bedrock, however, it is generally unsuited to septic tank absorption fields and sewage lagoons. Suitable sites for lagoons are commonly available in the nearby areas of more clayey soils on the lower side slopes.

The Collinsville soil is generally unsuited to building site development because of the shallowness 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.

Bo—Bolivar-Hector fine sandy loams, 4 to 20 percent slopes. These moderately sloping to moderately steep, well drained soils are on uplands. In most areas they are dissected by drainageways. The moderately deep Bolivar soil is on ridgetops. The shallow Hector soil is on side slopes. Individual areas are irregular in shape and range from 20 to 400 acres in size. They are about 65 percent Bolivar soil and 25 percent Hector soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Bolivar soil has a surface layer of very dark grayish brown fine sandy loam about 5 inches thick. The subsurface layer is brown fine sandy loam about 7 inches thick. The subsoil is mottled, firm clay loam about 15 inches thick. The upper part is brown, and the lower part is strong brown. Sandstone bedrock is at a depth of about 27 inches.

Typically, the Hector soil has a surface layer of dark brown fine sandy loam about 3 inches thick. The subsurface layer is brown fine sandy loam about 5 inches thick. The subsoil is yellowish brown and strong brown, friable fine sandy loam about 7 inches thick. Sandstone bedrock is at a depth of about 15 inches.

Included with these soils in mapping are small areas of the deep Dennis soils on foot slopes. These included soils make up less than 10 percent of the map unit.

Permeability is moderate in the Bolivar soil and moderately rapid in the Hector soil. Available water capacity is low in the Bolivar soil and very low in the Hector soil. Runoff is rapid on both soils. Root penetration is restricted by the bedrock at a depth of 20 to 40 inches in the Bolivar soil and 10 to 20 inches in the Hector soil. The shrink-swell potential is moderate in the subsoil of the Bolivar soil.

Most of the acreage is woodland that has an understory of shrubs and grasses. Some areas are used as range, most of which is grazed. Because of the hazard of water erosion on both soils and the shallowness to bedrock in the Hector soil, these soils are generally unsuited to cultivated crops. They are moderately well suited to trees. Most of the trees are used for firewood or charcoal. Because of the restricted root zone, the growth rate is only moderate and the quality of the timber is only fair. The growth rate and quality of the timber can be improved by removing undesirable trees, by protecting the woodland against fire, and by fencing, which helps to control grazing.

These soils are suited to range. The dominant vegetation is post oak and blackjack oak and an understory of big bluestem, little bluestem, and indiangrass. If the range is heavily used throughout the growing season, the more desirable grasses are replaced by less productive grasses, such as broomsedge bluestem, and by broomweed. Water erosion is a hazard if the range is overused. An adequate plant cover helps to prevent excessive soil loss. Measures that thin the canopy, a proper stocking rate, rotation grazing, and brush control help to keep the range productive.

The diverse vegetation of trees, shrubs, and grasses on these soils provides good habitat for many wildlife species, including quail, deer, wild turkey, rabbits, and numerous songbirds. Proper grazing use, brush control, and establishment of feed areas increase the wildlife population.

The Bolivar soil is moderately well suited to dwellings. The shrink-swell potential and slope of this soil are limitations. Also, the depth to bedrock is a limitation on sites for dwellings with basements. As a result, the soil is better suited to dwellings without 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. If the less sloping areas are selected as sites for dwellings, less leveling will be needed during construction.

Because of the depth to bedrock, the Bolivar soil is generally unsuited to septic tank absorption fields and sewage lagoons. Suitable sites for lagoons are commonly available in the nearby areas of more clayey soils on the lower side slopes.

The Hector soil is generally unsuited to building site development because of the shallowness to bedrock.

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

Br—Brazilton silty clay loam, 1 to 4 percent slopes. This deep, gently sloping, moderately well drained soil is on ridgetops and side slopes in the uplands. The topsoil and subsoil were stockpiled, and the substratum and underlying material were strip-mined. Later, the areas were shaped and smoothed and the subsoil and topsoil were replaced. Individual areas are generally rectangular and range from 40 to 100 acres in size.

Typically, the surface layer is very dark brown silty clay loam about 15 inches thick. The upper part of the substratum is dark grayish brown and brown, mottled silty clay. The lower part to a depth of about 60 inches is light yellowish brown very shaly silty clay loam. In places fragments of coal, limestone, sandstone, and shale are exposed. In some small areas the soil material is extremely acid.

Permeability is very slow, and runoff is medium. Available water capacity is low. In most areas the surface layer and subsoil are compacted. The shrink-swell potential is high in the upper part of the substratum. The surface layer is firm and can be easily tilled only within a fairly narrow range in moisture content.

Nearly all areas are used as tame grass pasture or are seeded to wheat or grain sorghum. This soil is moderately well suited to most cultivated crops. Water erosion is a hazard, and compaction is a limitation. Also, extreme acidity is a limitation in some small areas. Terraces, grassed waterways, contour farming, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the rate of water infiltration. Applications of lime reduce the extreme acidity.

This soil is suited to tame grass pasture and to native grasses. In the areas used as tame grass pasture, applications of fertilizer and lime, proper stocking rates, rotation grazing, and a timely season of use increase forage production. The lime should be incorporated into the soil prior to seeding. Timely mowing for hay allows the plants to recover before the first frost.

This soil is poorly suited to dwellings. The shrink-swell potential and low strength 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.

Because of the very slow permeability, this soil is generally unsuited to septic tank absorption fields. It is only moderately well suited to sewage lagoons because of seepage and slope. Sealing the lagoons with less permeable material helps to control seepage. If the less sloping areas are selected as sites for the lagoons, less cutting and filling will be needed during construction.

The land capability classification is IIIe. No range site is assigned.

Cd—Catoosa silt loam, 0 to 2 percent slopes. This moderately deep, nearly level, 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 soil is dark brown silt loam about 12 inches thick. The subsoil is dark reddish brown, firm silty clay loam about 26 inches thick. Limestone bedrock is at a depth of about 38 inches. In places the depth to bedrock is more than 40 inches. In some small areas limestone or chert fragments are on the surface and throughout the soil.

Included with this soil in mapping are small areas of Apperson, Kenoma, Shidler, and Zaar soils. Apperson and Kenoma soils are more than 40 inches deep over bedrock. Apperson soils are higher or lower on the landscape than the Catoosa soil. Kenoma soils are on broad ridgetops. The shallow Shidler soils are on the steeper side slopes. The clayey Zaar soils are along drainageways. Also included are small areas of rock outcrop. Included areas make up 5 to 15 percent of the map unit.

Permeability and available water capacity are moderate in the Catoosa soil. Runoff is medium. The shrink-swell potential is moderate in the subsoil. Root penetration is restricted by the bedrock at a depth of 20 to 40 inches. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas are used for cultivated crops. A few are used as pasture or range. This soil is well suited to soybeans, grain sorghum, wheat, and tall fescue. It is poorly suited to alfalfa because of seasonal droughtiness. Water erosion is a hazard if cultivated crops are grown. Terraces, grassed waterways, contour farming, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the rate of water infiltration. Soil depth should be considered when a terrace system is designed. In a few places where terraces have been built, the root zone is severely restricted because most of the soil overlying the bedrock has been removed.

This soil is suited to range and to tame grass pasture. The native vegetation is dominantly big bluestem, little bluestem, switchgrass, and indiangrass. If the range is heavily used throughout the growing season, these grasses are replaced by less desirable plants, such as broomsedge bluestem, Baldwin ironweed, and lanceleaf ragweed. Invasion of brushy plants, such as sumac, blackberry, and Osageorange, is a problem in some areas. Timely burning helps to control most of these plants. Water erosion is a hazard if the range is overused. An adequate plant cover helps to prevent excessive soil loss. Range seeding is needed to restore the productivity of abandoned cropland. A proper stocking rate, rotation grazing, a uniform distribution of grazing, and brush control help to keep the range productive.

In the areas of tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and a timely season of use increase forage production. Timely mowing for hay allows the plants to recover before the first frost.

Because of the depth to bedrock, this soil is generally unsuited to dwellings with basements. It is only moderately well suited to dwellings without basements because the shrink-swell potential and the depth to bedrock are limitations. Properly designing and reinforcing foundations and backfilling with suitable coarse textured material around the foundations help to prevent the structural damage caused by shrinking and swelling. The included areas of deeper soils generally are better sites for dwellings.

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

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

Ch—Cherokee silt loam, 0 to 1 percent slopes. This deep, nearly level, somewhat poorly drained soil is on broad flats in the uplands. Individual areas are irregular in shape and range from 40 to 800 acres in size.

Typically, the surface layer is dark grayish brown silt loam about 7 inches thick. The subsurface layer is grayish brown, mottled silt loam about 6 inches thick. The subsoil is mottled, very firm clay about 30 inches thick. The upper part is very dark gray, and the lower part is dark grayish brown. The substratum to a depth of about 60 inches is grayish brown, mottled silty clay loam. In some areas the subsurface layer is very dark grayish brown.

Permeability is very slow, and runoff is slow. Available water capacity is high. The shrink-swell potential is high in the subsoil. A perched seasonal high water table is at a depth of 0.5 foot to 1.5 feet from winter through early summer. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Nearly all areas are used for cultivated crops. The rest are used as pasture. This soil is well suited to alfalfa, soybeans, grain sorghum, wheat, and tall fescue. Crop yields are adversely affected during dry periods because the clayey subsoil fails to release water readily to plants. Also, the wetness can delay tillage and reduce yields. It can be reduced by drainage ditches. Keeping tillage at a minimum and leaving crop residue on the surface help to maintain tilth and increase the content of organic matter.

This soil is suited to tame grass pasture. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates and rotation grazing help to keep the pasture in good condition. Applications of fertilizer and lime improve plant growth and vigor. The lime should be incorporated into the soil prior to seeding. Timely mowing for hay allows the plants to recover before the first frost.

Because the wetness and the shrink-swell potential are limitations, this soil is poorly suited to dwellings. 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.

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

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

De—Dennis silt loam, 1 to 3 percent slopes. This deep, gently sloping, moderately well drained soil is on side slopes and low knolls in the uplands. Individual areas are irregular in shape and range from 40 to 200 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, mottled, friable silty clay loam; the next part is brown, mottled, very firm silty clay; and the lower part is coarsely mottled strong brown and gray, very firm silty clay. In places the upper part of the subsoil is silty clay. Some areas above flood plains are more sloping.

Included with this soil in mapping are small areas of the moderately deep Bates soils on the upper side slopes. Also included are small areas of alkali soils and slick spots. Included areas make up 5 to 10 percent of the map unit.

Permeability is slow in the Dennis soil, and runoff is medium. Available water capacity is high. The shrink-swell potential is high in the subsoil. A perched seasonal high water table is at a depth of about 2 to 3 feet in winter and in early spring. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

About 75 percent of the acreage is used for cultivated crops. The rest is used as pasture. This soil is well suited to alfalfa, soybeans, grain sorghum, and wheat. Water erosion is a hazard if cultivated crops are grown. Terraces, grassed waterways, contour farming, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the rate of water infiltration.

This soil is suited to tame grass pasture. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Under these conditions, the tame grasses are replaced by less productive grasses, by weeds, such as broomweed, and by Osageorange. Proper stocking rates and rotation grazing help to keep the pasture in good condition. Applications of fertilizer and lime improve plant growth and vigor. The lime should be incorporated into the soil prior to seeding. Timely mowing for hay allows the plants to recover before the first frost.

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 moderately well suited to sewage lagoons because of the slope. If the less sloping areas are selected as sites for lagoons, less cutting and filling will be needed during construction.

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

Ef—Eram silty clay loam, 1 to 3 percent slopes. This moderately deep, gently sloping, moderately well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 20 to 250 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 8 inches thick. The subsoil is mottled, very firm clay about 18 inches thick. The upper part is very dark grayish brown, and the lower part is dark grayish brown. Shale bedrock is at a depth of about 26 inches. In places the surface layer is silt loam or silty clay. In some small areas the depth to shale is more than 40 inches. In some areas seams of lime are in the lower part of the subsoil.

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

Permeability is slow in the Eram soil, and runoff is medium. Available water capacity is low. Tilth is good. The shrink-swell potential is high in the subsoil. A perched seasonal high water table is at a depth of about 1 to 2 feet in winter and in early spring. Root penetration is restricted by the bedrock at a depth of 20 to 40 inches. The surface layer is firm and can be easily tilled only within a fairly narrow range in moisture content.

Most areas are used for cultivated crops. A few are used as tame grass pasture or as range. This soil is moderately well suited to soybeans, grain sorghum, and wheat. It is poorly suited to alfalfa, however, because of seasonal droughtiness. Water erosion is a hazard if cultivated crops are grown. Terraces, grassed waterways, contour farming, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the rate of water infiltration. Soil depth should be considered when a terrace system is designed. In a few places where terraces have been built, the root zone is severely restricted because most of the soil overlying the bedrock has been removed.

This soil is suited to range and to tame grass pasture. The native vegetation is dominantly big bluestem, little bluestem, switchgrass, and indiangrass. If the range is heavily used throughout the growing season, these grasses are replaced by less desirable plants, such as broomsedge bluestem, Baldwin ironweed, and lanceleaf ragweed. Invasion of brushy plants, such as sumac, blackberry, and eastern redcedar, is a problem in some areas. Timely burning helps to control most of these plants. Water erosion is a hazard if the range is overused. An adequate plant cover helps to prevent excessive soil loss. Range seeding is needed to restore the productivity of abandoned cropland. A proper stocking rate, rotation grazing, a uniform distribution of grazing, and brush control help to keep the range productive.

In the areas of tame grass pasture, applications of lime and fertilizer, proper stocking rates, rotation grazing, and a timely season of use increase forage production. The lime should be incorporated into the soil prior to seeding. Timely mowing for hay allows the plants to recover before the first frost.

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. 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.

Eh—Eram silty clay 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 20 to 200 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 7 inches thick. The subsoil is very dark grayish brown and brown, mottled, very firm clay about 21 inches thick. Shale bedrock is at a depth of about 28 inches. In places the surface layer is silty clay. In some small areas the depth to shale is more than 40 inches. In some areas seams of lime are in the lower part of the subsoil.

Included with this soil in mapping are small areas of Bates, Lebo, and Zaar soils. Bates soils have a loamy subsoil. They are on the upper side slopes. Lebo soils have less clay in the subsoil than the Eram soil. They are on narrow ridgetops and the more sloping, upper side slopes. The deep Zaar soils are on the lower side slopes. Included soils make up 10 to 15 percent of the map unit.

Permeability is slow in the Eram soil, and runoff is medium. Available water capacity is low. The shrink-swell potential is high in the subsoil. A perched seasonal high water table is at a depth of about 1 to 2 feet in winter and in early spring. Root penetration is restricted by the bedrock at a depth of 20 to 40 inches. The surface layer is firm and can be easily tilled only within a fairly narrow range in moisture content.

About half of the areas are used for cultivated crops. The rest are used as range or tame grass pasture. Because of the hazard of water erosion, this soil is poorly suited to soybeans, grain sorghum, and wheat. It is poorly suited to alfalfa because of seasonal droughtiness. Terraces, grassed waterways, contour farming, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the rate of water infiltration. Soil depth should be considered when a terrace system is designed. In a few areas where terraces have been built, the root zone is severely restricted because most of the soil overlying the bedrock has been removed.

This soil is suited to range and to tame grass pasture. The native vegetation is dominantly big bluestem, little bluestem, switchgrass, and indiangrass. If the range is heavily used throughout the growing season, these grasses are replaced by less desirable plants, such as broomsedge bluestem, Baldwin ironweed, and lanceleaf ragweed. Invasion of brushy plants, such as sumac, blackberry, and eastern redcedar, is a problem in some areas. Timely burning helps to control most of these plants. Water erosion is a hazard if the range is overused. An adequate plant cover helps to prevent excessive soil loss. Range seeding is needed to restore the productivity of abandoned cropland. A proper stocking rate, rotation grazing, a uniform distribution of grazing, and brush control help to keep the range productive.

In the areas of tame grass pasture, applications of fertilizer and lime, proper stocking rates, rotation grazing, and a timely season of use increase forage production. The lime should be incorporated into the soil prior to seeding. Timely mowing for hay allows the plants to recover before the first frost.

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. Suitable sites for lagoons are generally available in areas where the depth to bedrock is more than 40 inches. If the less sloping areas are selected as sites for the lagoons, less cutting and filling will be needed during construction.

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

Eo—Eram-Lebo silty clay loams, 4 to 20 percent slopes. These moderately deep, moderately sloping to moderately steep soils are on uplands. The moderately well drained Eram soil is on the less sloping side slopes. The well drained Lebo soil is on the upper side slopes. Individual areas are irregular in shape and range from 20 to 250 acres in size. They are about 45 percent Eram soil and 35 percent Lebo soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Eram soil has a surface layer of very dark grayish brown silty clay loam about 7 inches thick. The subsoil is very dark grayish brown and brown, mottled, very firm clay about 21 inches thick. Shale bedrock is at a depth of about 28 inches. In places the surface layer is silty clay. In some small areas the depth to shale is more than 40 inches. In some areas seams of lime are in the lower part of the subsoil.

Typically, the Lebo soil has a surface layer of dark brown silty clay loam about 9 inches thick. The subsoil is about 13 inches thick. The upper part is dark yellowish brown, firm silty clay loam, and the lower part is olive brown, firm shaly silty clay loam. The substratum is light olive brown extremely shaly silty clay loam about 10 inches thick. Shale bedrock is at a depth of about 32 inches. In some small areas the depth to shale is less than 20 inches.

Included with these soils in mapping are small areas of Collinsville and Zaar soils. The shallow Collinsville soils are on narrow ridgetops. The clayey Zaar soils are on foot slopes and the lower side slopes. Also included are small areas where shale bedrock crops out on breaks and on the steeper side slopes. Included areas make up about 20 percent of the map unit.

Permeability is slow in the Eram soil and moderate in the Lebo soil. Available water capacity is low in both soils, and runoff is rapid. The shrink-swell potential is high in the subsoil of the Eram soil and moderate in the subsoil of the Lebo soil. The Eram soil has a perched seasonal high water table at a depth of about 1 to 2 feet in winter and in early spring. Root penetration is restricted by the bedrock at a depth of 20 to 40 inches in both soils.

Nearly all areas are used as range. A few are used as tame grass pasture. Because of the low available water capacity and a severe hazard of water erosion, these soils are generally unsuited to cultivated crops. They are better suited to range, pasture, and hay. The native vegetation is dominantly big bluestem, little bluestem, switchgrass, and indiangrass. If the range is heavily used throughout the growing season, the more desirable grasses and forbs are replaced by less productive mid and short grasses and by weeds and brush. If heavy overuse continues, the plant community is invaded by broomsedge bluestem, broomweed, Osageorange, and other less desirable vegetation. Water erosion is a hazard if the range is overused. An adequate plant cover helps to prevent excessive soil loss. A proper stocking rate, a uniform distribution of grazing, rotation grazing, and brush control help to keep the range productive. Forage production is low on abandoned cropland. It can be increased by seeding desirable mid and tall grasses.

If these soils are used for tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and a timely season of use increase forage production. Timely mowing for hay allows the plants to recover before the first frost.

The diverse vegetation of trees, shrubs, and grasses on these soils provides good habitat for many wildlife species, including quail, deer, wild turkey, rabbits, and numerous songbirds. Proper grazing use, brush control, and establishment of feed areas increase the wildlife population.

The Eram 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.

The Lebo soil is only moderately well suited to dwellings because the shrink-swell potential and the slope 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. If the less sloping areas are chosen as building sites, less earth moving will be required to compensate for the slope.

Because of the depth to bedrock in both soils and the slow permeability and wetness in the Eram soil, these soils are generally unsuited to septic tank absorption fields. They are poorly suited to sewage lagoons because of the depth to bedrock and the slope. The deeper, less sloping adjacent soils on the lower side slopes commonly can be used as sites for lagoons.

The land capability classification is VIe. The Eram soil is in the Clay Upland range site, and the Lebo soil is in the Loamy Upland range site.

Es—Eram-Nowata complex, 2 to 7 percent slopes. These moderately deep, moderately sloping soils are on uplands. The moderately well drained Eram soil is on side slopes. The well drained Nowata soil is on ridgetops. Individual areas are irregular in shape and range from 20 to 200 acres in size. They are about 50 percent Eram soil and 30 percent Nowata soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Eram soil has a surface layer of very dark grayish brown silty clay loam about 7 inches thick. The subsoil is very dark grayish brown and brown, mottled, very firm clay about 21 inches thick. Shale bedrock is at a depth of about 28 inches. In some small areas the depth to shale is more than 40 inches. In places seams of lime are in the lower part of the subsoil.

Typically, the Nowata soil has a surface layer of very dark grayish brown silt loam about 8 inches thick. The subsoil is about 28 inches thick. The upper part is very dark grayish brown, firm cherty silty clay loam, and the lower part is dark brown and brown, mottled, very firm very cherty silty clay loam. Limestone bedrock is at a depth of about 36 inches. In places the bedrock is shale rather than limestone. In a few areas the subsoil is silty clay loam.

Included with these soils in mapping are small areas of Apperson, Dennis, and Shidler soils. Apperson and Dennis soils are more than 40 inches deep over bedrock. Apperson soils are on ridgetops, and Dennis soils are on the lower side slopes. The shallow Shidler soils are on breaks on the upper side slopes. Included soils make up about 20 percent of the map unit.

Permeability is slow in the Eram soil and moderately slow in the Nowata soil. Available water capacity is low in the Eram soil and moderate in the Nowata soil. Runoff is medium on both soils. The shrink-swell potential is high in the subsoil of the Eram soil and moderate in the subsoil of the Nowata soil. The Eram soil has a perched seasonal high water table at a depth of about 1 to 2 feet in winter and in early spring. Root penetration is restricted by the bedrock at a depth of 20 to 40 inches in both soils.

Most areas are used as range, tame grass pasture, or hayland. A few are used for cultivated crops. These soils are poorly suited to cultivated crops because water erosion is a hazard. Also, droughtiness is a limitation in the Eram soil. Close-growing crops, such as wheat and legumes, provide the best protection against erosion.

These soils are better suited to range, pasture, and hay than to cultivated crops. The native vegetation is dominantly big bluestem, little bluestem, switchgrass, and indiangrass. If the range is heavily used throughout the growing season, the more desirable grasses and forbs are replaced by less desirable mid and short grasses and by weeds and brush. After continued heavy use, the plant community is invaded by broomsedge bluestem, broomweed, Osageorange, and other less desirable vegetation. Water erosion is a hazard if the range is overused. An adequate plant cover helps to prevent excessive soil loss. A proper stocking rate, a uniform distribution of grazing, rotation grazing, and brush control help to keep the range productive.

If these soils are used for tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, a timely season of use, and brush control increase forage production. Forage production is low on abandoned cropland. It can be increased by seeding desirable mid and tall grasses.

The diverse vegetation of trees, shrubs, and grasses on these soils provides good habitat for many wildlife species, including quail, deer, wild turkey, rabbits, and numerous songbirds. Proper grazing use, brush control, and establishment of feed areas increase the wildlife population.

The Eram 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 shrink-swell potential, large stones, and the depth to bedrock, the Nowata soil is only moderately well suited to dwellings without basements. It is poorly suited to dwellings with basements because of the depth to bedrock. The deeper included soils that do not have chert fragments are better sites for dwellings. 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 depth to bedrock in both soils, the wetness and slow permeability in the Eram soil, and the moderately slow permeability in the Nowata soil, these soils are generally unsuited to septic tank absorption fields. They are poorly suited to sewage lagoons because of the depth to bedrock. The deeper adjacent soils on the lower side slopes commonly can be used as sites for lagoons.

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

He—Hepler silt loam, occasionally flooded. This deep, nearly level, somewhat poorly drained soil is on flood plains. 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 mottled silt loam about 15 inches thick. The upper part is dark grayish brown, and the lower part is grayish brown. The subsoil to a depth of more than 60 inches is dark grayish brown, mottled, firm silty clay loam.

Included with this soil in mapping are small areas of the clayey Osage soils in swales and other concave areas. These soils make up less than 10 percent of the map unit.

Permeability is moderately slow in the Hepler soil, and runoff is slow. Available water capacity is high. The shrink-swell potential is moderate in the subsoil. A seasonal high water table is at a depth of about 1 to 3 feet in winter and in early spring. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Nearly all areas are used for cultivated crops. Some are used as pasture or woodland. This soil is well suited to alfalfa, soybeans, grain sorghum, corn, wheat, and tall fescue. The wetness and the flooding can delay fieldwork and reduce yields. Field drainage ditches or a bedding system may be needed to reduce the wetness. 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 tame grass pasture. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Grazing when the soil is wet causes surface compaction. Proper stocking rates, rotation grazing, and restricted use during wet periods help to keep the pasture in good condition. Applications of fertilizer improve plant growth and vigor. Timely mowing for hay allows the plants to recover before the first frost.

A few areas are used as native woodland. Important species include black walnut, northern red oak, pin oak, pecan, and green ash. This soil is well suited to trees. The equipment limitation and plant competition are management concerns. The use of equipment is restricted to dry periods. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. Adequate site preparation, spraying, and cutting or girdling control plant competition.

The wooded areas provide habitat for many kinds of wildlife, including quail, deer, wild turkey, rabbits, and numerous songbirds. The habitat can be improved by increasing the width of the fringe areas where woodland is adjacent to cropland.

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

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

Ka—Kanima shaly silty clay loam, 3 to 7 percent slopes. This deep, moderately sloping, well drained soil is in upland areas that formerly were strip-mined and then were smoothed and shaped. Individual areas are rectangular and range from 10 to 300 acres in size.

Typically, the surface layer is dark grayish brown and dark yellowish brown shaly silty clay loam about 6 inches thick. The substratum to a depth of about 60 inches is dark grayish brown and dark yellowish brown very shaly silty clay loam. In scattered small areas the original subsoil and underlying material are still intact. In other small areas the soil material is extremely acid.

Permeability is moderate, and runoff is medium. Available water capacity is low. The surface layer is firm and can be easily tilled only within a fairly narrow range in moisture content.

Most areas have been seeded to tall fescue, wheat, or clover. A few have been seeded to native grasses. Because of the low available water capacity, this soil is generally unsuited to cultivated crops. It is moderately well suited to tall fescue, switchgrass, and western wheatgrass. The major concerns in managing pasture or hayland are undesirable plants and low forage production. Grazing and haying should be deferred until the cover of grasses is well established. Proper stocking rates and rotation grazing help to keep the pasture in good condition. Applications of fertilizer improve plant growth and vigor. The fertilizer should be applied according to the results of soil tests and field observations. Lime may be needed in some areas prior to seeding. Timely mowing for hay allows the plants to recover before the first frost.

Although soil settling is a problem in some areas, this soil is well suited to dwellings. It is moderately well suited to septic tank absorption fields and sewage lagoons. The moderate permeability restricts the absorption of effluent in septic tank absorption fields. Enlarging the field, however, helps to overcome this limitation. Seepage and slope are limitations on sites for sewage lagoons. Seepage can be controlled by sealing the floor and walls of the lagoons. If the less sloping areas are selected as sites for the lagoons, less cutting and filling will be needed during construction.

The land capability classification is VIs. No range site is assigned.

Kb—Kanima shaly silty clay loam, 10 to 30 percent slopes. This deep, strongly sloping to steep, well drained soil is in upland areas that formerly were strip-mined. Individual areas are irregular in shape and range from 10 to 300 acres in size.

Typically, the surface layer is dark grayish brown and dark yellowish brown shaly silty clay loam about 6 inches thick. The substratum to a depth of about 60 inches is dark grayish brown and dark yellowish brown very shaly silty clay loam. In some areas it is extremely shaly silty clay loam or extremely shaly silty clay.

Included with this soil in mapping are areas of water and small areas of extremely acid soil material. Included areas make up 5 to 10 percent of the map unit.

Permeability is moderate in the Kanima soil, and runoff is rapid. Available water capacity is low.

Most of the acreage is idle land. Some areas are used for wildlife habitat or recreational purposes. A few small areas are used for grazing by livestock. The vegetation is generally weeds, annual grasses, and trees. A few areas support no vegetation.

This soil is unsuited to cultivated crops because of the slope and the rock fragments. If the slopes are graded and shaped, the soil is suited to switchgrass, western wheatgrass, tall fescue, and other grasses. Grazing or haying should be deferred until the cover of grasses is well established. Proper stocking rates and rotation grazing help to keep the pasture in good condition. Applications of fertilizer improve plant growth and vigor. The fertilizer should be applied according to the results of soil tests and field observations. Lime may be needed in some areas prior to seeding. Timely mowing for hay allows the plants to recover before the first frost.

Because of the slope, this soil is poorly suited to dwellings and septic tank absorption fields and is generally unsuited to sewage lagoons. Settling may be a problem, especially on the newer building sites. Buildings should be designed so that they conform to the natural slope of the land. Land shaping and leveling may be needed on sites for dwellings and septic tank absorption fields.

The land capability classification is VIIs. No range site is assigned.

Ke—Kenoma silt loam, 1 to 3 percent slopes. This deep, gently sloping, moderately well drained soil is on broad ridgetops in the uplands. Individual areas are irregular in shape and range from 20 to 400 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 6 inches thick. The subsurface layer also is very dark grayish brown silt loam. It is about 7 inches thick. The subsoil is mottled silty clay about 36 inches thick. The upper part is dark brown and very firm, and the lower part is dark yellowish brown and extremely firm. The substratum to a depth of about 60 inches is yellowish brown, mottled silty clay loam. In some areas the upper part of the subsoil is silty clay loam. In other areas shale bedrock is within a depth of 40 inches.

Included with this soil in mapping are small areas of Catoosa and Zaar soils. The moderately deep Catoosa soils are lower on the landscape than the Kenoma soil. Zaar soils have a clayey surface layer. They are along drainageways. Also included are small areas of alkali soils and slick spots. Included areas make up 10 to 15 percent of the map unit.

Permeability is very slow in the Kenoma soil, and runoff is medium. Available water capacity is high. The shrink-swell potential is high in the subsoil. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas are cultivated. A few are used as tame grass pasture. This soil is moderately well suited to alfalfa, soybeans, grain sorghum, and wheat. Water erosion is a hazard if cultivated crops are grown. Crops are adversely affected during dry periods because the clayey subsoil fails to release water readily to plants. Terraces, grassed waterways, contour farming, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the rate of water infiltration.

This soil is suited to tame grass pasture. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates and rotation grazing help to keep the pasture in good condition. Applications of fertilizer and lime improve plant growth and vigor. The lime should be incorporated into the soil prior to seeding. Timely mowing for hay allows the plants to recover before the first frost.

Because the shrink-swell potential is a limitation, this soil is poorly suited to dwellings. 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 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 leveling and shaping may be needed on sites for lagoons.

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

Ln—Lanton silt loam, occasionally flooded. This deep, nearly level, somewhat poorly drained soil is on flood plains. Individual areas are long and narrow or irregular in shape and range from 30 to 200 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsurface layer is mottled silty clay loam about 29 inches thick. The upper part is black, and the lower part is very dark gray. The substratum to a depth of about 60 inches is dark grayish brown, mottled silty clay.

Included with this soil in mapping are small areas of the clayey Osage soils in swales and other concave areas. These soils make up less than 10 percent of the map unit.

Permeability is slow in the Lanton soil. Runoff also is slow. Available water capacity is high. The shrink-swell potential is moderate in the substratum. 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 friable and can be easily tilled throughout a fairly wide range in moisture content.

Nearly all areas are used for cultivated crops. Some are used for pasture or woodland. This soil is well suited to alfalfa, soybeans, grain sorghum, corn, wheat, and tall fescue. The wetness and the flooding can delay fieldwork and reduce yields. Land smoothing, surface ditches, and a bedding system improve drainage.

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 tame grass pasture. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Grazing when the soil is wet causes surface compaction. Proper stocking rates, rotation grazing, and restricted use during wet periods help to keep the pasture in good condition. Applications of fertilizer improve plant growth and vigor. Timely mowing for hay allows the plants to recover before the first frost.

A few areas are used as native woodland. Important species include black walnut, pecan, pin oak, northern red oak, green ash, and eastern cottonwood. This soil is well suited to trees. The equipment limitation and plant competition are management concerns. Because of the wetness, the use of equipment is restricted to dry periods. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. Adequate site preparation, spraying, and cutting or girdling control plant competition.

The wooded areas provide habitat for many kinds of wildlife, including quail, deer, wild turkey, rabbits, and numerous songbirds. The habitat can be improved by increasing the width of the fringe areas where woodland is adjacent to cropland.

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.

Od—Olpe-Dennis silt loams, 3 to 7 percent slopes. These deep, moderately sloping soils are on uplands. The well drained Olpe soil is on narrow ridgetops. The moderately well drained Dennis soil is on side slopes. Individual areas are irregular in shape and range from 10 to 80 acres in size. They are about 45 percent Olpe soil and 40 percent Dennis soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Olpe soil has a surface layer of dark brown silt loam about 7 inches thick. The subsurface layer is dark brown gravelly silt loam about 6 inches thick. The subsoil extends to a depth of more than 60 inches. The upper part is dark brown, firm extremely gravelly clay loam. The next part is dark brown, mottled, firm very gravelly silty clay loam and dark brown, mottled, very firm very gravelly silty clay. The lower part is mottled dark red, light brownish gray, and strong brown, very firm silty clay. In some small areas the surface layer is gravelly silt loam.

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, mottled, friable silty clay loam; the next part is dark brown and brown, mottled, very firm silty clay; and the lower part is coarsely mottled strong brown and gray, very firm silty clay. In some areas the upper part of the subsoil is silty clay.

Included with these soils in mapping are small areas of the moderately deep Eram and shallow Shidler soils on the lower side slopes. These included soils make up about 15 percent of the map unit.

Permeability is slow in the Olpe and Dennis soils, and runoff is medium. Available water capacity is moderate in the Olpe soil and high in the Dennis soil. The shrink-swell potential is moderate in the subsoil of the Olpe soil and high in the subsoil of the Dennis soil. 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. The surface layer of both soils is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas are used as tame grass pasture or hayland. A few are used for cultivated crops. These soils are suited to tame grass pasture and to hay. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates and rotation grazing keep the pasture in good condition. Applications of fertilizer and lime improve plant growth and vigor. The lime should be incorporated into the soil prior to seeding. Timely mowing for hay allows the plants to recover before the first frost.

These soils are poorly suited to cultivated crops because water erosion is a hazard. Terraces, grassed waterways, contour farming, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the rate of water infiltration.

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

These soils are generally unsuited to septic tank absorption fields because the slow permeability is a limitation. The wetness of the Dennis soil also is a limitation. Both soils are only moderately well suited to sewage lagoons because of the slope. Seepage also is a limitation in the Olpe soil. If the less sloping included or adjacent soils are chosen as sites for the lagoons, less land leveling and shaping will be required during construction. Seepage can be controlled by sealing the floor and walls of the lagoon.

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

Or—Orthents, clayey. These soils occur as areas on uplands where the upper 2 to 3 feet of soil material has been removed. In some areas the soil material that has been removed was left in 2- to 4-foot mounds near building sites. In other areas it was used as fill material on sites for roads, parking lots, ammunition storage bunkers, and airport runways. These areas are at the Kansas Army Ammunition Plant, the Tri-City Airport, and an abandoned airport near Edna. The soils generally are gently sloping. Individual areas are rectangular and range from 40 to 400 acres in size.

The profile of these soils varies from one area to another. In one of the more common areas, the surface layer is dark brown, mottled silty clay about 17 inches thick. The next layer is dark yellowish brown, mottled, very firm silty clay about 7 inches thick. The underlying material to a depth of about 60 inches is light brownish gray and yellowish brown, extremely firm silty clay. In some areas the surface layer is silt loam or silty clay loam.

Included with these soils in mapping are small areas where pieces of rock or old building material have been piled. Also included are areas covered by buildings, parking lots, roads, and airport runways and small areas of rock outcrop. Included areas make up 10 to 15 percent of the map unit.

Permeability is slow in the Orthents, and runoff is medium. The shrink-swell potential is high throughout the profile. The depth of the root zone varies.

Most areas are used as tame grass pasture. Some of the acreage is idle land. These soils are poorly suited to cultivated crops because of the hazard of water erosion, poor tilth, and low fertility. The main concerns in managing the pastured areas are controlling undesirable plants and low forage production in abandoned areas. Overgrazing reduces the quality and quantity of the forage and increases the extent of less productive annual grasses, weeds, and brush. After continued heavy grazing, the plant community is invaded by undesirable vegetation, such as broomsedge bluestem, ragweed, and Osageorange. Applications of fertilizer, rotation grazing, proper stocking rates, a timely season of use, and brush control increase forage production. Reseeding abandoned areas to native grasses also increases forage production.

The land capability classification is IVe. No range site is assigned.

Os—Osage silty clay, occasionally flooded. This deep, nearly level, poorly drained soil is on flood plains. Individual areas are elongated or irregular in shape and range from 40 to 800 acres in size.

Typically, the surface layer is very dark gray silty clay about 5 inches thick. The subsurface layer is silty clay about 12 inches thick. The upper part is black, and the lower part is very dark gray and mottled. The subsoil to a depth of about 60 inches is mottled, extremely firm clay. The upper part is very dark gray, and the lower part is dark gray.

Included with this soil in mapping are small areas of the somewhat poorly drained Hepler and Lanton and moderately well drained Verdigris soils. These soils are less clayey than the Osage soil. Also, Hepler and Lanton soils are slightly higher on the landscape, and Verdigris soils are closer to the stream channels. Included soils make up 5 to 10 percent of the map unit.

Permeability is very slow in the Osage soil. Runoff also is very slow. Available water capacity is moderate. The shrink-swell potential is very high throughout the profile. A seasonal high water table is within a depth of 1 foot in winter and spring. The surface layer is very firm and can be easily tilled only within a narrow range in moisture content.

Most areas are used for cultivated crops. Some are used for pasture or trees. This soil is moderately well suited to alfalfa, soybeans, grain sorghum, corn, wheat, and tall fescue. The wetness and the flooding can damage crops and delay tillage. Also, the crops are adversely affected during dry periods because the clayey subsoil fails to release water readily to plants. Compaction is a problem if the soil is tilled when wet. A bedding system, land smoothing, and drainage ditches remove excess surface water. Keeping tillage at a minimum helps to prevent excessive compaction. Tilling in the fall improves the seedbed for 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 tame grass pasture. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Grazing when the soil is wet causes surface compaction. Establishing grasses is difficult because of poor tilth in the surface layer. Proper stocking rates, rotation grazing, and restricted use during wet periods help to keep the pasture in good condition. Applications of fertilizer improve plant growth and vigor. Timely mowing for hay allows the plants to recover before the first frost.

A few areas are used as native woodland. Important species include eastern cottonwood, pecan, bur oak, northern red oak, and green ash. This soil is suited to trees. The equipment limitation is moderate, and seedling mortality and plant competition are severe. Because of the wetness, the use of equipment is restricted to dry periods. Tree seeds, cuttings, and seedlings survive and grow well only if competing vegetation is controlled or removed. Adequate site preparation, spraying, and cutting or girdling control plant competition.

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—Parsons silt loam, 0 to 2 percent slopes. This deep, nearly level, somewhat poorly drained soil is on broad flats 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 8 inches thick. The subsurface layer is dark grayish brown, mottled silt loam about 5 inches thick. The subsoil to a depth of more than 60 inches is mottled, very firm silty clay. The upper part is very dark grayish brown, and the lower part is gray, yellowish brown, and yellowish red. In some areas depth to the clayey subsoil is more than 16 inches.

Included with this soil in mapping are small areas of Dennis and Zaar soils. The moderately well drained Dennis soils are on side slopes. Zaar soils are along drainageways. They have a clayey surface layer. Included soils make up 5 to 10 percent of the map unit.

Permeability is very slow in the Parsons soil, and runoff is slow. Available water capacity is high. The shrink-swell potential is high in the subsoil. A perched seasonal high water table is at a depth of about 0.5 foot to 1.5 feet in winter and in early spring. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas are used for cultivated crops. A few are used as tame grass pasture. This soil is well suited to alfalfa, soybeans, grain sorghum, and wheat. Crop yields are reduced during dry periods, however, because the clayey subsoil fails to release water readily to plants. Also, the wetness can damage crops and delay tillage. A surface drainage system is needed in some areas. 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 well suited to tame grass pasture. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, rotation grazing, and restricted use during wet periods help to keep the pasture in good condition. Applications of fertilizer and lime improve plant growth and vigor. The lime should be incorporated into the soil prior to seeding. Timely mowing for hay allows the plants to recover before the first frost.

Because the wetness and the shrink-swell potential are limitations, this soil is poorly suited to dwellings. 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.

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

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

Pt—Pits, quarries. This map unit consists of areas from which soil material and some of the underlying limestone or shale have been excavated. The underlying material has been removed for use as gravel, cement, and agricultural lime (fig. 7). Individual areas are irregular in shape and range from 20 to 200 acres in size.

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

The surface is generally bare. Scattered trees, shrubs, and clumps of grass border the quarries. This map unit is unsuited to cultivated crops and to most other uses.

No land capability classification or range site is assigned.

Figure 7.—A rock quarry in an area of Pits, quarries, used as a source of gravel.

Sd—Shidler-Catoosa silt loams, 1 to 8 percent slopes. These gently sloping and moderately sloping, well drained soils are on uplands. The shallow Shidler soil is on side slopes. The moderately deep Catoosa soil is generally on the gently sloping ridgetops above the Shidler soil. Individual areas are long and narrow or irregular in shape and range from 20 to 300 acres in size. They are about 45 percent Shidler soil and 40 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 silt loam about 12 inches thick. The content of small limestone fragments is 5 to 10 percent in this layer. Limestone bedrock is at a depth of about 12 inches.

Typically, the Catoosa soil has a surface soil of dark brown silt loam about 12 inches thick. The subsoil is dark reddish brown, firm silty clay loam about 26 inches thick. Limestone bedrock is at a depth of about 38 inches.

Included with these soils in mapping are small areas of Eram soils. These included soils are moderately deep over shale bedrock. They are on the lower side slopes. Also included are small areas where limestone bedrock crops out near breaks on the ridgetops. Included areas make up about 15 percent of the map unit.

Permeability is moderate in the Shidler and Catoosa soils, and runoff is medium. Available water capacity is low in the Shidler soil and moderate in the Catoosa soil. The shrink-swell potential is moderate in the subsoil of the Catoosa soil. Root penetration is restricted by the bedrock at a depth of 4 to 20 inches in the Shidler soil and about 20 to 40 inches in the Catoosa soil.

Nearly all areas are used as range. Because of the hazard of water erosion on both soils and the shallowness to limestone in the Shidler soil, this map unit is generally unsuited to cultivated crops. It is better suited to range. The native grasses are dominantly big bluestem, little bluestem, and sideoats grama. If the range is heavily used throughout the growing season, the more desirable grasses and forbs are replaced by less productive grasses and by weeds and brush (fig. 8). After continued heavy grazing, the plant community is invaded by broomsedge bluestem, broomweed, Osageorange, and other less desirable vegetation. A proper stocking rate, a uniform distribution of grazing, rotation grazing, and brush control help to keep the range productive.

These soils are suited to tame grass pasture. Applications of fertilizer, proper stocking rates, rotation grazing, a timely season of use, and brush control increase forage production. Forage production is low on abandoned cropland. It can be increased by seeding desirable mid and tall grasses.

The diverse vegetation of trees, shrubs, and grasses on these soils provides good habitat for many species of wildlife, including quail, deer, wild turkey, rabbits, and numerous songbirds. Proper grazing use, brush control, and establishment of feed areas increase the wildlife population.

Because the depth to bedrock is a limitation, the Catoosa soil is only moderately well suited to dwellings without basements and is poorly suited to dwellings with basements. The shrink-swell potential is an additional 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. The areas where the depth to bedrock is more than 40 inches generally should be selected as sites for dwellings, especially dwellings with basements.

Because of the depth to bedrock, the Catoosa soil is generally unsuited to septic tank absorption fields and sewage lagoons. Suitable sites for lagoons are generally available in areas where the depth to bedrock is more than 40 inches.

The Shidler soil is generally unsuited to building site development because of the shallowness 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.

Vc—Verdigris silt loam, frequently flooded. This deep, nearly level, moderately well drained soil is on narrow flood plains that are dissected by meandering stream channels. Individual areas are long and about 200 to 500 feet wide. They range from 5 to 100 acres in size.

Typically, the surface layer is very dark brown silt loam about 11 inches thick. The subsurface layer is very dark brown, friable silt loam about 23 inches thick. The next layer is dark brown silty clay loam about 9 inches thick. The substratum to a depth of about 60 inches is brown silty clay loam. In some areas the surface layer or subsurface layer is silty clay loam. In other areas the subsurface layer is stratified with thin layers of lighter colored, silty, sandy, or clayey material below a depth of about 20 inches. In some places mottles are within 16 inches of the surface. In other places limestone bedrock is within 40 inches of the surface.

Included with this soil in mapping are small areas of Eram and Zaar soils. The moderately deep Eram soils are on side slopes in the uplands. The clayey Zaar soils are in swales and other concave areas on uplands. Included soils make up 10 to 15 percent of the map unit.

Permeability is moderate in the Verdigris soil, and runoff is slow. Available water capacity is high. The shrink-swell potential is low in the upper part of the profile and moderate in the lower part. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas are used as tame grass pasture. Some are used as range or woodland. Because of the flooding and the difficulty in operating machinery along the

Figure 8.—An area of Shidler-Catoosa silt loams, 1 to 8 percent slopes, invaded by undesirable plants because of overgrazing.

meandering stream channels, this soil is generally unsuited to cultivated crops. It is better suited to range. Many areas of range are overgrazed and are in poor condition because they are near watering facilities and shade trees where cattle congregate. In these areas the more desirable grasses are replaced by less productive grasses and by weeds. Restricted use during wet periods helps to keep the range productive. Range productivity can be increased by rotation grazing and a uniform distribution of grazing.

This soil is suited to tame grass pasture. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Grazing when the soil is wet causes surface compaction. Proper stocking rates, rotation grazing, and restricted use during wet periods help to keep the pasture in good condition. Applications of fertilizer improve plant growth and vigor. Timely mowing for hay allows the plants to recover before the first frost.

This soil is well suited to trees. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. Plant competition can be controlled by site preparation, spraying, and cutting or girdling. No major hazards or limitations affect planting or harvesting. Important species include black

Figure 9.—Native hay in an area of Zaar silty clay, 0 to 2 percent slopes.

walnut, pecan, pin oak, northern red oak, and green ash.

The wooded areas provide habitat for many kinds of wildlife, including quail, deer, wild turkey, rabbits, and numerous songbirds. The habitat can be improved by increasing the width of the fringe areas where woodland is adjacent to cropland.

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 Vw, and the range site is Loamy Lowland.

Vf—Verdigris silt loam, occasionally flooded. This deep, nearly level, moderately well drained soil is on flood plains. Individual areas are long and narrow or irregular in shape and range from 10 to 300 acres in size.

Typically, the surface layer is dark brown silt loam about 7 inches thick. The subsurface layer is silt loam about 27 inches thick. It is dark brown in the upper part and very dark grayish brown in the lower part. The next layer is very dark brown, friable silt loam about 20 inches thick. The substratum to a depth of about 60 inches is dark grayish brown silt loam. In some areas the subsurface layer is stratified with thin layers of lighter colored, silty, sandy, or clayey material below a depth of about 20 inches. In other areas mottles are within 16 inches of the surface.

Included with this soil in mapping are small areas of the poorly drained Osage soils. These soils 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 runoff is slow. Available water capacity is high. The shrink-swell potential is low in the upper part of the profile and moderate in the lower part. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Nearly all areas are used for cultivated crops. A few are used for pasture or trees. This soil is well suited to alfalfa, soybeans, grain sorghum, corn, wheat, and tall fescue. Spring flooding can delay planting in some years. 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 tame grass pasture. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Grazing when the soil is wet causes surface compaction. Proper stocking rates, rotation grazing, and restricted use during wet periods help to keep the pasture in good condition. Applications of fertilizer improve plant growth and vigor. Timely mowing for hay allows the plants to recover before the first frost.

A few areas are used as native woodland. Important species include black walnut, northern red oak, bur oak, eastern cottonwood, pecan, and green ash. This soil is well suited to trees. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. Adequate site preparation, controlled burning, spraying, and cutting or girdling control plant competition. No major hazards or limitations affect planting or harvesting.

The wooded areas provide habitat for many kinds of wildlife, including quail, deer, wild turkey, rabbits, and numerous songbirds. The habitat can be improved by increasing the width of the fringe areas where woodland is adjacent to cropland.

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.

Zb—Zaar silty clay, 0 to 2 percent slopes. This deep, nearly level, somewhat poorly drained soil is on foot slopes in the uplands. Individual areas are long and narrow or irregular in shape and range from 20 to 200 acres in size.

Typically, the surface layer is very dark gray silty clay about 7 inches thick. The subsurface layer is black silty clay about 10 inches thick. The subsoil is mottled, extremely firm clay about 37 inches thick. The upper part is black, and the lower part is dark grayish brown. The substratum to a depth of about 60 inches is yellowish brown, mottled clay. In some areas shale bedrock is within a depth of 40 inches. In other areas the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Verdigris and Parsons soils. These soils have a silty surface layer. Verdigris soils are on narrow, channeled flood plains. Parsons soils are on broad flats. Included soils make up 5 to 15 percent of the map unit.

Permeability is very slow in the Zaar soil, and runoff is slow. Available water capacity is high. The shrink-swell potential is high throughout the profile. Cracks are common during dry periods. 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 very firm and can be easily tilled only within a very narrow range in moisture content.

Most areas are used for cultivated crops. A few are used as tame grass pasture, range, or hayland (fig. 9). This soil is moderately well suited to alfalfa, soybeans, grain sorghum, wheat, and tall fescue. The wetness can damage crops and delay tillage. Also, the crops are adversely affected during dry periods because the clayey subsoil fails to release water readily to plants. Compaction is a problem if the soil is tilled when wet. A bedding system and drainage ditches reduce the wetness. Keeping tillage at a minimum helps to prevent excessive compaction. 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 tame grass pasture and to range. Overgrazing or grazing when the soil is wet, however, causes surface compaction and poor tilth, reduces the vigor and retards the growth of the grasses, and increases the extent of weeds. A proper stocking rate, a uniform distribution of grazing, and rotation grazing help to keep the range productive. Applications of fertilizer, proper stocking rates, rotation grazing, and a timely season of use increase forage production in the areas used as tame grass pasture.

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.

This soil is well suited to sewage lagoons, but it is generally unsuited to septic tank absorption fields because of the very slow permeability and the wetness.

The land capability classification is IIIw, 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.

Figure 10.—An area of Hepler silt loam, occasionally flooded, which qualifies as prime farmland.

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 324,500 acres in the survey area, or nearly 78 percent of the total acreage, meets the soil requirements for prime farmland (fig. 10). About 183,000 acres of this land is used for crops, mainly soybeans, wheat, and grain sorghum. Tall fescue is grown in some areas of pasture or hayland.

A recent trend in land use in some parts of the county has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

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 a land capability classification and a range site at the end of each map unit description and in tables 6 and 7. The capability classification and range site 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.

About 187,600 acres in Labette County, or nearly 45 percent of the total acreage, is used for cultivated crops. During the period 1976 to 1986, wheat was grown on about 40 percent of the cropland, soybeans on 25 percent, grain sorghum on 15 percent, and corn, barley, oats, alfalfa, and other crops on 20 percent *(3)*. The acreage used for wheat, soybeans, and grain sorghum increased during this period compared to that of the previous 10-year period. The acreage of oats, barley, corn, and alfalfa decreased.

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 Labette County are controlling water erosion, maintaining or improving fertility and tilth, and reducing wetness.

Water erosion is a hazard on about 55 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

Apperson, Bates, Catoosa, Dennis, Eram, Kenoma, and Parsons 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 Dennis and Kenoma 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 measures 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.

Conservation tillage and conservation cropping systems help to control both water erosion and soil blowing. Conservation tillage leaves the stubble of crops or a protective amount of crop residue on the surface before and during the preparation of a seedbed and during at least part of the growing period of the succeeding crop. The conservation tillage systems that are used in the county are no-till, mulch-till, and reduced till. Where a no-till is applied, the seed is planted into undisturbed soil and all residue from the preceding crop is left on the surface. Where mulch-till or reduced till is applied, a seedbed is prepared with stubble mulch plows, chisels, field cultivator disks, or blades that leave crop residue on the surface. Drilled crops, such as small grain or grasses and legumes, are alternated with row crops in a conservation cropping system.

Terraces, diversions, grassed waterways, and contour farming are needed in combination with conservation tillage on soils that have a slope of more than 2 percent. They also are needed on soils that have a slope of more than 1 percent and that are not protected by conservation tillage. Terraces and diversions shorten the length of slopes and thus reduce the runoff rate and the susceptibility to erosion. They are most practical on deep, well drained soils that have uniform slopes. Contour farming generally should be used in combination with terraces. It is best suited to those 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. Unless they have been limed, most of the soils in the survey area have a slightly acid or medium acid surface layer. Applications of lime reduce the acidity of these soils. They can increase the production of legumes, such as alfalfa, and other crops that grow well 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 water erosion, and improves tilth. Most of the soils in the county that are used for crops have a surface layer of silt loam. A surface crust forms during periods of heavy rainfall. When dry, the crusted surface is nearly impervious to water. As a result, the runoff rate is increased. Regularly adding organic material and leaving crop residue on the surface minimize surface crusting, increase the rate of water infiltration, and reduce the runoff rate and the hazard of erosion.

A drainage system is needed on some of the soils on flood plains in the county. Unless drained by surface drains or a bedding system, some areas of the somewhat poorly drained Hepler and Lanton soils and the poorly drained Osage soils are so wet that crop yields are reduced.

Information about the design of erosion-control measures and surface drainage systems 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.

About 28 percent of the acreage in Labette County is pasture. The pastured areas are throughout the county. They support mainly cool-season grasses, such as tall fescue and smooth bromegrass.

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 essential if optimum yields of forage are to be maintained. Proper stocking rates help to maintain a good stand of grasses. Overgrazing can result in the invasion of undesirable plants (fig. 11). The numbers 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 is a system that provides an adequate number of pastures with sufficient acreage in relation to the

Figure 11.—A pastured area of Apperson silty clay loam, 1 to 3 percent slopes, invaded by woody plants and weeds because of overgrazing.

number of livestock. It 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, low animal preference, and the loss of many stands because of the 1980 drought have sparked renewed interest in smooth bromegrass and other adapted cool-season grasses. Mixtures that include smooth bromegrass, spreading or creeping alfalfa, and orchardgrass have been seeded. If well managed, pastures that support a mixture of grasses and legumes can be significantly more productive than 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 or hazards that restrict their use.

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

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

Class IV soils have very severe limitations or hazards 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 or hazards, impractical to remove, that limit their use.

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

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

Class VIII soils and miscellaneous areas have limitations or hazards 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 hazard 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 or hazards. 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.

About 52,600 acres in Labette County, or nearly 13 percent of the total acreage, is range. This acreage is used dominantly for beef production (fig. 12). It is used in conjunction with approximately 118,000 acres of tame, cool-season pasture species. The native grass grows mainly in the western and southwestern parts of the county.

The principal livestock enterprises are cow-calf programs and stocker-feeder and yearling programs.

Figure 12.—Cattle grazing native range in an area of Bates-Collinsville complex, 4 to 15 percent slopes.

The production of beef cattle generates approximately 50 percent of the gross farm cash receipts in the county.

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 nearly every soil, the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the average percentage of each species. Only those soils that are used as rangeland or are suited to use as rangeland are listed. An explanation of the column headings in table 7 follows.

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.

Total production is the amount of vegetation that can be expected to grow annually on well managed rangeland 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.

Dry weight is the total annual yield per acre of air-dry vegetation. 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.

Characteristic vegetation—the grasses, forbs, and shrubs that make up most of the potential natural plant community on each soil—is listed by common name. Under *composition*, the expected percentage of the total annual production is given for each species making up the characteristic vegetation. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season.

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.

Most of the range in Labette County can be managed for an excellent range condition. A combination of good grazing management and prescribed burning generally can restore the potential natural plant community. In areas of poor-quality range and abandoned cropland, seeding is necessary to restore the natural plant community.

If well managed, practically all the soils in the county can produce high-quality forage. Only about 10 percent of the range currently is producing its production potential. About 70 percent can be restored to its potential by improved grazing management and supplemental measures that emphasize brush control. About 20 percent requires renovation or reestablishment measures.

Woodland Management and Productivity

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

About 11,700 acres in Labette 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 strips in upland drainageways, and as blocks of timber on steep upland soils underlain by sandstone. Some areas are used as commercial forest. The chief commercial wood products are lumber, black walnut veneer, and roundwood. Also, the production of pecan nuts is important in cultivated orchards and in areas of native trees, mainly in the eastern and southeastern parts of the county.

The county has two main forest cover types—post oak-blackjack oak and hackberry-American elm-green ash. The areas of bottom land in the Lanton-Osage-Hepler soil association and the upland drainageways support the hackberry-American elm-green ash forest cover type. Pecan is prevalent on most of the bottom land in the eastern part of the county. Black walnut grows on the well drained and moderately well drained soils throughout the areas of this cover type. Other woody plants in these areas include eastern cottonwood, silver maple, red oak, Shumard oak, black oak, bur oak, eastern redbud, mulberry, shellbark hickory, boxelder, roughleaf dogwood, red haw, common persimmon, indiancurrant coralberry, and black willow. Vines and herbaceous plants are abundant. The upland drainageways generally are heavily wooded with most of the species that grow on the bottom land.

The post oak-blackjack oak forest cover type is in areas of the Bates-Dennis-Eram association. It is limited to the northwestern part of the county, except for a few small areas along the Neosho River. Post oak is the dominant species in most of the stands. Blackjack oak makes up only 5 to 10 percent of the stands. Other species include bitternut hickory, Shumard oak, red oak, black oak, indiancurrant coralberry, common pricklyash, black cherry, roughleaf dogwood, mulberry, American elm, hackberry, redbud, American plum, Osageorange, eastern redcedar, wahoo, smooth sumac, rusty blackhaw, and multiflora rose. Vines and herbaceous plants also are abundant.

The forested areas, especially those on bottom land, have good potential for the production of commercial trees. The bottom land can produce high-value hardwoods within a short period. In contrast, low-value, long-rotation timber is produced in the forested areas on uplands. Only a small part of the forested acreage in the county is managed for commercial wood production. This acreage has steadily declined because of the conversion of woodland to cropland.

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.

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 and ranch headquarters in Labette County. Some are windbreaks, but most are environmental or ornamental plantings. The dominant species grown as windbreaks and environmental plantings are eastern redcedar, American elm, Siberian elm, and hackberry. Other common species on the farmsteads include green ash, black walnut, silver maple, boxelder, pin oak, arborvitae, Norway spruce, blue spruce, white poplar, Scotch pine, Austrian pine, ponderosa pine, American plum, lilac, and hard maples.

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 sites for new homes and on expanding farmsteads. Renovation measures, such as removal and replacement or supplemental planting, help to maintain the effectiveness of a windbreak.

Field windbreaks in the form of hedgerows of Osageorange are numerous throughout the county. They were planted to mark property lines and field boundaries and to serve as living fences and as a source of posts. About 50 percent of the hedgerows have been removed since 1950, mainly because of the need to enlarge fields or to prevent sapping of crops. Root plows currently are used to prune tree roots and thus prevent the sapping of crops. The use of these plows has reduced the rate of hedgerow removal.

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

Trees and shrubs can be easily established in Labette County. The main management concern is the plant competition caused by weeds and grasses. Proper site preparation before planting and control of competing vegetation after planting are important concerns in establishing and managing a windbreak.

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.

Labette County has several areas of scenic, geologic, and historic interest. Scenic views of cropland, rolling grassland, and rocky bluffs are available in the county. Big Hill Lake and its wooded surroundings provide many recreational opportunities. Paddlefish are snagged at the dam on the Neosho River at Chetopa.

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 sewer lines. 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 Labette County are bobwhite quail, mourning dove, prairie chicken, cottontail rabbit, fox squirrel, white-tailed deer, and several species of waterfowl.

Nongame species are numerous because of the diversity of 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. A good windbreak can provide winter cover for several cottontails, a covey of quail, and many songbirds.

Furbearers are common along the Neosho River and other streams in the county. They are trapped on a limited basis.

Big Hill Lake and numerous farm ponds and streams provide good to excellent fishing (fig. 13). Species commonly caught are largemouth bass, bluegill, crappie, channel cat, bullhead, and flathead catfish.

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

Figure 13.—A farm pond in an area of Bolivar-Hector fine sandy loams, 4 to 20 percent slopes.

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, grain sorghum, wheat, oats, barley, 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, bermudagrass, 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 bluestems, switchgrass, indiangrass, goldenrod, sunflowers, ragweed, wheatgrass, and native legumes.

Hardwood trees and woody understory produce nuts, seeds, 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, cottonwood, black walnut, hackberry, willow, ash, hickory, blackberry, and mulberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are plum, fragrant sumac, Russian olive, autumn olive, and crabapple.

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 redcedar, pine, spruce, and juniper.

Shrubs are bushy woody plants that produce fruit, seed 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 gooseberry, dogwood, blackberry, buckbrush, prairie rose, 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, prairie cordgrass, buttonbush, indigobush, 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, and ponds.

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, meadowlark, field sparrow, cottontail, and red fox.

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, skunk, 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, redwing blackbirds, muskrat, mink, and beaver.

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

Technical assistance in planning wildlife areas and in determining the vegetation suitable for planting in those areas 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 or 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, local roads and streets, and lawns and landscaping. 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 or 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, a 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 a 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. These soils 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 water 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. 14). "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.

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.

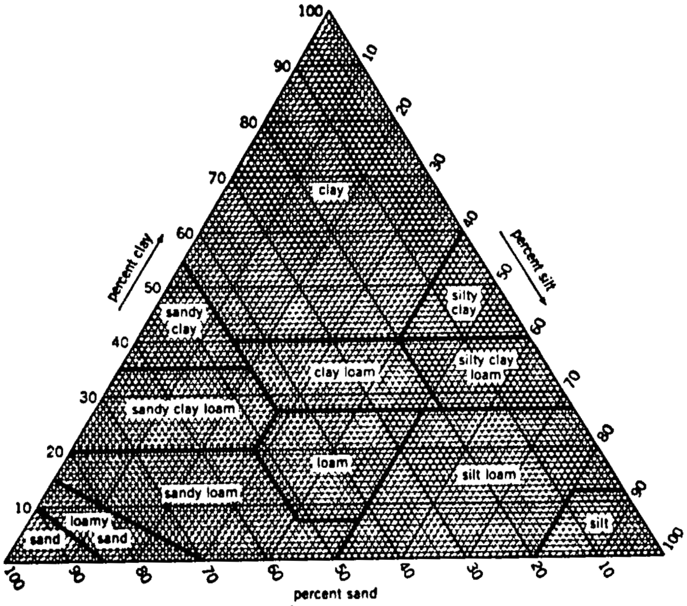


Figure 14.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

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. They also are based 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. They also are based 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 ⅓ 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 in 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 infiltration 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. Generally, 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 1 to 3 percent.

Apperson soils are similar to Dennis, Eram, and Kenoma soils and are commonly adjacent to Catoosa, Shidler, and Zaar soils. Dennis soils are more than 60 inches deep over shale. They are on side slopes. Eram soils are less than 40 inches deep over shale. They are on side slopes. Kenoma soils do not have a BA horizon. They are on broad ridgetops. Catoosa soils are less than 40 inches deep over limestone. They are generally in the more nearly level areas. Shidler soils are less than 20 inches deep over limestone. They are on the steeper side slopes. Zaar soils contain more clay in the surface layer than the Apperson soils. They are on the lower side slopes and along drainageways.

Typical pedon of Apperson silty clay loam, 1 to 3 percent slopes, 400 feet north and 150 feet west of the southeast corner of sec. 7, T. 35 S., R. 18 E.

Ap—0 to 7 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium granular structure; hard, firm; common fine roots; few worm casts; neutral; clear smooth boundary.

BA—7 to 13 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; hard, firm; common fine roots; neutral; gradual smooth boundary.

Bt1—13 to 24 inches; very dark grayish brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) dry; few fine faint dark yellowish brown (10YR 4/4) mottles; moderate medium blocky structure; very hard, very firm; few distinct very dark gray (10YR 3/1) clay films on faces of peds; few small vertical cracks filled with darker material from the overlying horizons; few black concretions; neutral; gradual smooth boundary.

Bt2—24 to 38 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; moderate medium blocky structure; very hard, very firm; few faint dark grayish brown (10YR 4/2) clay films on faces of peds; few fine black concretions; mildly alkaline; gradual smooth boundary.

BC—38 to 49 inches; olive brown (2.5Y 4/4) silty clay, light olive brown (2.5Y 5/4) dry; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium blocky structure; very hard, very firm; few fine black concretions; mildly alkaline; abrupt wavy boundary.

R—49 inches; hard limestone.

The thickness of the solum, or the depth to limestone, ranges from 40 to 60 inches. In some pedons the content of chert or limestone fragments less than 3 inches in diameter is as much as 10 percent in the lower part of the solum.

The A horizon has value of 2 or 3 (3 to 5 dry). It ranges from medium acid to neutral. The Bt horizon has hue of 10YR or 2.5Y, value of 2 to 4 (4 to 6 dry), and chroma of 1 to 3. It is typically silty clay, but in some pedons it is silty clay loam. It ranges from slightly acid to mildly alkaline. In some pedons the lower part of this horizon is calcareous.

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 7 percent.

Bates soils are commonly adjacent to Collinsville and Dennis soils. Collinsville soils are on the steeper side slopes. They are less than 20 inches deep over sandstone. Dennis soils have more clay in the subsoil than the Bates soils. Also, they are lower on the landscape.

Typical pedon of Bates loam, 1 to 3 percent slopes, 1,600 feet east and 350 feet south of the northwest corner of sec. 31, T. 31 S., R. 18 E.

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

BA—9 to 16 inches; dark brown (10YR 3/3) loam, brown (10YR 4/3) dry; few fine faint dark yellowish brown (10YR 4/4) mottles; moderate medium granular structure; slightly hard, friable; many fine roots; few worm casts; strongly acid; gradual smooth boundary.

Bt—16 to 21 inches; brown (10YR 4/3) clay loam, brown (10YR 5/3) dry; common fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; hard, firm; common fine roots; very few faint dark grayish brown (10YR 4/2) clay films on faces of peds; about

5 percent small fragments of soft sandstone; strongly acid; gradual smooth boundary.

BC—21 to 30 inches; dark yellowish brown (10YR 4/4) clay loam, yellowish brown (10YR 5/4) dry; common medium distinct brownish yellow (10YR 6/6) and few medium distinct grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; hard, firm; few fine roots; few small black concretions; about 10 percent fragments of soft sandstone; strongly acid; clear wavy boundary.

Cr—30 inches; soft sandstone interbedded with sandy and silty shale.

The thickness of the solum, or the depth to bedrock, ranges from 20 to 40 inches. The mollic epipedon ranges from 8 to 24 inches in thickness. A few sandstone fragments are throughout some pedons. Reaction ranges from strongly acid to slightly acid throughout the profile.

The A horizon has value of 2 or 3 (3 to 5 dry) and chroma of 2 or 3. It is typically loam, but the range includes silt loam and fine sandy loam. 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 clay loam or loam in which the content of clay ranges from 18 to 35 percent.

Bolivar Series

The Bolivar series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from sandstone and sandy shale. Slope ranges from 4 to 20 percent.

Bolivar soils are commonly adjacent to Bates and Hector soils. Bates soils have a mollic epipedon. They are in landscape positions similar to those of the Bolivar soils. Hector soils are less than 20 inches deep over sandstone. They are on the lower side slopes.

Typical pedon of Bolivar fine sandy loam, in an area of Bolivar-Hector fine sandy loams, 4 to 20 percent slopes; 2,400 feet west and 300 feet south of the northeast corner of sec. 7, T. 32 S., R. 18 E.

A—0 to 5 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; soft, very friable; many fine roots; common worm casts; medium acid; clear smooth boundary.

E--5 to 12 inches; brown (10YR 4/3 and 7.5YR 4/4) fine sandy loam, pale brown (10YR 6/3) and light brown (7.5YR 6/4) dry; moderate medium granular structure; soft, very friable; many fine roots; common worm casts; strongly acid; clear smooth boundary.

Bt1—12 to 17 inches; brown (7.5YR 4/4) clay loam, brown (7.5YR 5/4) dry; common fine faint strong brown (7.5YR 5/6) mottles; moderate medium blocky structure; hard, firm; many fine roots; few worm casts; few faint brown (10YR 4/3) clay films on faces of peds and along root channels; about 5 percent sandstone fragments 0.125 to 0.25 inch in diameter; strongly acid; gradual smooth boundary.

Bt2—17 to 21 inches; strong brown (7.5YR 5/6) clay loam, reddish yellow (7.5YR 6/6) dry; common medium distinct yellowish red (5YR 4/6) and common medium prominent dark reddish brown (2.5YR 3/4) mottles; moderate medium blocky structure; hard, firm; common fine roots; very few faint brown (10YR 4/3) clay films on faces of peds; about 5 percent sandstone fragments 0.25 to 0.5 inch in diameter; strongly acid; gradual smooth boundary.

BC—21 to 27 inches; strong brown (7.5YR 5/6) clay loam, reddish yellow (7.5YR 6/6) dry; common medium distinct yellowish red (5YR 4/6) mottles; weak fine subangular blocky structure; hard, firm; few very fine roots; about 12 percent sandstone fragments 0.25 to 0.5 inch in diameter; strongly acid; clear wavy boundary.

Cr—27 to 41 inches; strong brown (7.5YR 5/8) and red (2.5YR 4/6), thinly bedded soft sandstone and sandy shale.

R—41 inches; sandstone.

The thickness of the solum ranges from 20 to 40 inches. It is the same as the depth to soft sandstone bedrock. The depth to hard sandstone ranges from 40 to 60 inches. The content of sandstone fragments ranges from 0 to 20 percent throughout the solum.

The A horizon has value of 3 or 4 (4 or 5 dry) and chroma of 2 or 3. It is typically fine sandy loam, but in some pedons it is loam. It is strongly acid or medium acid. The E horizon has hue of 10YR or 7.5YR, value of 4 or 5 (5 or 6 dry), and chroma of 3 or 4. The Bt horizon has hue of 5YR or 7.5YR, value of 4 or 5 (5 to 7 dry), and chroma of 4 to 6. It is sandy clay loam, loam, or clay loam. It ranges from very strongly acid to medium acid.

Brazilton Series

The Brazilton series consists of deep, moderately well drained, very slowly permeable soils on uplands. These soils formed in material that was excavated and then was mechanically redeposited in the same sequence of major horizons as that of the original soils. Slope ranges from 1 to 4 percent.

Brazilton soils are commonly adjacent to Dennis and Parsons soils. The adjacent soils have a subsoil that is less compacted than that of the Brazilton soils. They are in areas that have not been excavated.

Typical pedon of Brazilton silty clay loam, 1 to 4 percent slopes, 1,100 feet south and 250 feet east of the northwest corner of sec. 27, T. 33 S., R. 21 E.

A—0 to 15 inches; very dark brown (10YR 2/2) silty clay loam, very dark grayish brown (10YR 3/2) dry; coarse platy fragments; weak fine granular structure in the upper 2 inches; hard, firm; few fine roots; neutral; abrupt smooth boundary.

C1—15 to 32 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; many medium prominent brownish yellow (10YR 6/8) and few medium distinct gray (10YR 5/1) mottles; massive; few subangular blocky peds; extremely hard, extremely firm; few fine roots along faces of soil fragments; neutral; abrupt smooth boundary.

C2—32 to 42 inches; brown (10YR 5/3) silty clay, pale brown (10YR 6/3) dry; many coarse prominent yellowish red (5YR 5/8) mottles; massive; few medium subangular blocky peds; extremely hard, extremely firm; strongly acid; abrupt wavy boundary.

2C—42 to 60 inches; light yellowish brown (2.5Y 6/4) very shaly silty clay loam, pale yellow (2.5Y 7/4) dry; massive; slightly hard, friable; neutral.

The A and C horizons range from strongly acid to neutral. The A horizon has value of 2 or 3 (3 to 5 dry) and chroma of 1 to 3. It is silt loam, silty clay loam, or silty clay. The C horizon has hue of 2.5Y to 7.5YR, value of 2 to 5 (3 to 6 dry), and chroma of 1 to 4. It is silty clay loam, silty clay, or clay. The 2C horizon has hue of 5Y to 7.5YR, value of 4 to 6 (5 to 7 dry), and chroma of 1 to 6. It is very shaly silty clay loam, very shaly silty clay, extremely shaly silty clay loam, or extremely shaly silty clay. It ranges from strongly acid to moderately alkaline. The mottles in these soils are not an indication of the present moisture condition. They were inherent in the soils before excavation.

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 Kenoma, Shidler, and Zaar soils. Kenoma soils have more clay in the subsoil than the Catoosa soils. They are on broad ridgetops. Shidler soils are less than 20 inches deep over limestone. They are on the steeper side slopes. Zaar soils have a clayey solum. They are on side slopes along drainageways.

Typical pedon of Catoosa silt loam, 0 to 2 percent slopes, 2,600 feet south and 1,450 feet east of the northwest corner of sec. 28, T. 32 S., R. 18 E.

Ap—0 to 6 inches; dark brown (7.5YR 3/2) silt loam, brown (7.5YR 4/2) dry; moderate fine granular structure; slightly hard, friable; many fine roots; neutral; clear smooth boundary.

A—6 to 12 inches; dark brown (7.5YR 3/2) silt loam, brown (7.5YR 4/2) dry; moderate medium granular structure; slightly hard, friable; many fine roots; slightly acid; gradual smooth boundary.

BA—12 to 17 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 fine black concretions; slightly acid; gradual smooth boundary.

Bt1—17 to 26 inches; dark reddish brown (5YR 3/4) silty clay loam, reddish brown (5YR 4/4) dry; few fine distinct yellowish red (5YR 5/6) mottles; moderate medium subangular blocky structure; hard, firm; few fine roots; few faint dark reddish brown (5YR 3/3) clay films on faces of peds; few fine black concretions; slightly acid; gradual smooth boundary.

Bt2—26 to 38 inches; dark reddish brown (5YR 3/4) silty clay loam, reddish brown (5YR 4/4) dry; few fine distinct yellowish red (5YR 4/6) mottles; moderate medium subangular blocky structure; hard, firm; few fine roots; few faint dark reddish brown (5YR 3/3) clay films on faces of peds; common fine and medium black concretions; slightly acid; abrupt wavy boundary.

R—38 inches; limestone.

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

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

Cherokee Series

The Cherokee series consists of deep, somewhat poorly drained, very slowly permeable soils on uplands. These soils formed in old alluvium. Slope is 0 to 1 percent.

Cherokee soils are similar to Parsons soils and are commonly adjacent to those soils. Parsons soils have a surface layer that is darker than that of the Cherokee soils. Also, they are slightly higher on the landscape.

Typical pedon of Cherokee silt loam, 0 to 1 percent slopes, 900 feet south and 500 feet west of the northeast corner of sec. 15, T. 32 S., R. 21 E.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable; common fine roots; medium acid; clear smooth boundary.

E—7 to 13 inches; grayish brown (10YR 5/2) silt loam, light brownish gray (10YR 6/2) dry; few fine faint dark brown (10YR 4/3) mottles; weak fine granular structure; slightly hard, friable; common fine roots; medium acid; abrupt smooth boundary.

Btg—13 to 30 inches; very dark gray (10YR 3/1) clay, dark gray (10YR 4/1) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; strong medium subangular blocky structure; extremely hard, very firm; few fine roots; common faint dark gray (10YR 4/1) clay films on faces of peds; medium acid; gradual smooth boundary.

BCg—30 to 43 inches; dark grayish brown (10YR 4/2) clay, grayish brown (10YR 5/2) dry; common medium distinct dark yellowish brown (10YR 4/4) and few fine distinct dark brown (7.5YR 4/4) mottles; moderate medium subangular blocky structure; extremely hard, very firm; medium acid; gradual smooth boundary.

Cg—43 to 60 inches; grayish brown (10YR 5/2) silty clay loam, light brownish gray (10YR 6/2) dry; common medium distinct dark yellowish brown (10YR 4/4) and common fine distinct dark brown (7.5YR 4/4) mottles; massive; extremely hard, very firm; few fine black concretions; strongly acid.

The thickness of the solum ranges from 36 to 60 inches. The A horizon has value of 3 to 5 (4 to 6 dry) and chroma of 1 or 2. The E horizon has value of 5 to 7 (6 to 8 dry) and chroma of 1 or 2. The Btg horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 6 dry), and chroma of 1 or 2. It is strongly acid or medium acid. The Cg horizon has hue of 10YR or 2.5Y, value of 4 or 5 (5 or 6 dry), and chroma of 1 or 2. It is silty clay loam, silty clay, or clay. 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 (fig. 15). Slope ranges from 4 to 15 percent.

Collinsville soils are commonly adjacent to Bates, Dennis, and Eram soils. The adjacent soils are more than 20 inches deep over bedrock and have an argillic horizon. Bates soils are generally higher on the landscape than the Collinsville soils. Dennis and Eram soils are on side slopes below the Collinsville soils.

Typical pedon of Collinsville fine sandy loam, in an area of Bates-Collinsville complex, 4 to 15 percent slopes; 2,100 feet north and 600 feet west of the southeast corner of sec. 9, T. 32 S., R. 18 E.

A1—0 to 8 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; slightly hard, very friable; many fine roots; slightly acid; clear wavy boundary.

A2—8 to 13 inches; dark brown (10YR 3/3) fine sandy loam, brown (10YR 4/3) dry; weak fine granular structure; slightly hard, friable; many fine roots; about 10 percent sandstone fragments 0.125 to 0.25 inch in diameter; medium acid; abrupt wavy boundary.

R—13 inches; sandstone.

The thickness of the solum, or the depth to sandstone bedrock, ranges from 4 to 20 inches. Reaction ranges from slightly acid to strongly acid throughout the profile.

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

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 Apperson, Eram, and Kenoma soils and are commonly adjacent to Bates, Kenoma, Olpe, and Parsons soils. Apperson soils have a surface layer that is more clayey than that of the Dennis soils. They are on the upper side slopes. Bates

Figure 15.—Profile of a Collinsville fine sandy loam. Sandstone bedrock is at a depth of about 13 inches. Depth is marked in feet.

and Eram soils are less than 40 inches deep over bedrock. They are generally on side slopes above the Dennis soils. Kenoma and Parsons soils do not have a BA horizon. They are on broad ridgetops. Olpe soils have chert pebbles in the subsoil. They are higher on the landscape than the Dennis soils.

Typical pedon of Dennis silt loam, 1 to 3 percent slopes, 1,000 feet south and 1,000 feet east of the northwest corner of sec. 34, T. 33 S., R. 21 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; slightly hard, friable; many fine roots; slightly acid; clear smooth boundary.

BA—10 to 15 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 4/3) dry; common medium distinct dark brown (7.5YR 4/4) mottles; moderate medium subangular blocky structure; hard, friable; many fine roots; few worm casts; gray silt grains on faces of peds in the upper 2 inches; medium acid; gradual smooth boundary.

Bt1—15 to 22 inches; brown (10YR 4/3) silty clay, brown (10YR 5/3) dry; common medium prominent dark red (2.5YR 3/6) mottles; moderate medium blocky structure; very hard, very firm; common fine roots; common faint dark grayish brown (10YR 4/2) clay films on faces of most peds; few fine black concretions; strongly acid; gradual smooth boundary.

Bt2—22 to 30 inches; brown (10YR 5/3) silty clay, pale brown (10YR 6/3) dry; common medium prominent strong brown (7.5YR 5/6) and dark red (2.5YR 3/6) mottles; moderate medium blocky structure; very hard, very firm; common fine roots; common faint dark grayish brown (10YR 4/2) clay films on faces of peds; few fine black concretions; strongly acid; gradual smooth boundary.

Bt3—30 to 49 inches; coarsely mottled strong brown (7.5YR 4/6) and gray (10YR 5/1) silty clay, strong brown (7.5YR 5/6) and light gray (10YR 6/1) dry; moderate medium blocky structure; very hard, very firm; few faint dark grayish brown (10YR 4/2) clay films on faces of peds; few fine black concretions; medium acid; gradual smooth boundary.

BC—49 to 60 inches; coarsely mottled strong brown (7.5YR 5/6) and gray (10YR 6/1) silty clay, reddish yellow (7.5YR 6/6) and light gray (10YR 7/1) dry; weak medium blocky structure; very hard, very firm; few fine black concretions; medium acid.

The solum is more than 60 inches thick. The A horizon has value of 2 or 3 (3 to 5 dry) and chroma of 2 or 3. It ranges from strongly acid to slightly acid. The BA horizon has hue of 10YR or 7.5YR, value of 3 or 4 (4 or 5 dry), and chroma of 3 or 4. It ranges from very strongly acid to 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 ranges from strongly acid to slightly acid. It is silty clay or silty clay loam.

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 10 percent.

Eram soils are similar to Apperson, Dennis, and Kenoma soils and are commonly adjacent to Collinsville, Lebo, Nowata, Shidler, and Zaar soils. Apperson, Dennis, and Kenoma soils are more than 40 inches deep over bedrock. Apperson soils are higher on the landscape than the Eram soils. Dennis soils are on side slopes below the Eram soils. Kenoma soils are on ridgetops. Collinsville and Shidler soils are less than 20 inches deep over bedrock. They are higher on the landscape than the Eram soils. Lebo soils do not have an argillic horizon. They are on the steeper side slopes above the Eram soils. Nowata soils have chert fragments in the subsoil. They are on ridgetops. Zaar soils have a surface layer that is more clayey than that of the Eram soils. They are along drainageways and on the lower side slopes.

Typical pedon of Eram silty clay loam, 1 to 3 percent slopes, 1,250 feet east and 150 feet south of the northwest corner of sec. 17, T. 33 S., R. 18 E.

A—0 to 8 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; hard, firm; many fine roots; slightly acid; clear smooth boundary.

Bt—8 to 18 inches; very dark grayish brown (10YR 3/2) clay, dark grayish brown (10YR 4/2) dry; common fine distinct dark yellowish brown (10YR 4/4) mottles; moderate medium blocky structure; very hard, very firm; common fine roots; common faint dark gray (10YR 4/1) clay films on faces of peds; medium acid; gradual smooth boundary.

BC—18 to 26 inches; dark grayish brown (2.5Y 4/2) clay, light brownish gray (2.5Y 6/2) dry; common medium distinct yellowish brown (10YR 5/6) and gray (10YR 5/1) mottles; weak medium blocky structure; extremely hard, very firm; few fine roots; about 5 percent shale fragments; strongly acid; gradual smooth boundary.

Cr—26 inches; dark gray (10YR 4/1) and yellowish brown (10YR 5/6), soft, platy shale.

The thickness of the solum, or the depth to shale, ranges from 20 to 40 inches. The mollic epipedon ranges from 8 to 20 inches in thickness.

The A horizon has value of 2 or 3 (3 to 5 dry) and chroma of 2 or 3. It is typically silty clay loam, but in some pedons it is silt loam. It is medium acid or slightly acid. The Bt horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 6 dry), and chroma of 2 or 3. It ranges from strongly acid to neutral.

Hector Series

The Hector series consists of shallow, well drained, moderately rapidly permeable soils on uplands. These soils formed in material weathered from sandstone. Slope ranges from 4 to 20 percent.

Hector soils are commonly adjacent to Bolivar soils. Bolivar soils are 20 to 40 inches deep over sandstone. They are on the upper side slopes.

Typical pedon of Hector fine sandy loam, in an area of Bolivar-Hector fine sandy loams, 4 to 20 percent slopes; 2,300 feet east and 400 feet south of the northwest corner of sec. 7, T. 32 S., R. 18 E.

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

E—3 to 8 inches; brown (10YR 4/3) fine sandy loam, pale brown (10YR 6/3) dry; moderate medium granular structure; soft, very friable; many fine and medium roots; medium acid; clear smooth boundary.

Bw—8 to 15 inches; yellowish brown (10YR 5/4) and strong brown (7.5YR 5/6) fine sandy loam, very pale brown (10YR 7/4) and reddish yellow (7.5YR 6/6) dry; weak fine subangular blocky structure; slightly hard, friable; many fine and medium roots; very strongly acid; abrupt wavy boundary.

R—15 inches; sandstone.

The thickness of the solum, or the depth to bedrock, ranges from 10 to 20 inches. The solum is fine sandy loam or loam.

The A horizon has value of 3 or 4 (4 or 5 dry) and chroma of 2 or 3. It ranges from strongly acid to slightly acid. The E horizon has value of 4 or 5 (5 or 6 dry) and chroma of 2 to 4. The Bw horizon has hue of 5YR to 10YR, value of 4 or 5 (5 to 7 dry), and chroma of 4 to 6. It is very strongly acid or strongly acid. The content of sandstone fragments in this horizon ranges from 0 to 15 percent.

Hepler Series

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

Hepler soils are commonly adjacent to Lanton, Osage, and Verdigris soils. Lanton and Verdigris soils have a mollic epipedon. They are in positions on the landscape similar to those of the Hepler soils. Osage soils have a clayey subsoil. They are in concave areas on the flood plains.

Typical pedon of Hepler silt loam, occasionally flooded, 1,050 feet east and 300 feet south of the northwest corner of sec. 16, T. 34 S., R. 21 E.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable; many fine roots; slightly acid; clear smooth boundary.

E1—9 to 17 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; few fine faint brown (10YR 4/3) mottles; moderate fine and medium granular structure; slightly hard, friable; many fine roots; common worm casts; strongly acid; gradual smooth boundary.

E2—17 to 24 inches; grayish brown (10YR 5/2) silt loam, light gray (10YR 7/2) dry; common medium distinct dark yellowish brown (10YR 4/4) mottles; moderate fine and medium granular structure; slightly hard, friable; many fine roots; common worm casts; few fine brown stains; strongly acid; clear smooth boundary.

Bt1—24 to 34 inches; dark grayish brown (10YR 4/2) silty clay loam, grayish brown (10YR 5/2) dry; common medium distinct dark yellowish brown (10YR 4/6) mottles; moderate medium subangular blocky structure; very hard, firm; common fine roots; few faint very dark grayish brown (10YR 3/2) clay films along pores and root channels; common fine black concretions and black stains; strongly acid; gradual smooth boundary.

Bt2—34 to 44 inches; dark grayish brown (10YR 4/2) silty clay loam, grayish brown (10YR 5/2) dry; common medium distinct dark yellowish brown (10YR 4/6) mottles; moderate medium subangular blocky structure; very hard, firm; few faint very dark grayish brown (10YR 3/2) clay films along pores and root channels; common fine black concretions and black stains; slightly acid; gradual smooth boundary.

BC—44 to 60 inches; dark grayish brown (10YR 4/2) silty clay loam, grayish brown (10YR 5/2) dry; common medium distinct dark yellowish brown (10YR 4/6) mottles; weak medium subangular blocky structure; very hard, firm; common fine black concretions; slightly acid.

The thickness of the solum ranges from 40 to more than 60 inches. Reaction ranges from very strongly acid to slightly acid throughout the profile.

The A horizon has value of 2 or 3 (3 to 5 dry) and chroma of 1 or 2. The E horizon has hue of 10YR or 2.5Y, value of 4 or 5 (5 to 7 dry), and chroma of 2 or 3. The Bt horizon has hue of 10YR or 2.5Y, value of 3 to 5 (5 to 7 dry), and chroma of 1 or 2.

Kanima Series

The Kanima series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in excavated material. Slope ranges from 3 to 30 percent.

Kanima soils are commonly adjacent to Dennis and Parsons soils. The adjacent soils generally have a clayey subsoil. They are in undisturbed areas.

Typical pedon of Kanima shaly silty clay loam, 3 to 7 percent slopes, 1,650 feet north and 400 feet east of the southwest corner of sec. 18, T. 34 S., R. 21 E.

A—0 to 6 inches; dark grayish brown (10YR 4/2) and dark yellowish brown (10YR 4/4) shaly silty clay loam, grayish brown (10YR 5/2) and yellowish brown (10YR 5/4) dry; weak thin platy soil fragments; hard, firm; many fine roots; about 25 percent shale fragments; mildly alkaline; gradual wavy boundary.

C—6 to 60 inches; dark grayish brown (10YR 4/2) and dark yellowish brown (10YR 4/4) very shaly silty clay loam, grayish brown (10YR 5/2) and yellowish brown (10YR 5/4) dry; massive; a few subangular blocky peds of the original B horizon; very hard, very firm; common fine roots in the upper 18 inches; about 60 percent shale fragments; mildly alkaline.

Reaction ranges from medium acid to moderately alkaline throughout the profile. Fragments of coal are throughout some pedons.

The A horizon has value of 3 to 5 (4 to 6 dry) and chroma of 2 to 4. It is shaly silty clay loam, shaly silt loam, or very shaly silty clay loam. The C horizon has hue of 10YR to 5Y, value of 4 or 5 (4 to 6 dry), and chroma of 2 to 4. The content of coarse fragments in this horizon ranges from 20 to 90 percent.

Kenoma Series

The Kenoma series consists of deep, moderately well drained, very slowly permeable soils on uplands. These soils formed in old alluvium that has a high content of silt and clay. Slope ranges from 1 to 3 percent.

Kenoma soils are similar to Apperson, Dennis, and Eram soils and are commonly adjacent to Catoosa, Dennis, and Parsons soils. Apperson and Dennis soils have a BA horizon. They are slightly lower on the landscape than the Kenoma soils. Eram soils have a surface layer that is more clayey than that of the Kenoma soils. They are on side slopes. Catoosa and Parsons soils are generally in the less sloping areas. Catoosa soils have a subsoil that is less clayey than that of the Kenoma soils. They are less than 40 inches deep over bedrock. Parsons soils have an E horizon.

Typical pedon of Kenoma silt loam, 1 to 3 percent slopes, 1,600 feet south and 100 feet west of the northeast corner of sec. 13, T. 31 S., R. 17 E.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable; many fine roots; slightly acid; clear smooth boundary.

A—6 to 13 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; slightly hard, friable; many fine roots; medium acid; abrupt wavy boundary.

Bt1—13 to 26 inches; dark brown (10YR 3/3) silty clay, brown (10YR 4/3) dry; common fine distinct dark yellowish brown (10YR 4/6) mottles; moderate medium blocky structure; very hard, very firm; few fine roots; common faint very dark grayish brown (10YR 3/2) clay films on faces of peds; few fine chert fragments; slightly acid; gradual smooth boundary.

Bt2—26 to 39 inches; dark yellowish brown (10YR 4/4) silty clay, yellowish brown (10YR 5/4) dry; common medium faint yellowish brown (10YR 5/6) mottles; moderate medium blocky structure; extremely hard, extremely firm; few fine roots; common distinct grayish brown (10YR 5/2) clay films on faces of peds; few black concretions; few fine chert fragments; neutral; gradual smooth boundary.

BC—39 to 49 inches; dark yellowish brown (10YR 4/6) silty clay, yellowish brown (10YR 5/6) dry; common medium prominent reddish brown (5YR 4/4) and few fine distinct grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; extremely hard, extremely firm; few fine black concretions; few fine chert fragments; neutral; gradual smooth boundary.

C—49 to 60 inches; yellowish brown (10YR 5/6) silty clay loam, brownish yellow (10YR 6/6) dry; many medium prominent reddish brown (5YR 4/4) mottles; massive; very hard, very firm; few fine black concretions; few fine chert fragments and weathered sandy shale fragments; neutral.

The solum is more than 40 inches thick. The mollic epipedon ranges from 10 to more than 20 inches in thickness. The content of fine and medium chert fragments is less than 10 percent throughout the profile.

The A horizon has value of 2 or 3 (4 or 5 dry) and chroma of 1 to 3. It ranges from strongly acid to slightly acid. It is typically silt loam, but in some pedons it is silty clay loam. The Bt horizon has hue of 10YR or 7.5YR, value of 3 to 5 (4 to 7 dry), and chroma of 2 to 4. It is silty clay loam, silty clay, or clay. It ranges from strongly acid to mildly alkaline.

Lanton Series

The Lanton series consists of deep, somewhat poorly drained, slowly permeable soils on flood plains. These soils formed in alluvium. Slope ranges from 0 to 2 percent.

Lanton soils are similar to Verdigris soils and are commonly adjacent to Hepler, Osage, and Verdigris soils. Hepler and Verdigris soils are in positions on the landscape similar to those of the Lanton soils. Hepler soils have an argillic horizon. Verdigris soils are moderately well drained. Osage soils have a clayey subsoil. They are in concave areas on the flood plains.

Typical pedon of Lanton silt loam, occasionally flooded, 1,200 feet east and 100 feet north of the southwest corner of sec. 17, T. 32 S., R. 18 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; many fine roots; neutral; clear smooth boundary.

A1—8 to 22 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; few fine faint dark gray (10YR 4/1) mottles; moderate medium subangular blocky structure; hard, firm; common fine roots; slightly acid; gradual wavy boundary.

A2—22 to 37 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; common medium distinct yellowish brown (10YR 5/4) mottles; moderate medium subangular blocky structure; very hard, very firm; common fine black concretions; slightly acid; gradual wavy boundary.

Cg—37 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; common medium prominent dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) mottles; massive; very hard, very firm; few black coatings and fine concretions; neutral.

The solum and the mollic epipedon are more than 24 inches thick. Reaction ranges from neutral to medium acid throughout the profile.

The A horizon has value of 2 or 3 (3 to 5 dry) and chroma of 1 or 2. It is silt loam or silty clay loam. The Cg horizon has hue of 10YR or 2.5Y, value of 4 or 5 (moist or dry), and chroma of 1 or 2. It is commonly mottled with shades of yellow, brown, and gray. It is silty clay loam, silty clay, or clay.

Lebo Series

The Lebo series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from shale and thin layers of sandstone. Slope ranges from 8 to 20 percent.

Lebo soils are commonly adjacent to Collinsville and Eram soils. Collinsville soils are less than 20 inches deep over sandstone. They are higher on the landscape than the Lebo soils. Eram soils have an argillic horizon. They are on side slopes below the Lebo soils.

Typical pedon of Lebo silty clay loam, in an area of Eram-Lebo silty clay loams, 4 to 20 percent slopes; 1,450 feet east and 300 feet south of the northwest corner of sec. 19, T. 31 S., R. 18 E.

A—0 to 9 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; strong medium granular structure; slightly hard, friable; many fine and medium roots; about 5 percent shale fragments 0.125 to 0.25 inch in diameter; neutral; clear smooth boundary.

Bw—9 to 15 inches; dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; moderate medium subangular blocky structure; hard, firm; many fine and medium roots; few worm casts; about 12 percent shale fragments 0.25 to 1.0 inch in diameter; neutral; clear wavy boundary.

BC—15 to 22 inches; olive brown (2.5Y 4/4) shaly silty clay loam, light olive brown (2.5Y 5/4) dry; weak fine subangular blocky structure; hard, firm; many fine roots; about 30 percent shale fragments 0.25 to 1.0 inch in diameter; neutral; clear wavy boundary.

C—22 to 32 inches; light olive brown (2.5Y 5/4) extremely shaly silty clay loam, light yellowish brown (2.5Y 6/4) dry; massive; hard, firm; about 90 percent shale fragments 0.25 inch to 1.5 inches in diameter; neutral; gradual wavy boundary.

Cr—32 to 38 inches; soft, platy shale.

The thickness of the solum, or the depth to shale, ranges from 20 to 40 inches. Reaction ranges from medium acid to mildly alkaline throughout the profile.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 to 5 dry), and chroma of 2 or 3. It is typically silty clay loam, but the range includes silt loam and shaly silty clay loam. The Bw 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 silty clay loam or shaly silty clay loam. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. The content of shale fragments in this horizon ranges from 35 to 90 percent.

Nowata Series

The Nowata series consists of moderately deep, well drained, moderately slowly permeable soils on uplands. These soils formed in material weathered from cherty limestone. Slope ranges from 2 to 7 percent.

Nowata soils are similar to Catoosa and Olpe soils and are commonly adjacent to Apperson, Dennis, and Eram soils. Catoosa soils do not have chert fragments in the subsoil. They are on ridgetops. Olpe, Apperson, and Dennis soils contain more clay in the subsoil than the Nowata soils and are more than 40 inches deep over bedrock. Apperson soils are on ridgetops, and Dennis soils are on the lower side slopes. Eram soils are less than 40 inches deep over shale bedrock. They are on ridgetops and side slopes.

Typical pedon of Nowata silt loam, in an area of Eram-Nowata complex, 2 to 7 percent slopes; 1,150 feet north and 700 feet west of the southeast corner of sec. 3, T. 31 S., R. 19 E.

A—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, friable; many fine roots; slightly acid; clear smooth boundary.

BA—8 to 13 inches; very dark grayish brown (10YR 3/2) cherty silty clay loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; hard, firm; many fine roots; about 15 percent chert fragments; slightly acid; clear smooth boundary.

Bt1—13 to 25 inches; dark brown (7.5YR 3/4) very cherty silty clay loam, brown (7.5YR 4/4) dry; few fine prominent dark red (2.5YR 3/6) mottles; moderate medium subangular blocky structure; very hard, very firm; common fine roots; few faint brown (10YR 4/3) clay films on faces of peds; about 40 to 50 percent chert fragments; medium acid; gradual wavy boundary.

Bt2—25 to 36 inches; brown (7.5YR 4/4) very cherty silty clay loam, light brown (7.5YR 6/4) dry; common medium prominent dark red (2.5YR 3/6) mottles; moderate medium subangular blocky structure; very hard, very firm; few faint brown (10YR 4/3) clay films on faces of peds; about 45 to 55 percent chert fragments; slightly acid; abrupt wavy boundary.

R—36 inches; limestone.

The thickness of the solum, or the depth to limestone bedrock, ranges from 20 to 40 inches. Scattered chert fragments are generally on the surface.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 (3 to 5 dry), and chroma of 2 or 3. It is slightly acid or medium acid. The content of chert fragments in this horizon is less than 10 percent. The Bt horizon has hue of 7.5YR or 2.5YR, value of 3 or 4 (4 to 6 dry), and chroma of 3 or 4. It ranges from medium acid to neutral. The content of angular chert fragments in this horizon ranges from about 35 to 80 percent.

Olpe Series

The Olpe series consists of deep, well drained, slowly permeable soils on uplands. These soils formed in gravelly old alluvial sediments. Slope ranges from 3 to 7 percent.

Olpe soils are similar to Catoosa and Nowata soils and are commonly adjacent to Dennis and Shidler soils. Catoosa and Nowata soils are moderately deep over limestone. They are on ridgetops. Dennis soils do not have chert pebbles in the solum. They are on side slopes below the Olpe soils. Shidler soils are less than 20 inches deep over limestone. They are on the steeper side slopes.

Typical pedon of Olpe silt loam, in an area of Olpe-Dennis silt loams, 3 to 7 percent slopes; 2,400 feet south and 600 feet west of the northeast corner of sec. 3, T. 34 S., R. 21 E.

Ap—0 to 7 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate medium granular structure; slightly hard, friable; many fine and very fine roots; about 5 percent rounded chert pebbles 0.125 to 0.25 inch in diameter; medium acid; clear wavy boundary.

A—7 to 13 inches; dark brown (10YR 3/3) gravelly silt loam, brown (10YR 5/3) dry; moderate medium granular structure; slightly hard, friable; many fine roots; about 30 percent rounded chert pebbles 0.25 to 0.5 inch in diameter; slightly acid; clear wavy boundary.

BA—13 to 20 inches; dark brown (7.5YR 4/4) extremely gravelly clay loam, brown (7.5YR 5/4) dry; moderate fine subangular blocky structure; hard, firm; common fine roots; about 75 percent rounded chert pebbles 0.25 to 0.75 inch in diameter; medium acid; gradual wavy boundary.

Bt1—20 to 30 inches; dark brown (7.5YR 4/4) very gravelly silty clay loam, brown (7.5YR 5/4) dry; many medium prominent dark red (2.5YR 3/6) mottles; moderate fine blocky structure; hard, firm; few faint brown (10YR 4/3) clay films on faces of peds; about 50 percent rounded chert pebbles 0.25 to 0.5 inch in diameter; medium acid; gradual wavy boundary.

Bt2—30 to 44 inches; dark brown (7.5YR 4/4) very gravelly silty clay, brown (7.5YR 5/4) dry; many coarse prominent dark red (2.5YR 3/6) mottles; moderate medium subangular blocky structure; very hard, very firm; common faint brown (10YR 4/3) clay films on faces of peds; about 40 percent rounded chert pebbles 0.25 to 0.5 inch in diameter; medium acid; gradual wavy boundary.

2BC—44 to 60 inches; mottled dark red (2.5YR 3/6), light brownish gray (10YR 6/2), and strong brown (7.5YR 5/6) silty clay; weak fine blocky structure; very hard, very firm; about 10 percent fine, partially weathered shale fragments; medium acid.

The solum is more than 60 inches thick. The thickness of the mollic epipedon ranges from 10 to 20 inches.

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 silt loam or gravelly silt loam. It ranges from strongly acid to slightly acid. The Bt horizon has hue of 5YR or 7.5YR, value of 3 or 4 (4 or 5 dry), and chroma of 4 to 6. It ranges from medium acid to neutral. The content of rounded chert pebbles in this horizon ranges from about 35 to 80 percent.

Osage Series

The Osage series consists of deep, poorly drained, very slowly permeable soils on flood plains. These soils formed in clayey alluvium. Slope ranges from 0 to 2 percent.

Osage soils are commonly adjacent to Hepler, Lanton, and Verdigris soils. The adjacent soils have less clay in the solum than the Osage soils. Also, Hepler and Lanton soils are slightly higher on the landscape, and Verdigris soils are closer to stream channels.

Typical pedon of Osage silty clay, occasionally flooded, 1,875 feet west and 1,400 feet north of the southeast corner of sec. 10, T. 33 S., R. 21 E.

Ap—0 to 5 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; moderate medium granular structure; very hard, very firm; many fine roots; neutral; clear smooth boundary.

A1—5 to 12 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; very hard, very firm; common fine roots; common worm casts; neutral; gradual smooth boundary.

A2—12 to 17 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; few fine distinct olive brown (2.5Y 4/4) and common fine faint dark gray (N 4/0) mottles; moderate medium blocky structure; very hard, very firm; few fine roots; few worm casts; few fine brown concretions; slightly acid; gradual smooth boundary.

Bg1—17 to 30 inches; very dark gray (5Y 3/1) clay, dark gray (5Y 4/1) dry; few fine distinct olive brown (2.5Y 4/4) and common fine faint dark gray (N 4/0) mottles; moderate medium blocky structure; extremely hard, extremely firm; few fine brown concretions; few slickensides; neutral; gradual smooth boundary.

Bg2—30 to 42 inches; very dark gray (5Y 3/1) clay, dark gray (5Y 4/1) dry; few fine distinct olive brown (2.5Y 4/4) and few fine faint dark gray (N 4/0) mottles; moderate medium blocky structure; extremely hard, extremely firm; few fine brown concretions; few slickensides; mildly alkaline; diffuse smooth boundary.

BCg—42 to 60 inches; dark gray (5Y 4/1) clay, gray (5Y 5/1) dry; few fine distinct olive brown (2.5Y 4/4) mottles; weak fine blocky structure; extremely hard, extremely firm; few fine brown concretions; few slickensides; 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 ranges from strongly acid to moderately alkaline. The Bg horizon has hue of 10YR to 5Y, value of 3 or 4 (4 or 5 dry), and chroma of less than 2. It ranges from medium acid to mildly alkaline.

Parsons Series

The Parsons series consists of deep, somewhat poorly drained, very slowly permeable soils on uplands. These soils formed in old alluvium that in some areas is mantled with a thin layer of loess. Slope ranges from 0 to 2 percent.

Parsons soils are similar to Cherokee soils and are commonly adjacent to Cherokee, Dennis, Kenoma, and Zaar soils. Cherokee soils are lighter colored in the surface layer than the Parsons soils. Dennis soils have a BA horizon. They are on side slopes. Kenoma soils do not have an E horizon. They are in the more sloping areas. Zaar soils have more clay in the surface layer than the Parsons soils and do not have an E horizon. They are on the higher side slopes and in convex areas and swales.

Typical pedon of Parsons silt loam, 0 to 2 percent slopes, 1,200 feet south and 200 feet east of the northwest corner of sec. 12, T. 33 S., R. 20 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable; many fine roots; slightly acid; clear smooth boundary.

E—8 to 13 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; few fine faint dark yellowish brown (10YR 4/4) mottles; weak medium granular structure; slightly hard, friable; many fine roots; strongly acid; abrupt smooth boundary.

Btg1—13 to 23 inches; very dark grayish brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) dry; common fine distinct dark yellowish brown (10YR 4/6) mottles; moderate medium blocky structure; very hard, very firm; common fine roots; common faint dark grayish brown (10YR 4/2) clay films on faces of peds; few fine black concretions; strongly acid; gradual smooth boundary.

Btg2—23 to 36 inches; very dark grayish brown (10YR 3/2) silty clay, grayish brown (10YR 5/2) dry; common medium distinct dark yellowish brown (10YR 4/6) mottles; moderate medium subangular blocky structure; very hard, very firm; few fine roots; common faint dark grayish brown (10YR 4/2) clay films on faces of peds; few fine black concretions; strongly acid; gradual smooth boundary.

Btg3—36 to 41 inches; gray (10YR 5/1) and yellowish brown (10YR 5/6) silty clay, gray (10YR 6/1) and brownish yellow (10YR 6/6) dry; moderate medium blocky structure; extremely hard, very firm; few distinct very dark grayish brown (10YR 3/2) clay films on faces of peds; few fine black concretions; few vertical cracks filled with darker material; slightly acid; gradual smooth boundary.

BC—41 to 60 inches; gray (10YR 6/1) and yellowish red (5YR 5/6) silty clay, light gray (10YR 7/1) and reddish yellow (5YR 6/6) dry; weak coarse blocky structure; very hard, very firm; common fine and medium black concretions; neutral.

The solum ranges from 40 to more than 60 inches in thickness. It ranges from strongly acid to mildly alkaline.

The A horizon has value of 3 or 4 (4 or 5 dry). The E horizon has value of 4 or 5 (5 to 7 dry) and chroma of 1 or 2. The Bt horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 7 dry), and chroma of 1 or 2. It is mottled with shades of gray, brown, or red. It is silty clay loam, silty clay, or clay.

Shidler Series

The Shidler series consists of shallow, well drained, moderately permeable soils on uplands. These soils formed in material weathered from limestone (fig. 16). Slope ranges from 1 to 8 percent.

Shidler soils are commonly adjacent to Apperson, Catoosa, and Eram soils. Apperson soils are more than 40 inches deep over bedrock. They are on ridgetops and side slopes above the Shidler soils. Catoosa and Eram soils are 20 to 40 inches deep over bedrock. Catoosa soils are on ridgetops, and Eram soils are on the lower side slopes.

Typical pedon of Shidler silt loam, in an area of Shidler-Catoosa silt loams, 1 to 8 percent slopes; 900 feet west and 80 feet north of the southeast corner of sec. 14, T. 34 S., R. 17 E.

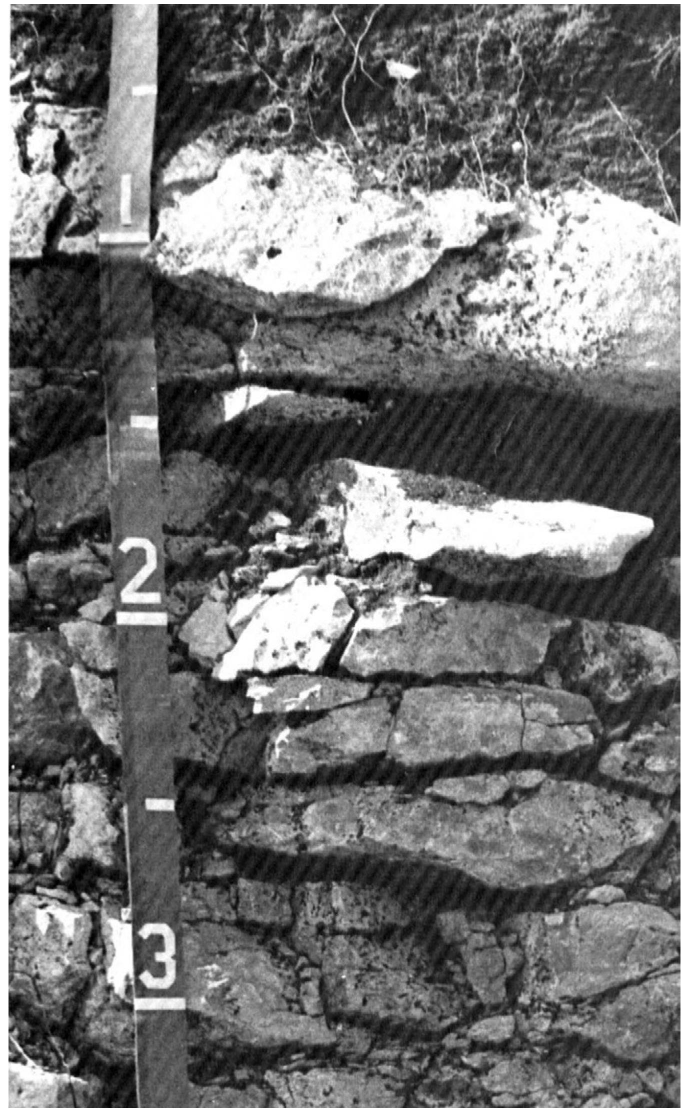


Figure 16.—Profile of a Shidler silt loam. Limestone bedrock is at a depth of about 8 inches. Depth is marked in feet.

A—0 to 12 inches; very dark brown (10YR 2/2) silt loam, very dark grayish brown (10YR 3/2) dry; moderate medium granular structure; slightly hard, friable; many fine roots; about 5 percent flat limestone fragments in the lower part; neutral; abrupt irregular boundary.

R—12 inches; hard limestone.

The thickness of the solum, or the depth to limestone, ranges from 4 to 20 inches. The A horizon has hue of 5YR to 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 silt loam, but in some pedons it is silty clay loam. The content of thin, flat limestone fragments that are 1 to 3 inches in length along the longer axis is less than 15 percent.

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 Lanton soils and are commonly adjacent to Hepler, Lanton, and Osage soils. Hepler and Lanton soils have mottles within 16 inches of the surface. They are in landscape positions similar to those of the Verdigris soils. Osage soils have a clayey subsoil. They are in concave areas on the flood plains.

Typical pedon of Verdigris silt loam, occasionally flooded, 2,400 feet south and 2,200 feet east of the northwest corner of sec. 24, T. 32 S., R. 17 E.

Ap—0 to 7 inches; dark brown (10YR 3/3) silt loam, brown (10YR 4/3) dry; weak medium granular structure; slightly hard, friable; many fine roots; neutral; clear smooth boundary.

A1—7 to 18 inches; dark brown (10YR 3/3) silt loam, brown (10YR 4/3) dry; moderate medium granular structure; slightly hard, friable; many fine roots; scattered worm casts; slightly acid; gradual smooth boundary.

A2—18 to 29 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; scattered worm casts; slightly acid; gradual smooth boundary.

A3—29 to 34 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak medium granular structure; slightly hard, friable; few fine roots; scattered worm casts; slightly acid; gradual smooth boundary.

AC—34 to 54 inches; very dark brown (10YR 2/2) silt loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; slightly hard, friable; few medium black stains; slightly acid; gradual smooth boundary.

C—54 to 60 inches; dark grayish brown (10YR 4/2) silt loam, grayish brown (10YR 5/2) dry; massive; slightly hard, friable; slightly acid.

The solum and the mollic epipedon range from 24 to more than 50 inches in thickness. The soils are medium acid to neutral silt loam or silty clay loam throughout.

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. The AC horizon has hue of 2.5Y or 10YR, value of 2 to 5 (4 to 6 dry), and chroma of 2 or 3.

Zaar Series

The Zaar series consists of deep, somewhat poorly drained, very slowly permeable soils on uplands. These soils formed in material weathered from shale. Slope ranges from 0 to 2 percent.

Zaar soils are commonly adjacent to Apperson, Catoosa, Eram, and Parsons soils. Apperson, Catoosa, and Parsons soils have an argillic horizon, and Eram soils are 20 to 40 inches deep over shale. Apperson and Catoosa soils are on ridgetops. Eram soils are on side slopes. Parsons soils are on broad ridgetops.

Typical pedon of Zaar silty clay, 0 to 2 percent slopes, 350 feet north and 250 feet east of the southwest corner of sec. 2, T. 32 S., R. 21 E.

Ap—0 to 7 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; weak fine blocky structure; hard, very firm; many fine and very fine roots; neutral; clear smooth boundary.

A—7 to 17 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate fine and medium blocky structure; very hard, very firm; many fine and very fine roots; scattered worm casts; neutral; gradual smooth boundary.

Bw1—17 to 26 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; common fine distinct dark yellowish brown (10YR 4/4) mottles; moderate medium blocky structure; extremely hard, extremely firm; common fine roots; few small black concretions; few slickensides; mildly alkaline; gradual smooth boundary.

Bw2—26 to 36 inches; dark grayish brown (2.5Y 4/2) clay, grayish brown (2.5Y 5/2) dry; common medium distinct dark yellowish brown (10YR 4/4) mottles; weak medium blocky structure; extremely hard, extremely firm; few fine roots; common small black concretions; few slickensides; few fine chert fragments; mildly alkaline; gradual smooth boundary.

BC—36 to 54 inches; dark grayish brown (2.5Y 4/2) clay, grayish brown (2.5Y 5/2) dry; common medium distinct dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; extremely hard, extremely firm; common small black concretions; few slickensides; few fine chert fragments; mildly alkaline; gradual smooth boundary.

C—54 to 60 inches; yellowish brown (10YR 5/6) clay, brownish yellow (10YR 6/6) dry; many medium distinct dark yellowish brown (10YR 4/4) and gray (10YR 5/1) mottles; massive; extremely hard, extremely firm; many small black concretions; few fine chert fragments; mildly alkaline.

The solum is more than 40 inches thick. In some pedons small concretions of carbonate are in the lower horizons.

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 ranges from medium acid to neutral. The Bw horizon has hue of 10YR to 5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 3. It ranges from slightly acid to mildly alkaline.

Formation of the Soils

Soil forms through processes that act on deposited or accumulated geologic material. The characteristics of a soil at any given point are determined by the interaction of five major factors of soil formation. These factors are climate, plants and other living organisms, parent material, relief, and time. 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.

Most of the soils in Labette County formed in material weathered from Pennsylvanian limestone, sandstone, and shale. Dennis, Eram, Lebo, and Zaar soils formed in material weathered from shale. Bates, Bolivar, Collinsville, and Hector soils formed in material weathered from sandstone and sandy shale. Apperson, Catoosa, Nowata, and Shidler soils formed in material weathered from limestone.

The soils on bottom land formed in alluvium, or water-deposited material. Both recent and old alluvial sediments are evident in Labette County. The recent alluvium is in stream valleys. Hepler, Lanton, Osage, and Verdigris soils formed in this material. Old alluvial sediments are on what are now uplands. In some areas Cherokee, Kenoma, and Parsons soils formed in these sediments. Olpe soils formed in gravelly old alluvium.

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. Soil-forming processes are most active when the soil is warm and moist.

The climate of Labette 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 burrowing animals help to keep the soil open and porous. Bacteria and fungi help to decompose the plants, thus releasing plant nutrients.

Tall and mid prairie grasses have had a great influence on soil formation in Labette County. As a result of the grasses, the upper part of a typical soil in the county is dark and is high in content of organic matter. In many areas the next layer is slightly finer textured and somewhat lighter colored than the layer above. The underlying parent material is generally light in color. The soils that formed under a canopy of oaks in the northwestern part of the county do not have a thick, dark surface layer and are more acid than the soils that formed under prairie grasses.

Human activities have greatly affected soil formation. In most areas they have increased the susceptibility to erosion and increased or decreased the organic matter content. Also, land leveling and industrial and urban development have changed the relief in some areas.

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 soils in the uplands 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 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 Lanton 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 Dennis and Parsons 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. 1974. Standard test method for classification of soils for engineering purposes. ASTM Stand. D 2487.

(3) Kansas State Board of Agriculture. 1987. 1985-1986 farm facts. Spec. Rep. Kans. Crop and Kans. Cattle Mark. Stat., 110 pp., illus.

(4) Knobel, E.W., R.L. Von Trebra, and H.W. Higbee. 1926. Soil survey of Labette County, Kansas. U.S. Dep. Agric., Bur. of Chem. and Soils, 23 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.

Glossary

ABC soil. A soil having an A, a B, and a C horizon.

AC soil. A soil having only an A and a C horizon. Commonly, such soil formed in recent alluvium or on steep rocky slopes.

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—

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.

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.

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.

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.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity*.

Fine textured soil. Sandy clay, silty clay, and clay.

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 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.

Leaching. The removal of soluble material from soil or other material by percolating water.

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.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

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 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.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

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.

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 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 degrees of acidity or alkalinity, expressed as pH values, are—

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

Residuum (residual soil material). Unconsolidated, weathered or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts 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.

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.

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.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

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.

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.

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, in millimeters, of separates recognized in the United States are as follows:

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.

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.

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.

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.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1951-76 at Parsons, 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-----	44.2	23.7	34.0	71	-4	1.24	0.42	1.91	3	2.7
February----	50.5	28.7	39.6	76	4	1.31	.70	2.00	3	2.5
March-------	58.5	35.6	47.1	86	11	2.98	1.33	4.14	4	2.6
April-------	70.9	47.3	59.1	90	26	3.91	1.98	5.74	6	.2
May---------	79.0	56.5	67.8	94	36	5.15	3.09	6.20	8	.0
June--------	87.2	64.9	76.1	100	49	4.67	2.03	6.93	7	.0
July--------	92.7	69.3	81.0	105	54	3.84	1.32	5.51	5	.0
August------	92.4	67.5	80.0	106	53	3.16	1.15	4.84	5	.0
September---	83.7	60.0	71.9	99	42	4.64	1.92	6.65	6	.0
October-----	73.3	49.3	61.3	92	27	3.55	.79	6.21	5	.0
November----	58.1	36.7	47.4	78	13	2.26	.43	4.11	4	1.3
December----	47.2	28.0	37.6	70	0	1.79	.97	2.68	3	2.4
Year------	69.8	47.3	58.6	107	-4	38.50	30.81	45.62	59	11.7

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--	Mar. 30	Apr. 11	Apr. 21
2 years in 10 later than--	Mar. 25	Apr. 6	Apr. 16
5 years in 10 later than--	Mar. 16	Mar. 27	Apr. 6
First freezing temperature in fall:			
1 year in 10 earlier than--	Nov. 6	Oct. 23	Oct. 15
2 years in 10 earlier than--	Nov. 10	Oct. 28	Oct. 19
5 years in 10 earlier than--	Nov. 20	Nov. 6	Oct. 29

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	225	204	184
8 years in 10	233	211	191
5 years in 10	249	224	206
2 years in 10	264	236	220
1 year in 10	272	243	227

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Ae	Apperson silty clay loam, 1 to 3 percent slopes	37,709	9.0
Be	Bates loam, 1 to 3 percent slopes	11,195	2.7
Bf	Bates loam, 3 to 7 percent slopes	4,365	1.0
Bm	Bates-Collinsville complex, 4 to 15 percent slopes	6,050	1.4
Bo	Bolivar-Hector fine sandy loams, 4 to 20 percent slopes	4,140	1.0
Br	Brazilton silty clay loam, 1 to 4 percent slopes	550	0.1
Cd	Catoosa silt loam, 0 to 2 percent slopes	32,970	7.9
Ch	Cherokee silt loam, 0 to 1 percent slopes	17,120	4.1
De	Dennis silt loam, 1 to 3 percent slopes	42,510	10.2
Ef	Eram silty clay loam, 1 to 3 percent slopes	16,660	4.0
Eh	Eram silty clay loam, 3 to 7 percent slopes	13,660	3.3
Eo	Eram-Lebo silty clay loams, 4 to 20 percent slopes	3,410	0.8
Es	Eram-Nowata complex, 2 to 7 percent slopes	2,860	0.7
He	Hepler silt loam, occasionally flooded	11,290	2.7
Ka	Kanima shaly silty clay loam, 3 to 7 percent slopes	150	*
Kb	Kanima shaly silty clay loam, 10 to 30 percent slopes	310	0.1
Ke	Kenoma silt loam, 1 to 3 percent slopes	40,925	9.8
Ln	Lanton silt loam, occasionally flooded	20,220	4.8
Od	Olpe-Dennis silt loams, 3 to 7 percent slopes	2,350	0.6
Or	Orthents, clayey	3,000	0.7
Os	Osage silty clay, occasionally flooded	10,400	2.5
Pe	Parsons silt loam, 0 to 2 percent slopes	51,925	12.4
Pt	Pits, quarries	630	0.2
Sd	Shidler-Catoosa silt loams, 1 to 8 percent slopes	26,235	6.3
Vc	Verdigris silt loam, frequently flooded	13,080	3.1
Vf	Verdigris silt loam, occasionally flooded	8,180	2.0
Zb	Zaar silty clay, 0 to 2 percent slopes	34,440	8.2
	Water	1,650	0.4
	Total	417,984	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, 1 to 3 percent slopes
Be	Bates loam, 1 to 3 percent slopes
Bf	Bates loam, 3 to 7 percent slopes
Br	Brazilton silty clay loam, 1 to 4 percent slopes
Cd	Catoosa silt loam, 0 to 2 percent slopes
Ch	Cherokee silt loam, 0 to 1 percent slopes
De	Dennis silt loam, 1 to 3 percent slopes
Ef	Eram silty clay loam, 1 to 3 percent slopes
He	Hepler silt loam, occasionally flooded (where drained)
Ke	Kenoma silt loam, 1 to 3 percent slopes
Ln	Lanton silt loam, occasionally flooded (where drained)
Os	Osage silty clay, occasionally flooded (where drained)
Pe	Parsons silt loam, 0 to 2 percent slopes
Vf	Verdigris silt loam, occasionally flooded
Zb	Zaar silty clay, 0 to 2 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	Winter wheat	Grain sorghum	Soybeans	Tall fescue
		Bu	Bu	Bu	AUM*
Ae------------------------ Apperson	IIe	37	62	25	4.0
Be------------------------ Bates	IIe	34	58	23	4.0
Bf------------------------ Bates	IIIe	31	52	19	4.0
Bm------------------------ Bates-Collinsville	VIe	---	---	---	2.5
Bo------------------------ Bolivar-Hector	VIe	---	---	---	2.5
Br------------------------ Brazilton	IIIe	33	56	24	3.0
Cd------------------------ Catoosa	IIe	40	63	26	4.0
Ch------------------------ Cherokee	IIs	34	58	27	4.5
De------------------------ Dennis	IIe	38	67	26	4.5
Ef------------------------ Eram	IIIe	31	52	22	3.0
Eh------------------------ Eram	IVe	28	47	20	3.0
Eo------------------------ Eram-Lebo	VIe	---	---	---	3.0
Es------------------------ Eram-Nowata	IVe	30	50	20	4.6
He------------------------ Hepler	IIw	38	66	30	5.5
Ka------------------------ Kanima	VIs	---	---	---	---
Kb------------------------ Kanima	VIIs	---	---	---	---
Ke------------------------ Kenoma	IIIe	35	58	25	4.0
Ln------------------------ Lanton	IIw	39	64	30	5.5
Od------------------------ Olpe-Dennis	IVe	30	52	21	3.5

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	Winter wheat	Grain sorghum	Soybeans	Tall fescue
		Bu	Bu	Bu	AUM*
Or------------------------ Orthents	IVe	---	---	---	---
Os------------------------ Osage	IIIw	25	51	19	4.0
Pe------------------------ Parsons	IIs	34	58	25	4.5
Pt**. Pits					
Sd------------------------ Shidler-Catoosa	VIe	---	---	---	---
Vc------------------------ Verdigris	Vw	---	---	---	5.5
Vf------------------------ Verdigris	IIw	41	72	31	5.5
Zb------------------------ Zaar	IIIw	31	53	24	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 AND CHARACTERISTIC PLANT COMMUNITIES

(Only the soils that support rangeland vegetation suitable for grazing are listed)

Soil name and map symbol	Range site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Ae: Apperson	Loamy Upland	Favorable	6,500	Big bluestem	35
		Normal	5,000	Little bluestem	25
		Unfavorable	4,000	Switchgrass	10
				Indiangrass	10
				Eastern gamagrass	5
Be, Bf: Bates	Loamy Upland	Favorable	7,000	Big bluestem	35
		Normal	5,500	Little bluestem	25
		Unfavorable	4,500	Indiangrass	10
				Switchgrass	10
				Eastern gamagrass	5
Bm*:					
Bates	Loamy Upland	Favorable	7,000	Big bluestem	35
		Normal	5,500	Little bluestem	25
		Unfavorable	4,000	Indiangrass	10
				Switchgrass	10
				Eastern gamagrass	5
Collinsville	Shallow Sandstone	Favorable	4,000	Little bluestem	30
		Normal	3,000	Big bluestem	15
		Unfavorable	2,000	Indiangrass	10
				Switchgrass	10
				Sideoats grama	10
				Tall dropseed	5
Bo*:					
Bolivar	Savannah	Favorable	5,500	Big bluestem	25
		Normal	3,500	Little bluestem	20
		Unfavorable	2,500	Blackjack oak	15
				Indiangrass	10
				Switchgrass	5
Hector	Shallow Savannah	Favorable	3,500	Little bluestem	45
		Normal	2,500	Blackjack oak	20
		Unfavorable	1,500	Indiangrass	15
				Big bluestem	8
				Switchgrass	5
Cd: Catoosa	Loamy Upland	Favorable	6,500	Little bluestem	25
		Normal	5,000	Big bluestem	25
		Unfavorable	4,000	Indiangrass	10
				Switchgrass	10
				Sideoats grama	5
				Tall dropseed	5
Ch: Cherokee	Clay Upland	Favorable	6,000	Big bluestem	35
		Normal	4,500	Little bluestem	20
		Unfavorable	3,000	Indiangrass	15
				Switchgrass	10
				Tall dropseed	5
				Eastern gamagrass	5
De: Dennis	Loamy Upland	Favorable	7,000	Big bluestem	35
		Normal	5,500	Little bluestem	25
		Unfavorable	4,000	Switchgrass	10
				Eastern gamagrass	10
				Indiangrass	5

See footnote at end of table.

TABLE 7.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Ef, Eh: Eram	Clay Upland	Favorable	6,000	Big bluestem	25
		Normal	4,000	Little bluestem	25
		Unfavorable	3,000	Switchgrass	15
				Indiangrass	10
				Sideoats grama	5
Eo*:					
Eram	Clay Upland	Favorable	6,000	Big bluestem	30
		Normal	4,000	Little bluestem	15
		Unfavorable	3,000	Switchgrass	15
				Indiangrass	10
				Sideoats grama	5
Lebo	Loamy Upland	Favorable	6,000	Big bluestem	25
		Normal	5,000	Little bluestem	20
		Unfavorable	3,500	Indiangrass	15
				Switchgrass	5
Es*:					
Eram	Clay Upland	Favorable	6,000	Big bluestem	25
		Normal	4,000	Little bluestem	25
		Unfavorable	3,000	Switchgrass	15
				Indiangrass	10
				Sideoats grama	5
Nowata	Loamy Upland	Favorable	5,000	Little bluestem	25
		Normal	3,500	Big bluestem	20
		Unfavorable	2,000	Indiangrass	10
				Switchgrass	10
				Scribner panicum	5
He: Hepler	Loamy Lowland	Favorable	10,000	Big bluestem	30
		Normal	8,000	Indiangrass	15
		Unfavorable	6,000	Eastern gamagrass	15
				Switchgrass	10
				Prairie cordgrass	5
Ke: Kenoma	Clay Upland	Favorable	6,000	Big bluestem	25
		Normal	4,500	Little bluestem	20
		Unfavorable	3,000	Indiangrass	15
				Switchgrass	15
				Tall dropseed	5
				Sideoats grama	5
				Eastern gamagrass	5
Ln: Lanton	Loamy Lowland	Favorable	10,000	Big bluestem	30
		Normal	8,000	Eastern gamagrass	15
		Unfavorable	6,000	Indiangrass	15
				Switchgrass	10
				Prairie cordgrass	5
Od*:					
Olpe	Loamy Upland	Favorable	6,000	Big bluestem	35
		Normal	4,500	Little bluestem	20
		Unfavorable	3,000	Indiangrass	10
				Switchgrass	10
				Sideoats grama	5

See footnote at end of table.

TABLE 7.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Od*:					
Dennis	Loamy Upland	Favorable	7,000	Big bluestem	35
		Normal	5,500	Little bluestem	25
		Unfavorable	4,000	Switchgrass	10
				Indiangrass	10
				Eastern gamagrass	5
Os Osage	Clay Lowland	Favorable	9,000	Prairie cordgrass	40
		Normal	8,000	Switchgrass	15
		Unfavorable	6,000	Big bluestem	10
				Indiangrass	5
				Eastern gamagrass	5
Pe Parsons	Clay Upland	Favorable	6,000	Big bluestem	35
		Normal	4,500	Little bluestem	20
		Unfavorable	3,000	Indiangrass	15
				Switchgrass	10
				Tall dropseed	5
				Eastern gamagrass	5
Sd*:					
Shidler	Shallow Limy	Favorable	3,000	Sideoats grama	30
		Normal	2,000	Little bluestem	15
		Unfavorable	1,000	Big bluestem	15
				Indiangrass	10
				Hairy grama	5
Catoosa	Loamy Upland	Favorable	6,500	Little bluestem	25
		Normal	5,000	Big bluestem	25
		Unfavorable	4,000	Indiangrass	10
				Switchgrass	10
				Sideoats grama	5
				Tall dropseed	5
Vc, Vf Verdigris	Loamy Lowland	Favorable	10,000	Big bluestem	35
		Normal	8,000	Indiangrass	15
		Unfavorable	6,000	Eastern gamagrass	15
				Switchgrass	10
				Prairie cordgrass	5
Zb Zaar	Clay Upland	Favorable	6,000	Big bluestem	30
		Normal	4,500	Little bluestem	25
		Unfavorable	2,500	Indiangrass	15
				Switchgrass	10
				Tall dropseed	5
				Eastern gamagrass	5

* 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
Bo**:									
Bolivar	2A	Slight	Slight	Slight	Slight	Post oak	35	22	Bitternut hickory, hackberry, Shumard oak, black oak, green ash, loblolly pine.
						Blackjack oak	---	---	
						Bitternut hickory	---	---	
						Black oak	57	40	
Hector	2D	Slight	Slight	Moderate	Slight	Post oak	34	21	Black oak, loblolly pine, eastern redcedar, bitternut hickory.
						Bitternut hickory	---	---	
						Black oak	50	34	
						Blackjack oak	---	---	
Eo**:									
Eram.									
Lebo	2F	Slight	Slight	Moderate	Slight	Bur oak	50	34	Bur oak, green ash, hackberry.
						Shagbark hickory	---	---	
						Green ash	---	---	
						Chinkapin oak	---	---	
						Hackberry	---	---	
He Hepler	5W	Slight	Moderate	Slight	Moderate	Eastern cottonwood	79	76	Pecan, green ash, eastern cottonwood, hackberry, black walnut, bur oak.
						Northern red oak	67	49	
						Hackberry	76	75	
						Green ash	73	70	
						Pecan	---	---	
						Black walnut	---	---	
Ln Lanton	6W	Slight	Moderate	Moderate	Moderate	Eastern cottonwood	85	91	Pecan, black walnut, green ash, hackberry, eastern cottonwood.
						Green ash	71	67	
						Hackberry	70	66	
						Pecan	---	---	
Os Osage	4W	Slight	Moderate	Severe	Severe	Pecan	61	53	Pecan, bur oak, hackberry, green ash.
						Eastern cottonwood	80	78	
						Bur oak	55	38	
						Shellbark hickory	---	---	
Vc, Vf Verdigris	4A	Slight	Slight	Slight	Moderate	Black walnut	69	64	Eastern cottonwood, black walnut, green ash, pecan, hackberry, bur oak.
						Eastern cottonwood	87	95	
						Shagbark hickory	---	---	
						Hackberry	69	64	
						Silver maple	---	---	
						Green ash	69	64	
						Bur oak	55	38	

* Volume 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.	---
Be, Bf: Bates	Lilac, Peking cotoneaster, Amur honeysuckle, fragrant sumac.	---	Eastern redcedar, green ash, Austrian pine, bur oak, hackberry, Russian olive.	Siberian elm, honeylocust.	---
Bm*:					
Bates	Lilac, Peking cotoneaster, Amur honeysuckle, fragrant sumac.	---	Eastern redcedar, green ash, Austrian pine, bur oak, hackberry, Russian olive.	Siberian elm, honeylocust.	---
Collinsville.					
Bo*:					
Bolivar	Amur honeysuckle, lilac, fragrant sumac.	Autumn olive	Green ash, hackberry, bur oak, Russian olive, Austrian pine, eastern redcedar.	Siberian elm, honeylocust.	---
Hector.					
Br: Brazilton	Lilac, Peking cotoneaster.	Siberian peashrub, Manchurian crabapple, Amur honeysuckle.	Eastern redcedar, hackberry, Russian olive, Austrian pine, green ash.	Honeylocust, Siberian elm.	---
Cd: Catoosa	Amur honeysuckle, fragrant sumac, Peking cotoneaster, lilac.	---	Bur oak, Russian olive, hackberry, eastern redcedar, green ash, Austrian pine.	Honeylocust, Siberian elm.	---
Ch: Cherokee	Peking cotoneaster, lilac.	Amur honeysuckle, Siberian peashrub, Manchurian crabapple.	Green ash, hackberry, Austrian pine, eastern redcedar, Russian olive.	Honeylocust, Siberian elm.	---
De: Dennis	American plum, fragrant sumac, Peking cotoneaster, lilac.	Autumn olive	Russian mulberry, hackberry, eastern redcedar, green ash.	Honeylocust, Austrian pine, Scotch pine.	---

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
Ef, Eh: Eram	Lilac, Peking cotoneaster.	Manchurian crabapple, Amur honeysuckle, Siberian peashrub.	Eastern redcedar, hackberry, green ash, Austrian pine, Russian olive.	Siberian elm, honeylocust.	---
Eo*:					
Eram	Lilac, Peking cotoneaster.	Manchurian crabapple, Amur honeysuckle, Siberian peashrub.	Eastern redcedar, hackberry, green ash, Austrian pine, Russian olive.	Siberian elm, honeylocust.	---
Lebo	Amur honeysuckle, fragrant sumac, lilac, Peking cotoneaster.	---	Eastern redcedar, Russian olive, green ash, bur oak, Austrian pine, hackberry.	Siberian elm, honeylocust.	---
Es*:					
Eram	Lilac, Peking cotoneaster.	Manchurian crabapple, Amur honeysuckle, Siberian peashrub.	Eastern redcedar, hackberry, green ash, Austrian pine, Russian olive.	Siberian elm, honeylocust.	---
Nowata	Lilac, fragrant sumac, Peking cotoneaster.	Autumn olive	Bur oak, Russian olive, Austrian pine, eastern redcedar, hackberry, green ash.	Honeylocust, Siberian elm.	---
He: Hepler	---	Peking cotoneaster, Amur honeysuckle, lilac, American plum.	Eastern redcedar	Austrian pine, eastern white pine, honeylocust, hackberry, green ash, bur oak.	Eastern cottonwood.
Ka, Kb. Kanima					
Ke: Kenoma	Peking cotoneaster, lilac, fragrant sumac.	Amur honeysuckle, Manchurian crabapple.	Green ash, hackberry, Austrian pine, Russian olive, eastern redcedar.	Siberian elm, honeylocust.	---
Ln: Lanton	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Northern red oak, green ash, Austrian pine, honeylocust, silver maple, golden willow.	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
Od*:					
Olpe	Fragrant sumac, Amur honeysuckle, lilac.	Autumn olive	Bur oak, eastern redcedar, Russian olive, hackberry, Austrian pine, green ash, honeylocust.	Siberian elm	---
Dennis	American plum, fragrant sumac, Peking cotoneaster, lilac.	Autumn olive	Russian mulberry, hackberry, eastern redcedar, green ash.	Honeylocust, Austrian pine, Scotch pine.	---
Or. Orthents					
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.
Pe Parsons	Peking cotoneaster, lilac.	Amur honeysuckle, Siberian peashrub, Manchurian crabapple.	Eastern redcedar, Austrian pine, green ash, Russian olive, hackberry.	Honeylocust, Siberian elm.	---
Pt*. Pits					
Sd*: Shidler.					
Catoosa	Amur honeysuckle, fragrant sumac, Peking cotoneaster, lilac.	---	Bur oak, Russian olive, hackberry, eastern redcedar, green ash, Austrian pine.	Honeylocust, Siberian elm.	---
Vc, Vf Verdigris	Fragrant sumac	Lilac, autumn olive, American plum.	Eastern redcedar	Austrian pine, green ash, hackberry, pin oak, honeylocust, eastern white pine.	Eastern cottonwood.
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: slope, wetness, percs slowly.	Slight.
Be, Bf Bates	Slight	Slight	Moderate: slope, small stones, thin layer.	Slight.
Bm*:				
Bates	Slight	Slight	Severe: slope.	Slight.
Collinsville	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Slight.
Bo*:				
Bolivar	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Hector	Severe: thin layer, area reclaim.	Severe: thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Slight.
Br Brazilton	Severe: percs slowly.	Severe: percs slowly.	Severe: percs slowly.	Slight.
Cd Catoosa	Slight	Slight	Moderate: slope, thin layer, area reclaim.	Slight.
Ch Cherokee	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.
De Dennis	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Slight.
Ef, Eh Eram	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
Eo*:				
Eram	Severe: wetness.	Moderate: slope, wetness.	Severe: slope, wetness.	Severe: erodes easily.
Lebo	Moderate: slope.	Moderate: slope.	Severe: slope.	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
Es*:				
Eram	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
Nowata	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, small stones, thin layer.	Slight.
He. Hepler	Severe: flooding, wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.
Ka. Kanima	Moderate: small stones.	Moderate: small stones.	Severe: small stones.	Slight.
Kb. Kanima	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Moderate: slope.
Ke. Kenoma	Severe: percs slowly.	Severe: percs slowly.	Severe: percs slowly.	Slight.
Ln. Lanton	Severe: flooding, wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.
Od*:				
Olpe	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, small stones.	Slight.
Dennis	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Slight.
Or. Orthents				
Os. Osage	Severe: flooding, wetness, percs slowly.	Severe: wetness, too clayey, percs slowly.	Severe: too clayey, wetness.	Severe: wetness, too clayey.
Pe. Parsons	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.
Pt*. Pits				
Sd*:				
Shidler	Severe: thin layer, area reclaim.	Severe: thin layer, area reclaim.	Severe: thin layer, area reclaim.	Slight.
Catoosa	Slight	Slight	Moderate: slope, thin layer, area reclaim.	Severe: erodes easily.

See footnote at end of table.

TABLE 10.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Vc: Verdigris	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.
Vf: Verdigris	Severe: flooding.	Slight	Moderate: flooding.	Slight.
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	---
Be, Bf------------- Bates	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Bm*:												
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.	---
Bo*:												
Bolivar-----------	Fair	Good	Good	Good	Good	---	Very poor.	Very poor.	Good	Good	Very poor.	---
Hector------------	Very poor.	Poor	Poor	Poor	Very poor.	---	Very poor.	Very poor.	Poor	Poor	Very poor.	---
Br----------------- Brazilton	Fair	Good	Fair	Fair	Fair	Fair	Poor	Poor	Fair	Fair	Poor	Fair.
Cd----------------- Catoosa	Fair	Good	Good	Good	Good	---	Poor	Very poor.	Good	Good	Very poor.	---
Ch----------------- Cherokee	Fair	Good	Fair	Fair	Fair	Fair	Fair	Fair	Fair	---	Fair	Fair.
De----------------- Dennis	Good	Good	Good	Good	Good	---	Poor	Poor	Good	Good	Poor	---
Ef----------------- Eram	Good	Good	Good	Good	Good	---	Poor	Very poor.	Good	Good	Very poor.	---
Eh----------------- Eram	Fair	Good	Good	Good	Good	---	Very poor.	Very poor.	Good	Good	Very poor.	---
Eo*:												
Eram--------------	Fair	Good	Good	Good	Good	---	Very poor.	Very poor.	Good	Good	Very poor.	---
Lebo--------------	Poor	Poor	Good	Good	Good	---	Very poor.	Very poor.	Fair	Good	Very poor.	---
Es*:												
Eram--------------	Good	Good	Good	Good	Good	---	Poor	Very poor.	Good	Good	Very poor.	---
Nowata------------	Fair	Good	Good	Good	Good	Fair	Poor	Very poor.	Good	Good	Very poor.	Fair.
He----------------- Hepler	Fair	Good	Good	Good	Good	Good	Good	Fair	Good	Good	Fair	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
Ka, Kb: Kanima	Poor	Fair	Fair	Fair	Poor	---	Very poor.	Very poor.	Fair	Fair	Very poor.	---
Ke: Kenoma	Good	Good	Fair	Fair	Fair	Fair	Poor	Fair	Good	Fair	Poor	Fair.
Ln: Lanton	Fair	Good	Fair	Good	Good	Good	Fair	Good	Fair	Good	Fair	---
Od*:												
Olpe	Good	Good	Good	Fair	Fair	Good	Poor	Very poor.	Good	Fair	Very poor.	Good.
Dennis	Good	Good	Good	Good	Good	---	Poor	Very poor.	Good	Good	Very poor.	---
Or. Orthents												
Os: Osage	Fair	Fair	Fair	Fair	Fair	---	Poor	Good	Fair	Fair	Fair	---
Pe: Parsons	Fair	Good	Good	Good	Good	---	Fair	Fair	Good	Good	Fair	---
Pt*. Pits												
Sd*:												
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.	---
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.
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.
Be----------------- Bates	Slight-----------	Slight-----------	Slight-----------	Slight-------------	Slight.
Bf----------------- Bates	Slight-----------	Slight-----------	Slight-----------	Moderate: slope.	Slight.
Bm*:					
Bates--------------	Slight-----------	Slight-----------	Slight-----------	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.
Bo*:					
Bolivar------------	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell, depth to rock.	Severe: slope.	Moderate: low strength, slope, shrink-swell.
Hector-------------	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.
Br----------------- Brazilton	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Cd----------------- 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.
Ch----------------- Cherokee	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.
De----------------- Dennis	Moderate: too clayey, wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Ef, Eh------------- Eram	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell, wetness.	Severe: low strength, shrink-swell.
Eo*:					
Eram---------------	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell, slope, wetness.	Severe: low strength, shrink-swell.

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
Eo*:					
Lebo	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.
Es*:					
Eram	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell, wetness.	Severe: low strength, shrink-swell.
Nowata	Severe: depth to rock.	Moderate: shrink-swell, depth to rock, large stones.	Severe: depth to rock.	Moderate: shrink-swell, slope, depth to rock.	Moderate: depth to rock, shrink-swell, large stones.
He. Hepler	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding.
Ka. Kanima	Slight	Slight	Slight	Moderate: slope.	Slight.
Kb. Kanima	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Ke. Kenoma	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Ln. Lanton	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding.
Od*:					
Olpe	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell.
Dennis	Moderate: too clayey, wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Or. Orthents					
Os. Osage	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, wetness, flooding.
Pe. Parsons	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, wetness, shrink-swell.
Pt*. Pits					
Sd*:					
Shidler	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: 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
Sd*:					
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.
Vc, Vf Verdigris	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
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.	Moderate: depth to rock, slope, seepage.	Severe: depth to rock, wetness, seepage.	Moderate: wetness.	Poor: too clayey, hard to pack.
Be, Bf: Bates	Severe: thin layer, seepage.	Severe: seepage.	Severe: seepage.	Moderate: seepage.	Poor: area reclaim, thin layer.
Bm*:					
Bates	Severe: thin layer, seepage.	Severe: seepage.	Severe: seepage.	Moderate: seepage.	Poor: area reclaim, thin layer.
Collinsville	Severe: thin layer, seepage.	Severe: depth to rock, slope, seepage.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: area reclaim, thin layer.
Bo*:					
Bolivar	Severe: thin layer, seepage.	Severe: seepage, slope.	Severe: seepage.	Moderate: seepage, slope.	Poor: area reclaim, thin layer.
Hector	Severe: thin layer, seepage.	Severe: seepage, depth to rock, slope.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: area reclaim, small stones, thin layer.
Br: Brazilton	Severe: percs slowly.	Moderate: seepage, slope.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
Cd: Catoosa	Severe: thin layer, seepage.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Moderate: seepage.	Poor: area reclaim, thin layer.
Ch: Cherokee	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
De: Dennis	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
Ef, Eh: Eram	Severe: thin layer, wetness, percs slowly.	Severe: seepage.	Severe: seepage, wetness, too clayey.	Severe: wetness.	Poor: area reclaim, too clayey, 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
Eo*:					
Eram	Severe: thin layer, wetness, percs slowly.	Severe: seepage, slope.	Severe: seepage, wetness, too clayey.	Severe: wetness.	Poor: area reclaim, too clayey, hard to pack.
Lebo	Severe: thin layer, seepage.	Severe: seepage, slope.	Severe: seepage.	Moderate: seepage, slope.	Poor: area reclaim, thin layer.
Es*:					
Eram	Severe: thin layer, wetness, percs slowly.	Severe: seepage.	Severe: seepage, wetness, too clayey.	Severe: wetness.	Poor: area reclaim, too clayey, hard to pack.
Nowata	Severe: thin layer, seepage, percs slowly.	Severe: seepage, depth to rock.	Severe: seepage, large stones.	Moderate: seepage.	Poor: area reclaim, small stones.
He: Hepler	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, wetness.
Ka: Kanima	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Poor: small stones.
Kb: Kanima	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: small stones, slope.
Ke: Kenoma	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
Ln: Lanton	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
Od*:					
Olpe	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, small stones.
Dennis	Severe: percs slowly, wetness.	Severe: wetness.	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
Or. Orthents					
Os: Osage	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.

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
Pe------------------ Parsons	Severe: wetness, percs slowly.	Slight-----------	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
Pt*. Pits					
Sd*:					
Shidler------------	Severe: thin layer, seepage.	Severe: seepage.	Severe: depth to rock, seepage.	Severe: seepage.	Poor: area reclaim.
Catoosa------------	Severe: thin layer, seepage.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Moderate: seepage.	Poor: area reclaim, thin layer.
Vc, Vf-------------- Verdigris	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
Zb------------------ Zaar	Severe: wetness, percs slowly.	Slight-----------	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.
Be, Bf---------------- Bates	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones.
Bm*:				
Bates----------------	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones.
Collinsville---------	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: large stones, area reclaim.
Bo*:				
Bolivar--------------	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones, thin layer.
Hector---------------	Poor: area reclaim, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.
Br-------------------- Brazilton	Good-----------------	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.
Cd-------------------- Catoosa	Poor: area reclaim, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, thin layer, too clayey.
Ch-------------------- Cherokee	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
De-------------------- Dennis	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, thin layer.
Ef, Eh---------------- Eram	Poor: depth to rock, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
Eo*:				
Eram-----------------	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.

See footnote at end of table.

TABLE 14.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Eo*:				
Lebo	Poor: area reclaim, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Es*:				
Eram	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
Nowata	Poor: area reclaim.	Improbable: excess fines, large stones.	Improbable: excess fines, large stones.	Poor: small stones.
He Hepler	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
Ka Kanima	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim.
Kb Kanima	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim, slope.
Ke Kenoma	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Ln Lanton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, thin layer.
Od*:				
Olpe	Fair: shrink-swell, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, small stones, area reclaim.
Dennis	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, thin layer.
Or. Orthents				
Os Osage	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, too clayey.
Pe Parsons	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
Pt*. Pits				

See footnote at end of table.

TABLE 14.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Sd*:				
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.
Vc, Vf Verdigris	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
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-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
Ae: Apperson	Moderate: depth to rock, seepage.	Severe: hard to pack.	Percs slowly	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Erodes easily, percs slowly.
Be: Bates	Moderate: seepage.	Severe: thin layer.	Deep to water	Thin layer	Area reclaim	Area reclaim.
Bf: Bates	Moderate: seepage, slope.	Severe: thin layer.	Deep to water	Thin layer, slope.	Area reclaim	Area reclaim.
Bm*:						
Bates	Moderate: seepage, slope.	Severe: thin layer.	Deep to water	Thin layer, slope.	Area reclaim	Area reclaim.
Collinsville	Severe: depth to rock, slope, seepage.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Slope, area reclaim, large stones.	Slope, depth to rock, area reclaim, large stones.
Bo*:						
Bolivar	Severe: slope.	Severe: thin layer.	Deep to water	Slope, soil blowing, thin layer.	Slope, area reclaim, soil blowing.	Slope, area reclaim.
Hector	Severe: depth to rock, seepage.	Severe: thin layer, piping.	Deep to water	Droughty, thin layer, slope.	Slope, depth to rock, area reclaim.	Slope, droughty, depth to rock.
Br: Brazilton	Moderate: seepage.	Moderate: hard to pack.	Deep to water	Percs slowly	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Cd: Catoosa	Moderate: seepage, depth to rock.	Severe: thin layer.	Deep to water	Thin layer, rooting depth.	Depth to rock, area reclaim, erodes easily.	Erodes easily, depth to rock, area reclaim.
Ch: Cherokee	Slight	Severe: hard to pack, wetness.	Percs slowly	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
De: 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.
Ef: Eram	Moderate: seepage.	Severe: thin layer.	Percs slowly, thin layer.	Percs slowly, erodes easily, thin layer.	Area reclaim, erodes easily, wetness.	Wetness, erodes easily, area reclaim.
Eh: Eram	Moderate: seepage, slope.	Severe: thin layer.	Percs slowly, thin layer, slope.	Percs slowly, thin layer, slope.	Area reclaim, erodes easily, wetness.	Wetness, erodes easily, area reclaim.

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
Eo*:						
Eram	Severe: slope.	Severe: thin layer.	Percs slowly, thin layer, slope.	Percs slowly, thin layer, slope.	Slope, area reclaim, erodes easily.	Wetness, slope, erodes easily.
Lebo	Severe: slope.	Moderate: thin layer.	Deep to water	Slope, thin layer.	Slope, area reclaim.	Slope, area reclaim.
Es*:						
Eram	Moderate: seepage, slope.	Severe: thin layer.	Percs slowly, thin layer, slope.	Percs slowly, thin layer, slope.	Area reclaim, erodes easily, wetness.	Wetness, erodes easily, area reclaim.
Nowata	Moderate: depth to rock, seepage, slope.	Severe: large stones.	Deep to water	Large stones, thin layer, rooting depth.	Large stones, depth to rock, area reclaim.	Large stones, erodes easily, area reclaim.
He: Hepler	Moderate: seepage.	Severe: wetness.	Flooding	Wetness, erodes easily, flooding.	Erodes easily, wetness.	Wetness, erodes easily.
Ka: Kanima	Moderate: seepage, slope.	Slight	Deep to water	Droughty, slope.	Favorable	Droughty.
Kb: Kanima	Severe: slope.	Slight	Deep to water	Droughty, slope.	Slope	Slope, droughty.
Ke: Kenoma	Slight	Severe: hard to pack.	Deep to water	Percs slowly, erodes easily.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Ln: Lanton	Slight	Moderate: piping, hard to pack, wetness.	Percs slowly, flooding.	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
Od*:						
Olpe	Moderate: slope.	Slight	Deep to water	Slope, droughty, percs slowly.	Erodes easily, percs slowly.	Erodes easily, droughty.
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.
Or. Orthents						
Os: Osage	Slight	Severe: hard to pack, wetness.	Percs slowly, flooding.	Wetness, droughty, slow intake.	Wetness, percs slowly.	Wetness, droughty, percs slowly.
Pe: Parsons	Slight	Severe: wetness.	Percs slowly	Percs slowly	Wetness, percs slowly.	Wetness, percs slowly.
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
Sd*:						
Shidler	Severe: depth to rock, seepage.	Severe: thin layer.	Deep to water	Thin layer, slope, erodes easily.	Depth to rock, area reclaim, erodes easily.	Erodes easily, depth to rock, area reclaim.
Catoosa	Moderate: seepage, depth to rock, slope.	Severe: thin layer.	Deep to water	Thin layer, rooting depth, slope.	Depth to rock, area reclaim, erodes easily.	Erodes easily, depth to rock, area reclaim.
Vc, Vf Verdigris	Moderate: seepage.	Moderate: piping.	Deep to water	Flooding	Favorable	Favorable.
Zb Zaar	Slight	Moderate: hard to pack, wetness.	Percs slowly	Wetness, slow intake.	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: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
Ae--------------- Apperson	0-7	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	75-98	33-44	12-20
	7-13	Silty clay loam, silty clay.	CL, CH	A-7	0	100	100	95-100	80-99	41-70	20-40
	13-49	Silty clay--------	CL, CH	A-7	0	85-100	83-100	80-100	75-99	41-70	20-40
	49	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Be, Bf----------- Bates	0-16	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-100	80-100	55-90	20-40	3-15
	16-30	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
	30	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Bm*:											
Bates-----------	0-16	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-100	80-100	55-90	20-40	3-15
	16-27	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
	27	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Collinsville----	0-8	Fine sandy loam	SM, ML, CL-ML, SM-SC	A-4, A-2	0-15	85-100	85-100	75-95	30-60	<26	NP-7
	8-13	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
	13	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Bo*:											
Bolivar---------	0-12	Fine sandy loam	ML, SM	A-4	0	100	90-100	70-95	40-55	20-30	NP-5
	12-27	Loam, sandy clay loam, clay loam.	CL, SC	A-6	0-10	85-100	85-100	70-95	45-80	25-40	10-25
	27-41	Weathered bedrock	---	---	---	---	---	---	---	---	---
	41	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Hector----------	0-8	Fine sandy loam	SM, ML, SM-SC, CL-ML	A-4, A-2	0	80-100	80-100	80-100	30-65	<30	NP-7
	8-15	Fine sandy loam, gravelly fine sandy loam, gravelly loam.	SM, ML, GM, GM-GC	A-4, A-2	0-15	55-100	55-100	45-100	30-65	<30	NP-7
	15	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Br--------------- Brazilton	0-15	Silty clay loam	CL	A-6, A-7	0-5	95-100	90-100	85-100	70-95	35-50	15-25
	15-42	Silty clay loam, silty clay, clay.	CL, CH	A-7	0-5	95-100	90-100	85-100	70-95	45-60	20-35
	42-60	Very shaly silty clay loam, very shaly silty clay.	GC, GP-GC	A-2-6, A-2-7	0-5	40-60	30-50	20-40	10-30	30-55	10-30

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	
Cd-------------- Catoosa	0-12	Silt loam--------	CL	A-4, A-6	0	100	100	96-100	65-97	30-37	8-14
	12-38	Silty clay loam, clay loam.	CL	A-6, A-7	0	85-100	85-100	85-100	70-98	33-48	12-22
	38	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ch-------------- Cherokee	0-13	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	90-100	80-95	20-35	5-15
	13-43	Clay, silty clay	CH, CL, MH	A-7	0	100	100	95-100	85-95	45-70	20-40
	43-60	Silty clay loam, clay, silty clay.	CH, CL	A-7, A-6	0	100	100	95-100	85-95	35-70	15-40
De-------------- Dennis	0-10	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	96-100	65-97	20-37	1-15
	10-15	Silty clay loam, clay loam.	CL	A-6, A-7	0	98-100	98-100	94-100	75-98	33-48	13-25
	15-60	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
Ef, Eh----------- Eram	0-8	Silty clay loam	CL	A-6, A-7	0	85-100	85-100	85-100	70-95	33-48	12-25
	8-26	Clay, silty clay, clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	90-100	80-98	37-65	15-35
	26	Weathered bedrock	---	---	---	---	---	---	---	---	---
Eo*:											
Eram------------	0-7	Silty clay loam	CL	A-6, A-7	0	85-100	85-100	85-100	70-95	33-48	12-25
	7-28	Clay, silty clay, clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	90-100	80-98	37-65	15-35
	28	Weathered bedrock	---	---	---	---	---	---	---	---	---
Lebo------------	0-15	Silty clay loam	CL	A-6, A-7-6	0-5	95-100	90-100	90-100	80-95	35-50	15-25
	15-22	Channery silty clay loam, shaly silty clay loam, silty clay loam.	CL	A-6, A-7-6	0-5	75-95	55-95	55-85	50-80	35-50	15-25
	22-32	Extremely shaly silty clay loam, very shaly silt loam.	SC, GC, GP-GC, SP-SC	A-2-7, A-2-6	0-5	50-75	10-50	5-40	5-35	35-50	15-25
	32	Weathered bedrock	---	---	---	---	---	---	---	---	---
Es*:											
Eram------------	0-7	Silty clay loam	CL	A-6, A-7	0	85-100	85-100	85-100	70-95	33-48	12-25
	7-28	Clay, silty clay, clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	90-100	80-98	37-65	15-35
	28	Weathered bedrock	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 16.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
Es*:											
Nowata	0-8	Silt loam	CL	A-4, A-6	0-15	85-100	80-100	75-95	70-95	30-37	8-13
	8-13	Gravelly silty clay loam, very cherty silty clay loam, cherty silty clay loam.	GC, GP-GC	A-2, A-6, A-7	0-65	15-50	10-50	10-45	5-40	33-42	12-19
	13-36	Gravelly silty clay loam, very cherty silty clay loam, cherty silty clay loam.	GC, GP-GC	A-2, A-6, A-7	0-65	15-50	10-50	10-45	5-40	37-50	15-25
	36	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
He Hepler	0-24	Silt loam	ML, CL, CL-ML	A-4, A-6	0	100	100	90-100	75-95	20-35	2-15
	24-44	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	85-95	35-50	15-25
	44-60	Silty clay loam, silty clay.	CL	A-6, A-7	0	100	100	95-100	85-95	35-50	15-30
Ka, Kb Kanima	0-6	Shaly silty clay loam.	CL, SC, GC	A-6	0-10	50-75	50-75	50-75	40-75	33-40	12-18
	6-60	Very shaly clay loam, very shaly silty clay loam, very shaly loam.	GC, GP-GC	A-2, A-4, A-6	0-10	25-50	25-50	5-50	5-49	30-40	8-18
Ke Kenoma	0-13	Silt loam	CL, CL-ML, ML	A-4, A-6	0	85-100	85-100	85-100	85-100	25-40	3-18
	13-39	Silty clay, clay	CH	A-7	0	85-100	85-100	85-100	85-100	50-75	30-48
	39-60	Silty clay, silty clay loam.	CL, CH	A-7	0	85-100	85-100	75-100	75-95	45-65	25-44
Ln Lanton	0-8	Silt loam	CL, ML	A-4, A-6	0	100	100	96-100	80-97	30-37	8-13
	8-37	Silty clay loam	CL	A-6, A-7	0	100	100	98-100	90-98	33-42	12-19
	37-60	Silty clay loam, silty clay, clay.	CL, CH	A-6, A-7	0	100	100	98-100	90-98	33-55	12-30
Od*:											
Olpe	0-7	Silt loam	CL	A-6, A-4	0	80-100	75-100	60-100	50-95	20-40	7-20
	7-30	Very gravelly silty clay loam, gravelly silt loam, extremely gravelly clay loam.	GC, CL, SC, CH	A-2, A-6, A-7	0	20-80	10-75	10-75	10-70	35-55	15-30
	30-44	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
	44-60	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: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
Od*:											
Dennis----------	0-10	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	96-100	65-97	20-37	1-15
	10-15	Silty clay loam, clay loam.	CL	A-6, A-7	0	98-100	98-100	94-100	75-98	33-48	13-25
	15-60	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
Or. Orthents											
Os--------------- Osage	0-17	Silty clay-------	CH	A-7	0	100	100	100	95-100	50-75	30-55
	17-60	Silty clay, clay, silty clay loam.	CH, CL	A-7	0	100	100	100	95-100	40-80	20-50
Pe--------------- Parsons	0-13	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	96-100	96-100	80-97	20-37	1-12
	13-60	Clay, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	100	96-100	96-100	80-99	37-70	15-40
Pt*. Pits											
Sd*:											
Shidler---------	0-12	Silt loam--------	CL	A-4, A-6	0-25	75-100	75-100	70-100	60-97	30-37	8-13
	12	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Catoosa---------	0-12	Silt loam--------	CL	A-4, A-6	0	100	100	96-100	65-97	30-37	8-14
	12-38	Silty clay loam, clay loam.	CL	A-6, A-7	0	85-100	85-100	85-100	70-98	33-48	12-22
	38	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Vc, Vf----------- Verdigris	0-34	Silt loam--------	CL, CL-ML, ML	A-4, A-6	0	100	100	95-100	65-100	22-35	2-13
	34-60	Silt loam, silty clay loam.	CL	A-4, A-6, A-7	0	100	100	95-100	80-100	30-45	8-23
Zb--------------- Zaar	0-17	Silty clay-------	CH	A-7	0	100	100	95-100	90-100	50-70	25-40
	17-54	Silty clay, clay	CH	A-7	0	100	100	95-100	90-100	50-70	25-40
	54-60	Silty clay, clay, silty clay loam.	CH, CL	A-7	0	100	100	95-100	90-100	40-65	15-40

* 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	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
Ae---------------- Apperson	0-7	27-35	1.30-1.60	0.2-0.6	0.16-0.20	5.6-7.3	<2	Moderate	0.37	4	7	1-3
	7-13	35-45	1.35-1.70	0.2-0.6	0.16-0.20	5.6-7.8	<2	High------	0.37			
	13-49	40-60	1.35-1.60	0.06-0.2	0.14-0.18	6.1-7.8	<2	High------	0.32			
	49	---	---	---	---	---	---	----------	----			
Be, Bf----------- Bates	0-16	15-27	1.40-1.50	0.6-2.0	0.20-0.24	5.1-6.5	<2	Low-------	0.28	4	6	1-4
	16-30	18-35	1.50-1.60	0.6-2.0	0.15-0.19	5.1-6.5	<2	Low-------	0.28			
	30	---	---	---	---	---	---	----------	----			
Bm*:												
Bates-----------	0-16	15-27	1.40-1.50	0.6-2.0	0.20-0.24	5.1-6.5	<2	Low-------	0.28	4	6	1-4
	16-27	18-35	1.50-1.60	0.6-2.0	0.15-0.19	5.1-6.5	<2	Low-------	0.28			
	27	---	---	---	---	---	---	----------	----			
Collinsville----	0-8	5-20	1.30-1.60	2.0-6.0	0.09-0.15	5.1-6.5	<2	Low-------	0.20	2	3	1-3
	8-13	5-20	1.40-1.70	2.0-6.0	0.07-0.20	5.1-6.5	<2	Low-------	0.20			
	13	---	---	---	---	---	---	----------	----			
Bo*:												
Bolivar---------	0-12	12-18	1.20-1.45	2.0-6.0	0.16-0.18	5.1-6.0	<2	Low-------	0.24	4	3	.5-2
	12-27	20-35	1.30-1.50	0.6-2.0	0.12-0.16	4.5-6.0	<2	Moderate	0.32			
	27-41	---	---	---	---	---	---	----------	----			
	41	---	---	---	---	---	---	----------	----			
Hector----------	0-8	5-20	1.30-1.60	2.0-6.0	0.10-0.14	5.1-6.5	<2	Low-------	0.24	2	3	.5-2
	8-15	10-25	1.30-1.60	2.0-6.0	0.08-0.15	4.5-5.5	<2	Low-------	0.17			
	15	---	---	---	---	---	---	----------	----			
Br--------------- Brazilton	0-15	28-40	1.40-1.60	0.06-0.2	0.15-0.18	5.1-7.3	<2	Moderate	0.43	4	7	1-4
	15-42	35-55	1.50-1.70	<0.06	0.10-0.15	5.1-7.3	<2	High------	0.28			
	42-60	28-45	1.45-1.65	0.6-2.0	0.02-0.05	5.1-8.4	<4	Low-------	0.28			
Cd--------------- Catoosa	0-12	15-26	1.30-1.55	0.6-2.0	0.15-0.24	5.6-7.3	<2	Low-------	0.32	4	6	1-3
	12-38	27-39	1.45-1.70	0.6-2.0	0.15-0.22	5.1-7.3	<2	Moderate	0.32			
	38	---	---	---	---	---	---	----------	----			
Ch--------------- Cherokee	0-13	10-27	1.25-1.35	0.6-2.0	0.22-0.24	5.1-7.3	<2	Low-------	0.43	4	6	<2
	13-43	40-50	1.35-1.50	<0.06	0.10-0.15	5.1-6.0	<2	High------	0.32			
	43-60	35-50	1.35-1.45	0.06-0.2	0.09-0.18	5.1-7.3	<2	High------	0.32			
De--------------- Dennis	0-10	10-27	1.30-1.55	0.6-2.0	0.15-0.20	5.1-6.5	<2	Low-------	0.37	4	6	1-3
	10-15	27-35	1.45-1.70	0.2-0.6	0.15-0.20	4.5-6.0	<2	Moderate	0.37			
	15-60	35-55	1.35-1.65	0.06-0.2	0.15-0.20	5.1-6.5	<2	High------	0.37			
Ef, Eh----------- Eram	0-8	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
	8-26	35-55	1.35-1.65	0.06-0.2	0.10-0.18	5.1-7.3	<2	High------	0.37			
	26	---	---	---	---	---	---	----------	----			
Eo*:												
Eram------------	0-7	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
	7-28	35-55	1.35-1.65	0.06-0.2	0.10-0.18	5.1-7.3	<2	High------	0.37			
	28	---	---	---	---	---	---	----------	----			

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
Eo*:												
Lebo------------	0-15	27-35	1.35-1.45	0.6-2.0	0.21-0.23	5.6-7.8	<2	Moderate	0.32	4	7	1-3
	15-22	22-35	1.40-1.50	0.6-2.0	0.15-0.18	5.6-7.8	<2	Moderate	0.24			
	22-32	22-35	1.45-1.65	0.6-2.0	0.07-0.10	5.6-7.8	<2	Moderate	0.24			
	32	---	---	---	---	---	---	----------	----			
Es*:												
Eram------------	0-7	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
	7-28	35-55	1.35-1.65	0.06-0.2	0.10-0.18	5.1-7.3	<2	High------	0.37			
	28	---	---	---	---	---	---	----------	----			
Nowata----------	0-8	15-27	1.30-1.50	0.6-2.0	0.15-0.22	5.6-6.5	<2	Low-------	0.32	4	6	1-3
	8-13	27-35	1.45-1.75	0.2-0.6	0.08-0.12	5.6-7.3	<2	Moderate	0.32			
	13-36	27-35	1.45-1.75	0.2-0.6	0.08-0.12	5.6-7.3	<2	Moderate	0.32			
	36	---	---	---	---	---	---	----------	----			
He--------------- Hepler	0-24	12-27	1.25-1.35	0.6-2.0	0.22-0.24	4.5-6.5	<2	Low-------	0.37	5	6	.5-1
	24-44	27-35	1.35-1.45	0.6-2.0	0.18-0.20	4.5-6.5	<2	Moderate	0.37			
	44-60	27-42	1.35-1.45	0.2-0.6	0.14-0.17	4.5-6.5	<2	Moderate	0.37			
Ka, Kb----------- Kanima	0-6	27-35	1.30-1.60	0.6-2.0	0.08-0.17	5.6-8.4	<2	Low-------	0.28	4	8	.5-2
	6-60	18-35	1.40-1.70	0.6-2.0	0.02-0.12	5.6-8.4	<2	Low-------	0.32			
Ke--------------- Kenoma	0-13	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
	13-39	40-60	1.40-1.50	<0.06	0.10-0.15	5.1-7.8	<2	High------	0.32			
	39-60	30-50	1.35-1.45	0.06-0.2	0.18-0.20	6.1-8.4	<4	High------	0.32			
Ln--------------- Lanton	0-8	18-27	1.30-1.50	0.6-2.0	0.18-0.22	5.6-7.3	<2	Low-------	0.32	5	7	1-5
	8-37	27-35	1.45-1.70	0.2-0.6	0.18-0.22	5.6-6.5	<2	Moderate	0.43			
	37-60	30-45	1.35-1.65	0.06-0.2	0.12-0.18	6.6-7.3	<2	Moderate	0.32			
Od*:												
Olpe------------	0-7	15-30	1.25-1.35	0.6-2.0	0.15-0.20	5.1-6.5	<2	Low-------	0.32	3	6	1-2
	7-30	20-40	1.30-1.40	0.2-0.6	0.02-0.04	5.1-6.5	<2	Moderate	0.24			
	30-44	35-50	1.35-1.45	0.06-0.2	0.01-0.03	5.6-7.3	<2	Moderate	0.24			
	44-60	35-50	1.40-1.55	0.06-0.2	0.05-0.08	5.6-7.8	<2	High------	0.24			
Dennis----------	0-10	10-27	1.30-1.55	0.6-2.0	0.15-0.20	5.1-6.5	<2	Low-------	0.37	4	6	1-3
	10-15	27-35	1.45-1.70	0.2-0.6	0.15-0.20	4.5-6.0	<2	Moderate	0.37			
	15-60	35-55	1.35-1.65	0.06-0.2	0.15-0.20	5.1-8.4	<2	High------	0.37			
Or. Orthents												
Os--------------- Osage	0-17	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
	17-60	35-60	1.50-1.70	<0.06	0.08-0.12	5.6-7.8	<2	Very high	0.28			
Pe--------------- Parsons	0-13	15-25	1.30-1.50	0.6-2.0	0.16-0.24	5.1-6.5	<2	Low-------	0.43	4	6	.5-1
	13-60	35-60	1.40-1.70	<0.06	0.10-0.18	5.1-7.8	<2	High------	0.43			
Pt*. Pits												
Sd*:												
Shidler---------	0-12	18-26	1.30-1.50	0.6-2.0	0.16-0.24	6.1-8.4	<2	Low-------	0.32	2	4L	1-5
	12	---	---	---	---	---	---	----------	----			
Catoosa---------	0-12	15-26	1.30-1.55	0.6-2.0	0.15-0.24	5.6-7.3	<2	Low-------	0.32	4	6	1-3
	12-38	27-39	1.45-1.70	0.6-2.0	0.15-0.22	5.1-7.3	<2	Moderate	0.32			
	38	---	---	---	---	---	---	----------	----			

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		Wind erodi- bility group	Organic matter
									K	T		
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
Vc, Vf----------- Verdigris	0-34	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
	34-60	18-35	1.40-1.65	0.6-2.0	0.17-0.22	5.6-7.3	<2	Moderate	0.32			
Zb--------------- Zaar	0-17	40-60	1.20-1.30	<0.06	0.12-0.14	5.6-7.3	<2	High------	0.28	5	4	2-4
	17-54	40-60	1.35-1.50	<0.06	0.11-0.18	6.1-8.4	<2	High------	0.28			
	54-60	35-50	1.35-1.50	<0.06	0.10-0.18	6.6-8.4	<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 "occasional," "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.
Be, Bf: Bates	B	None	---	---	>6.0	---	---	20-40	Soft	Low	Moderate.
Bm*:											
Bates	B	None	---	---	>6.0	---	---	20-40	Soft	Low	Moderate.
Collinsville	D	None	---	---	>6.0	---	---	4-20	Hard	Low	Moderate.
Bo*:											
Bolivar	B	None	---	---	>6.0	---	---	20-40	Soft	Low	Moderate.
Hector	D	None	---	---	>6.0	---	---	10-20	Hard	Low	Moderate.
Br: Brazilton	D	None	---	---	>6.0	---	---	>60	---	High	Moderate.
Cd: Catoosa	B	None	---	---	>6.0	---	---	20-40	Hard	Moderate	Moderate.
Ch: Cherokee	D	None	---	---	0.5-1.5	Perched	Dec-Jun	>60	---	High	Moderate.
De: Dennis	C	None	---	---	2.0-3.0	Perched	Dec-Apr	>60	---	High	Moderate.
Ef, Eh: Eram	C	None	---	---	1.0-2.0	Perched	Dec-Apr	20-40	Soft	High	Moderate.
Eo*:											
Eram	C	None	---	---	1.0-2.0	Perched	Dec-Apr	20-40	Soft	High	Moderate.
Lebo	B	None	---	---	>6.0	---	---	20-40	Soft	Moderate	Low.
Es*:											
Eram	C	None	---	---	1.0-2.0	Perched	Dec-Apr	20-40	Soft	High	Moderate.
Nowata	B	None	---	---	>6.0	---	---	20-40	Hard	Moderate	Moderate.
He: Hepler	C	Occasional	Brief	Apr-Sep	1.0-3.0	Apparent	Nov-Mar	>60	---	High	Moderate.
Ka, Kb: Kanima	C	None	---	---	>6.0	---	---	>60	---	Moderate	Low.
Ke: Kenoma	D	None	---	---	>6.0	---	---	>60	---	High	Moderate.
Ln: Lanton	C	Occasional	Very brief	Apr-Sep	1.0-2.0	Perched	Nov-Apr	>60	---	High	Moderate.
Od*:											
Olpe	C	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			
Od*:											
Dennis	C	None	---	---	2.0-3.0	Perched	Dec-Apr	>60	---	High	Moderate.
Or. Orthents											
Os Osage	D	Occasional	Very brief to long.	Apr-Sep	0-1.0	Apparent	Nov-May	>60	---	High	Moderate.
Pe Parsons	D	None	---	---	0.5-1.5	Perched	Dec-Apr	>60	---	High	Moderate.
Pt*. Pits											
Sd*:											
Shidler	D	None	---	---	>6.0	---	---	4-20	Hard	Moderate	Low.
Catoosa	B	None	---	---	>6.0	---	---	20-40	Hard	Moderate	Moderate.
Vc Verdigris	B	Frequent	Very brief	Mar-Nov	>6.0	---	---	>60	---	Low	Low.
Vf Verdigris	B	Occasional	Very brief	Apr-Sep	>6.0	---	---	>60	---	Low	Low.
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								Moisture density	
			Percentage passing sieve--				Percentage smaller than--					
	AASHTO	Unified	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm	LL	PI	MD	OM
										Pct		Lb/ft^3	Pct
Bolivar fine sandy loam: (S8KS-099-004)													
A------ 0 to 5	A-4	SM	100	100	96	50	19	6	1	30	5	99	17
Bt2---- 17 to 21	A-6	CL	100	100	98	76	53	38	33	35	14	102	19
Kenoma silt loam: (S86KS-099-005)													
Ap----- 0 to 6	A-4	CL	100	100	97	91	59	25	14	30	10	103	18
Bt2---- 26 to 39	A-7	CH	100	100	99	96	78	52	36	57	28	92	25
C------ 49 to 60	A-7	CH	100	100	99	95	83	56	12	60	31	95	25
Osage silty clay: (S86KS-099-006)													
Ap----- 0 to 5	A-7	CH	100	100	99	96	76	45	17	51	24	94	23
Bw2---- 30 to 42	A-7	CH	100	100	99	98	85	59	41	56	28	93	25

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
Bolivar	Fine-loamy, mixed, thermic Ultic Hapludalfs
Brazilton	Fine, mixed, nonacid, thermic Hapludollic Arents
Catoosa	Fine-silty, mixed, thermic Typic Argiudolls
Cherokee	Fine, mixed, thermic Typic Albaqualfs
Collinsville	Loamy, siliceous, thermic Lithic Hapludolls
Dennis	Fine, mixed, thermic Aquic Paleudolls
Eram	Fine, mixed, thermic Aquic Argiudolls
Hector	Loamy, siliceous, thermic Lithic Dystrochrepts
Hepler	Fine-silty, mixed, thermic Udollic Ochraqualfs
Kanima	Loamy-skeletal, mixed, nonacid, thermic Udalfic Arents
Kenoma	Fine, montmorillonitic, thermic Vertic Argiudolls
Lanton	Fine-silty, mixed, thermic Cumulic Haplaquolls
Lebo	Loamy-skeletal, mixed, thermic Typic Hapludolls
Nowata	Loamy-skeletal, mixed, thermic Typic Argiudolls
Olpe	Clayey-skeletal, montmorillonitic, thermic Typic Paleudolls
Orthents	Loamy, thermic Orthents
Osage	Fine, montmorillonitic, thermic Vertic Haplaquolls
Parsons	Fine, mixed, thermic Mollic Albaqualfs
Shidler	Loamy, mixed, thermic Lithic Haplustolls
Verdigris	Fine-silty, mixed, thermic Cumulic Hapludolls
Zaar	Fine, montmorillonitic, thermic Vertic Hapludolls

Interpretive Groups

INTERPRETIVE GROUPS

(Dashes indicate that the soil was not assigned to the interpretive group)

Map symbol	Map unit	Land capability*	Prime farmland*	Range site
Ae	Apperson silty clay loam, 1 to 3 percent slopes	IIe	Yes	Loamy Upland.
Be	Bates loam, 1 to 3 percent slopes	IIe	Yes	Loamy Upland.
Bf	Bates loam, 3 to 7 percent slopes	IIIe	Yes	Loamy Upland.
Bm	Bates-Collinsville complex, 4 to 15 percent slopes	VIe	No	
	Bates			Loamy Upland.
	Collinsville			Shallow Sandstone.
Bo	Bolivar-Hector fine sandy loams, 4 to 20 percent slopes	VIe	No	
	Bolivar			Savannah.
	Hector			Shallow Savannah.
Br	Brazilton silty clay loam, 1 to 4 percent slopes	IIIe	Yes	---
Cd	Catoosa silt loam, 0 to 2 percent slopes	IIe	Yes	Loamy Upland.
Ch	Cherokee silt loam, 0 to 1 percent slopes	IIs	Yes	Clay Upland.
De	Dennis silt loam, 1 to 3 percent slopes	IIe	Yes	Loamy Upland.
Ef	Eram silty clay loam, 1 to 3 percent slopes	IIIe	Yes	Clay Upland.
Eh	Eram silty clay loam, 3 to 7 percent slopes	IVe	No	Clay Upland.
Eo	Eram-Lebo silty clay loams, 4 to 20 percent slopes	VIe	No	
	Eram			Clay Upland.
	Lebo			Loamy Upland.
Es	Eram-Nowata complex, 2 to 7 percent slopes	IVe	No	
	Eram			Clay Upland.
	Nowata			Loamy Upland.
He	Hepler silt loam, occasionally flooded	IIw	Yes**	Loamy Lowland.
Ka	Kanima shaly silty clay loam, 3 to 7 percent slopes	VIs	No	---
Kb	Kanima shaly silty clay loam, 10 to 30 percent slopes	VIIs	No	---
Ke	Kenoma silt loam, 1 to 3 percent slopes	IIIe	Yes	Clay Upland.
Ln	Lanton silt loam, occasionally flooded	IIw	Yes**	Loamy Lowland.
Od	Olpe-Dennis silt loams, 3 to 7 percent slopes	IVe	No	Loamy Upland.
Or	Orthents, clayey	IVe	No	---
Os	Osage silty clay, occasionally flooded	IIIw	Yes**	Clay Lowland.
Pe	Parsons silt loam, 0 to 2 percent slopes	IIs	Yes	Clay Upland.
Pt	Pits, quarries	---	No	---
Sd	Shidler-Catoosa silt loams, 1 to 8 percent slopes	VIe	No	
	Shidler			Shallow Limy.
	Catoosa			Loamy Upland.
Vc	Verdigris silt loam, frequently flooded	Vw	No	Loamy Lowland.
Vf	Verdigris silt loam, occasionally flooded	IIw	Yes	Loamy Lowland.
Zb	Zaar silty clay, 0 to 2 percent slopes	IIIw	Yes	Clay Upland.

* A soil complex is treated as a single management unit in the land capability classification and prime farmland columns.

** Where drained.

NRCS Accessibility Statement

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at 1-800-457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.