United States
Department of
Agriculture

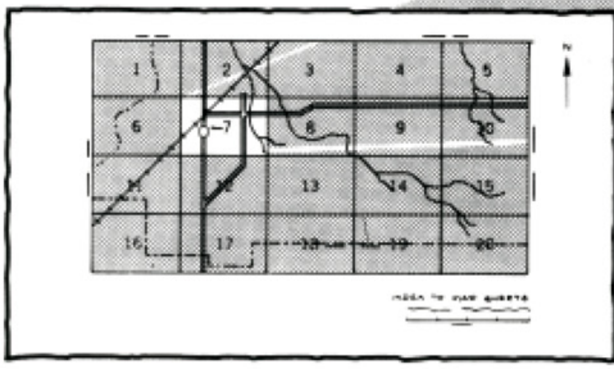
Soil
Conservation
Service

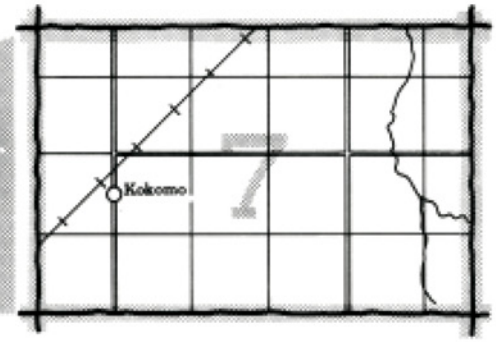
In cooperation with
Kansas Agricultural
Experiment Station

Soil Survey of Osage County Kansas

HOW TO USE

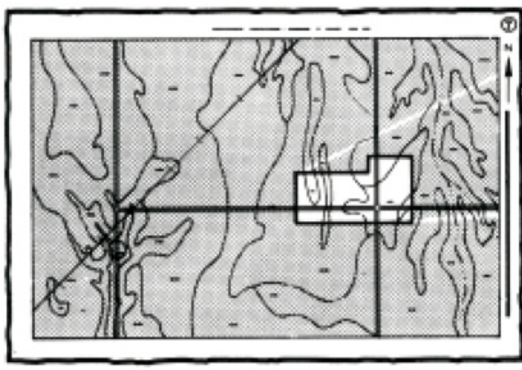
1. Locate your area of interest on the "Index to Map Sheets"

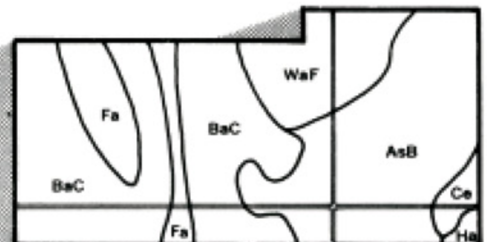




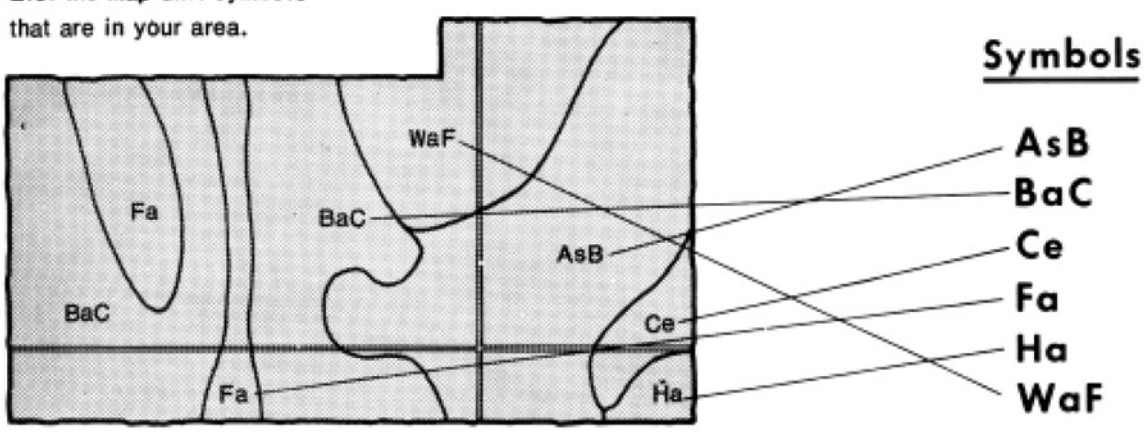
2. Note the number of the map sheet and turn to that sheet.

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



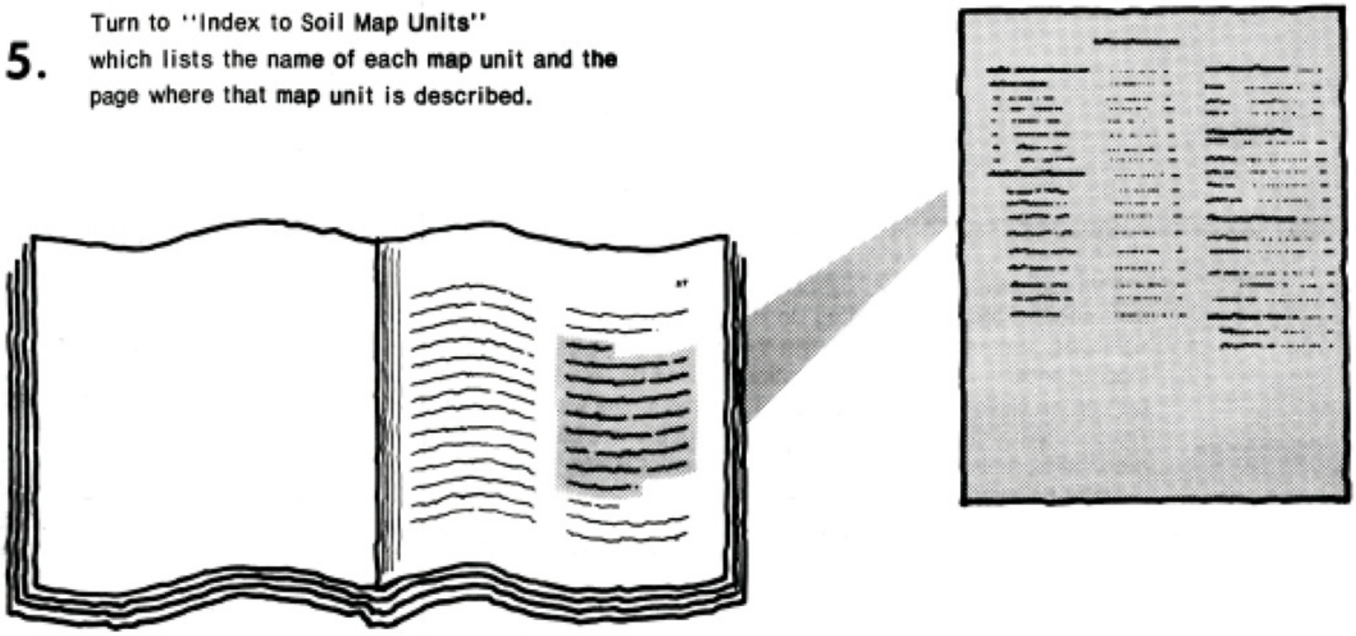


4. List the map unit symbols that are in your area.

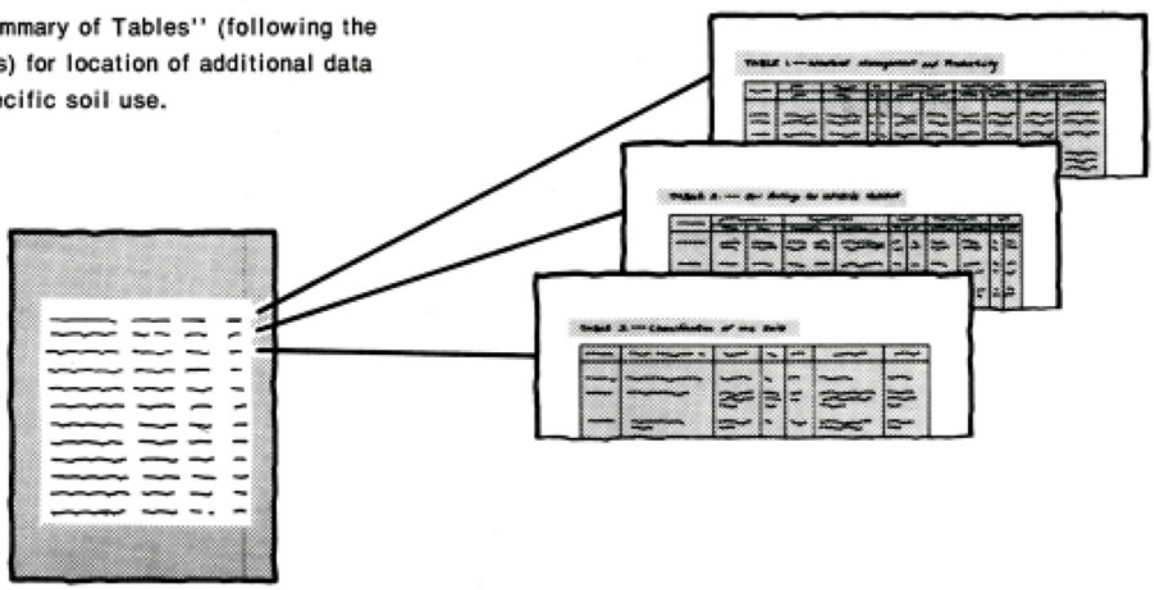


THIS SOIL SURVEY

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



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



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

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

Major fieldwork for this soil survey was completed in 1982. Soil names and descriptions were approved in 1982. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1982. 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 Osage County Conservation District.

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

Cover: An area of native grass in excellent condition. The soil in the foreground is Dennis silt loam, 2 to 6 percent slopes.

Contents

Soil Series

Issued March 1985

Index to Map Units

Summary of Tables

Foreword

This soil survey contains information that can be used in land-planning programs in Osage 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 insure 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.

John W. Tippie

John W. Tippie
State Conservationist
Soil Conservation Service

Soil Survey of
Osage County, Kansas

By Harold P. Dickey and Harold Penner,
Soil Conservation Service

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

OSAGE COUNTY is in the east-central part of Kansas (fig. 1). It has a total area of 460,608 acres, or about 720 square miles. In 1980, it had a population of 14,370. Osage City, the largest town in the county, has a population of 2,434. Lyndon is the county seat. The county was established in 1855.

Farming and related services are the most important enterprises in the county. Livestock and cash grain farming are of equal importance to the local economy. Grain sorghum, soybeans, and wheat are the principal crops.

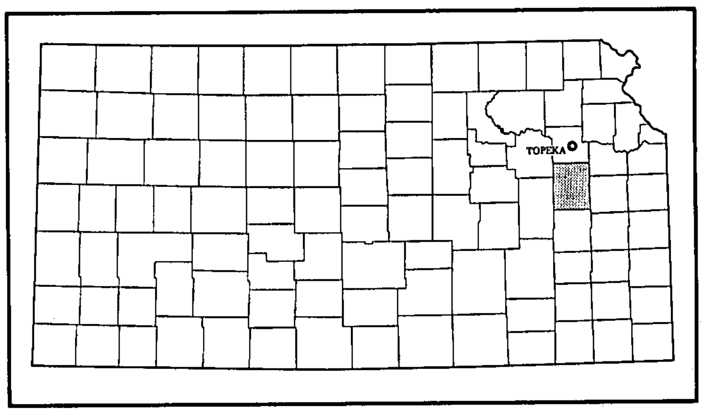


Figure 1.—Location of Osage County in Kansas.

General Nature of the County

This section gives general information concerning the county. It describes the 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 of Osage 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 the frequent outbreaks of polar air. They last from December to February. Warm summer temperatures last for about 6 months every year. They provide a long growing season for crops commonly grown in the county. Spring and fall are relatively short.

Osage 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 annual precipitation generally is adequate for the commonly grown crops, its distribution may cause problems in some years. Prolonged dry periods of several weeks are not uncommon during the growing season. A surplus of precipitation often results in muddy fields and thus delays planting and harvesting.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Osage City 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 32.6 degrees F, and the average daily minimum temperature is 21.9 degrees. The lowest temperature on record, which occurred at Osage City on February 12, 1899, is -26 degrees. In summer the average temperature is 76.8 degrees, and the average daily maximum temperature is 89.0 degrees. The highest recorded temperature, which occurred at Osage City on July 18, 1936, is 118 degrees.

The total annual precipitation is 35.52 inches. Of this, 25.30 inches, or 71 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 16.93 inches. The heaviest 1-day rainfall on record is 9.65 inches at Osage City on July 7, 1909.

The average seasonal snowfall is 20 inches. The highest seasonal snowfall during the period of record was 52.3 inches. On an average of 21 days, at least 1 inch of snow is on the ground, but the snow cover generally does not last for more than 7 days in succession.

The sun shines 74 percent of the time possible in summer and 59 percent in winter. The prevailing wind is from the south. Average annual windspeed is 10.3 miles per hour. It is highest in March.

Tornadoes and severe thunderstorms occur occasionally in the county. These storms usually are local in extent and of short duration, so that the risk of damage is slight. Hail falls during the warmer part of the year, but the hailstorms are infrequent and of local extent. Hail causes less crop damage in this part of the state than in western Kansas.

Physiography, Drainage, and Relief

Osage County lies within the Osage Plains section of the Central Lowland physiographic province (*3*). The land resource area is the Cherokee Prairies. The major topographic features are the east-trending valleys of the Marais des Cygnes River and its tributaries and the upland cuestas formed by differential erosion of limestone, shale, and sandstone strata. The land surface generally is nearly level to rolling, and a few areas have strong relief.

The Marais des Cygnes River and its tributaries drain about 86 percent of the county. The Wakarusa River drains the northern 14 percent.

The highest elevation, in the northwestern part of the county, is about 1,300 feet above sea level. The lowest, in an area along the Marais des Cygnes River in the eastern part, is about 900 feet. The average gradient of the Marais des Cygnes River is about 2 feet per mile.

Water Supply

The valleys of the Marais des Cygnes River and its tributaries are the major sources of ground water in the county. In some areas in the southeastern part of the county, ground water is available from wells, which generally provide enough water for domestic uses. Only a few wells in other parts of the county provide dependable water supplies. The main source of water for livestock is surface water impounded by dams and local streams.

Natural Resources

Soil is the most important natural resource in the county. It provides a growing medium for cash crops and the grasses grazed by livestock. Other mineral resources are limestone, coal, oil, and gravel. Limestone is quarried and crushed for various uses, such as road surfacing and agricultural lime.

How This Survey Was Made

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

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

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

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

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

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

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

Map Unit Composition

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

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

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

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.

Soil Descriptions

1. Eram-Lula-Summit association

Deep and moderately deep, nearly level to strongly sloping, well drained and moderately well drained soils that have a silty or clayey subsoil; on uplands

This association is on ridgetops and side slopes that are dissected by many drainageways. Slope generally ranges from 0 to 12 percent. In a few areas along drainageways, however, it is more than 12 percent.

This association makes up about 49 percent of the county. It is about 34 percent Eram soils, 14 percent Lula soils, 12 percent Summit soils, and 40 percent minor soils (fig. 2).

The moderately deep, moderately well drained Eram soils formed in material weathered from shale. They are on side slopes below limestone ledges. They are gently sloping to strongly sloping. Typically, the surface layer is very dark grayish brown silty clay loam about 9 inches thick. The subsoil is about 19 inches thick. It is mottled. The upper part is very dark grayish brown and dark grayish brown, very firm silty clay, and the lower part is yellowish brown and strong brown, very firm silty clay loam. Shale is at a depth of about 28 inches.

The deep, well drained Lula soils formed in material weathered from limestone and shale. They are on ridgetops. They are nearly level to moderately sloping. Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsurface layer is dark reddish brown, firm silty clay loam about 6 inches thick. The subsoil is firm or very firm silty clay loam about 30 inches thick. The upper part is dark reddish brown, and the lower part is dark yellowish brown and mottled. Limestone is at a depth of about 44 inches.

The deep, moderately well drained Summit soils formed in material weathered from shale. They are on side slopes and foot slopes. They are gently sloping to strongly sloping. Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is black, firm silty clay loam about 5 inches thick. The subsoil is mottled, very firm silty clay about 43 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.

Minor in this association are Clareson, Kenoma, Lebo, and Verdigris soils. Clareson soils have many flagstones in the subsoil. They are strongly sloping and are on side slopes. Lebo soils have many shale fragments in the subsoil. They are on the steeper slopes. The moderately well drained Kenoma soils are on ridgetops. They have an abrupt boundary between the silt loam surface layer and the clayey subsoil. The deep Verdigris soils are on flood plains along drainageways.

About 55 percent of this association is used as range or pasture, and the rest is used for cultivated crops. Limestone quarries are in a few areas. Livestock farming and general cash grain farming are the main farm enterprises. The principal crops are soybeans, grain sorghum, and wheat. The main management need is increased grass production on range or pasture. Controlling erosion and improving fertility and tilth are concerns in managing cultivated areas.

2. Kenoma-Dennis-Summit association

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

This association is on broad ridgetops and side slopes that are dissected by drainageways. Slope ranges from 1 to 7 percent.

This association makes up about 24 percent of the county. It is about 30 percent Kenoma soils, 24 percent Dennis soils, 16 percent Summit soils, and 30 percent minor soils (fig. 3).

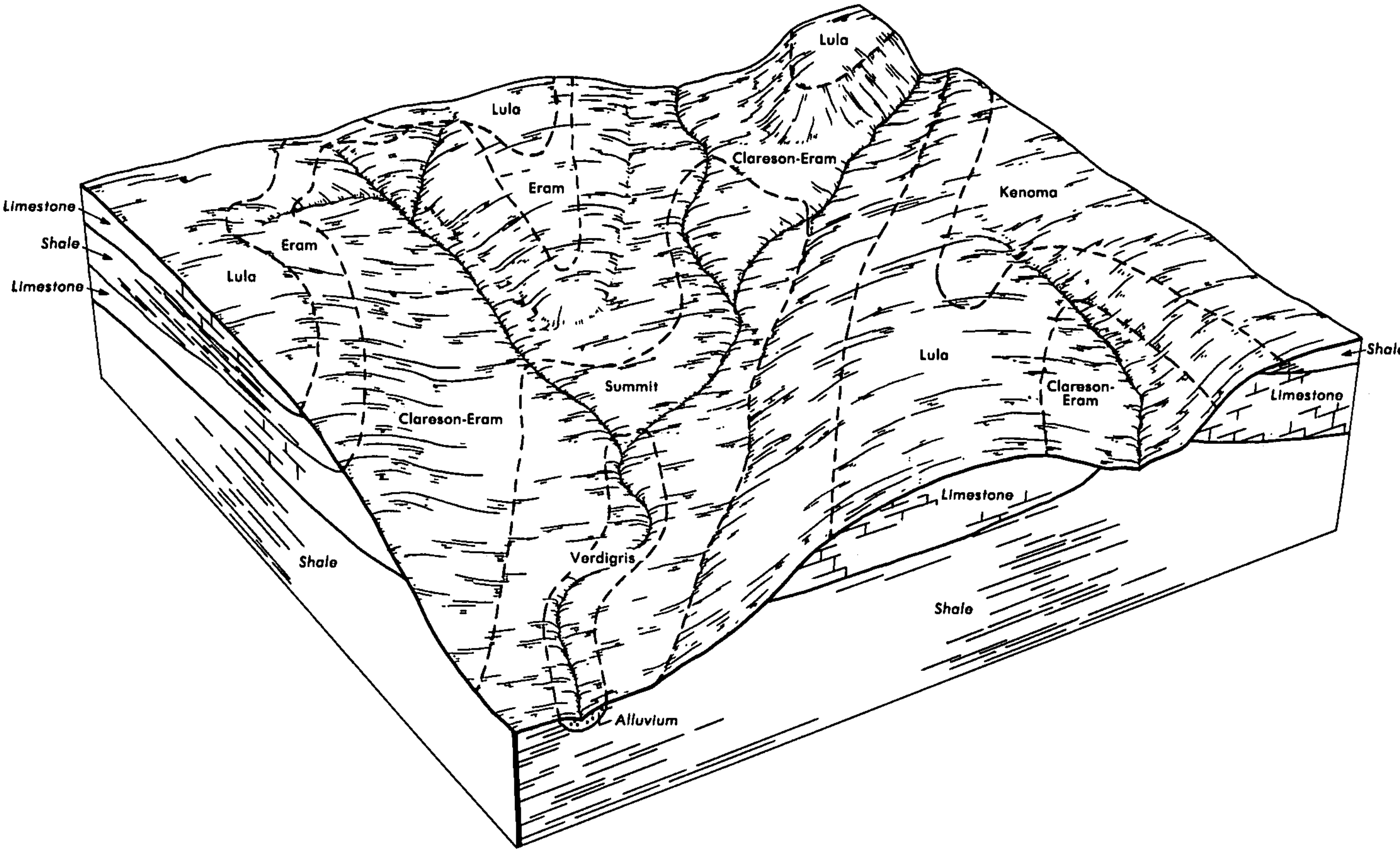


Figure 2.—Typical pattern of soils and parent material in the Eram-Lula-Summit association.

Kenoma soils formed in material weathered from shale. They are on ridgetops. They are gently sloping and moderately sloping. Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsoil is mottled, very firm silty clay about 45 inches thick. The upper part is very dark grayish brown, the next part is dark brown, and the lower part is light olive brown. Shale is at a depth of about 53 inches.

Dennis soils formed in silty and clayey material weathered from shale. They are on side slopes and narrow ridgetops. They are moderately sloping. Typically, the surface layer is very dark brown silt loam about 9 inches thick. The subsurface layer is very dark grayish brown, friable silty clay loam about 5 inches thick. The subsoil extends to a depth of more than 60 inches. The upper part is dark brown, mottled, firm silty clay loam; the next part is brown, mottled, very firm silty clay; and the lower part is dark yellowish brown and yellowish brown, mottled, firm silty clay.

Summit soils formed in material weathered from shale. They are on side slopes and foot slopes. They are gently sloping and moderately sloping. Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is black, firm silty clay loam about 5 inches thick. The subsoil is mottled, very firm silty clay about 43 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.

Minor in this association are Bates, Clime, Sogn, and Verdigris soils. The moderately deep Bates and Clime soils and the shallow Sogn soils are on the upper side slopes. The deep Verdigris soils are on flood plains along drainageways.

About 55 percent of this association is cultivated, and the rest is used as pasture or range. Livestock farming and general cash grain farming are the main farm enterprises. The main crops are grain sorghum, soybeans, and wheat. The main management needs in cultivated areas are measures that help to control erosion and maintain or improve tilth and fertility. Good pasture and range management is needed to prevent invasion of undesirable grasses, bushes, and trees.

3. Kenoma-Woodson association

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

This association is on broad ridgetops that are dissected by shallow drainageways. Slope ranges from 0 to 5 percent.

This association makes up about 18 percent of the county. It is about 45 percent Kenoma soils, 20 percent Woodson soils, and 35 percent minor soils (fig. 4).

The moderately well drained Kenoma soils formed in material weathered from shale. They are on ridgetops. They are gently sloping and moderately sloping. Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsoil is mottled, very firm silty clay about 45 inches thick. The upper part is very dark grayish brown, the next part is dark brown, and the lower part is light olive brown. Shale is at a depth of about 53 inches.

The somewhat poorly drained Woodson soils formed in clayey and silty sediments. They are on broad ridgetops. They are nearly level. Typically, the surface layer is black silt loam about 8 inches thick. The subsoil is mottled, very firm silty clay about 28 inches thick. The upper part is black, the next part is very dark gray, and the lower part is dark grayish brown. The upper part of the substratum is brown, mottled silty clay loam. The lower part to a depth of about 60 inches is mottled reddish brown and grayish brown clay.

Minor in this association are Dennis, Eram, Olpe, and Verdigris soils. Dennis soils are on the lower side slopes. The upper part of their subsoil is silty clay loam. The moderately deep Eram soils are on side slopes. Olpe soils have a gravelly subsoil. They are on ridgetops. The deep Verdigris soils are on flood plains along drainageways.

About 60 percent of this association is used for cultivated crops, and the rest is used as range or pasture. Osage City, the largest town in the county, is in an area of this association. The main crops are grain sorghum, soybeans, and wheat. The main management needs in cultivated areas are measures that help to control erosion and maintain fertility and tilth. The main concern in managing range or pasture is maintaining a vigorous stand of desirable grasses.

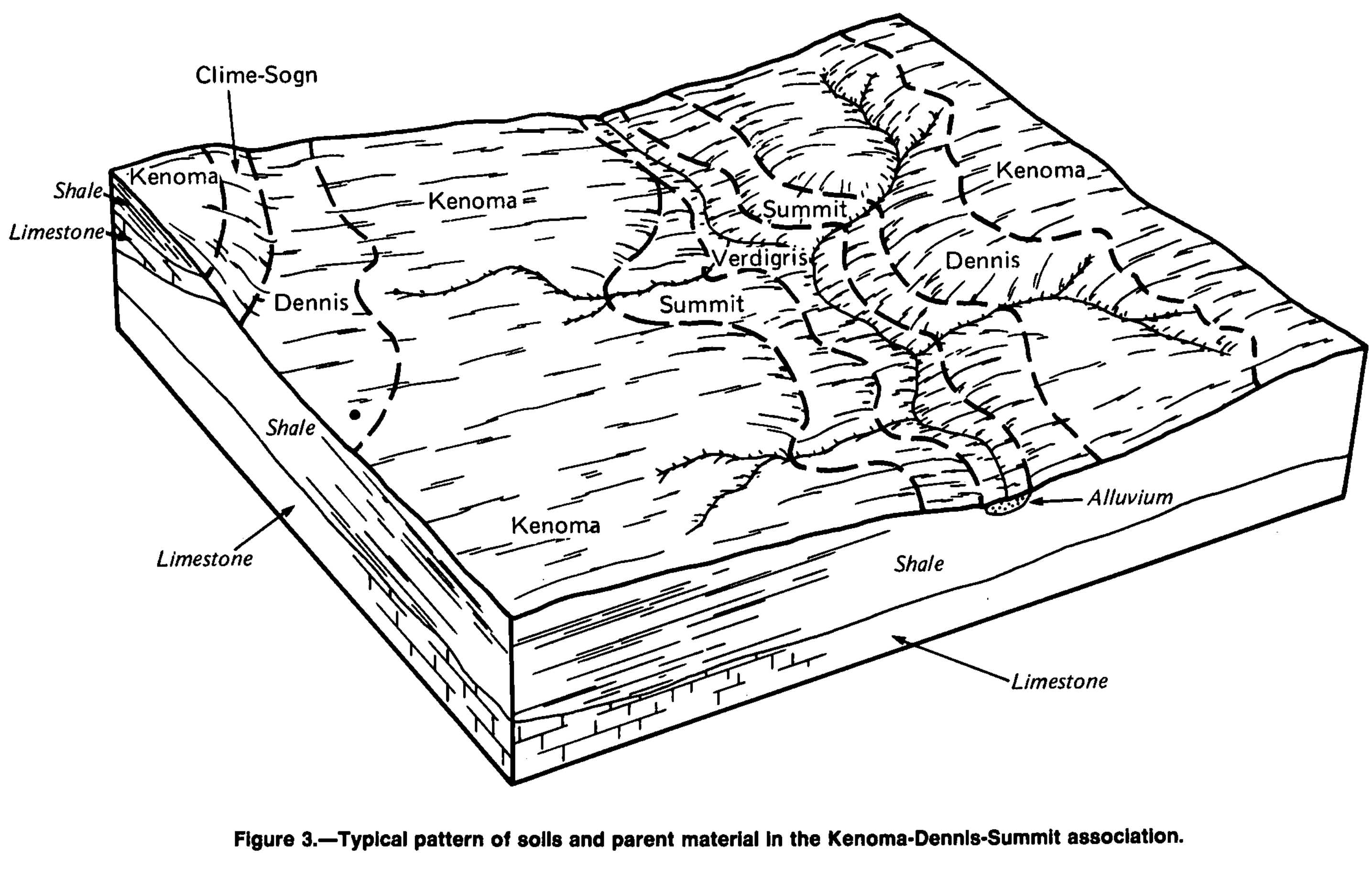


Figure 3.—Typical pattern of soils and parent material in the Kenoma-Dennis-Summit association.

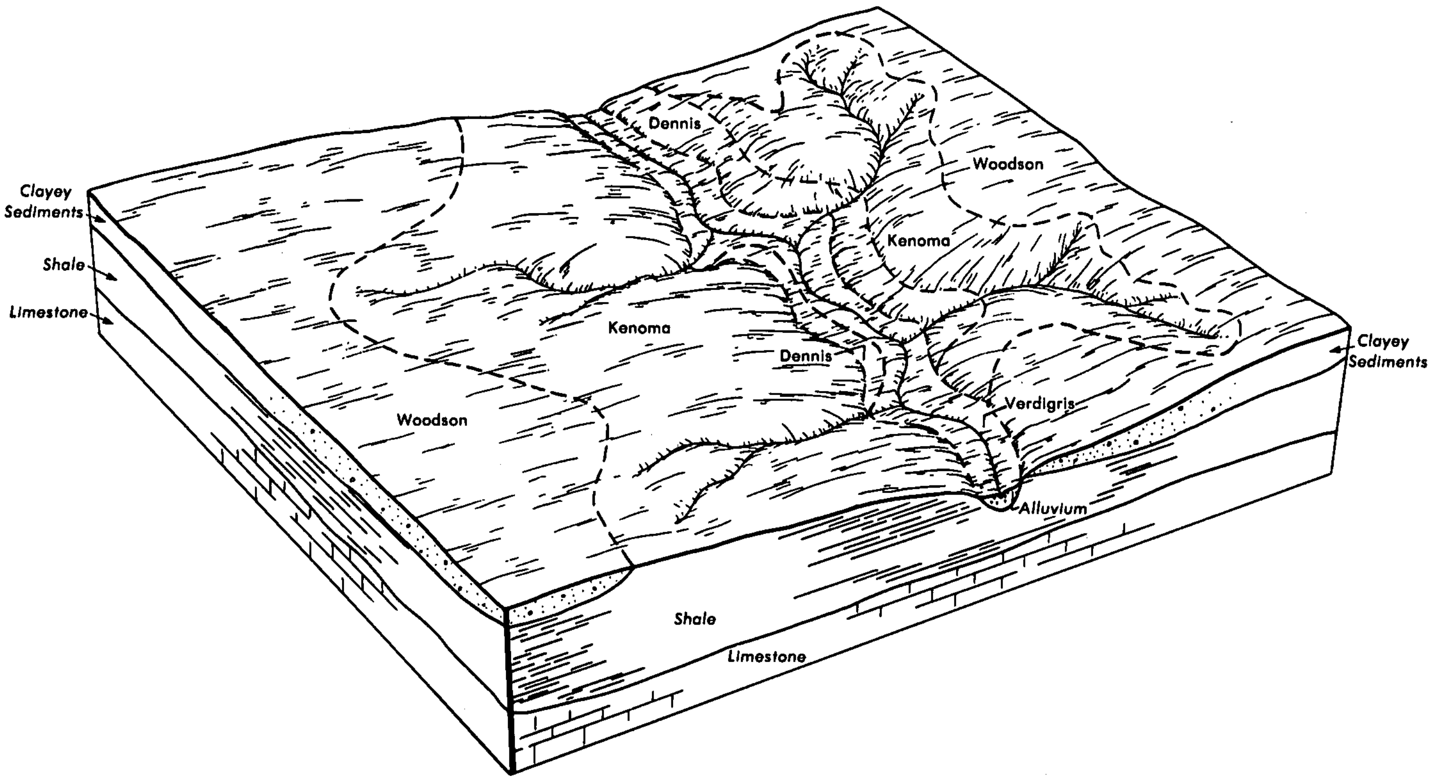


Figure 4.—Typical pattern of soils and parent material in the Kenoma-Woodson association.

4. Verdigris-Osage association

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

This association is on bottom land along the major streams. The soils are occasionally or frequently flooded. Slope generally is less than 2 percent but is steeper along the stream channels.

This association makes up about 9 percent of the county. It is about 45 percent Verdigris soils, 31 percent Osage soils, and 24 percent minor soils.

The well drained Verdigris soils formed in silty alluvium on flood plains adjacent to stream channels. Typically, the surface layer is very dark grayish brown, friable silt loam about 7 inches thick. The subsurface layer is very dark grayish brown silt loam about 7 inches thick. The next 21 inches is dark brown, friable silt loam. The substratum to a depth of about 60 inches is brown silt loam.

The poorly drained Osage soils formed in alluvium on flood plains. Typically, the surface layer is very dark gray, firm silty clay about 8 inches thick. The subsurface layer is black, mottled, very firm silty clay about 8 inches thick. The subsoil to a depth of about 60 inches is black, mottled, very firm silty clay.

Minor in this association are Kenoma and Mason soils. The moderately well drained Kenoma soils are on uplands and high terraces. The deep Mason soils are on terraces that are subject to rare flooding.

Most of this association is used for cultivated crops. A few areas are used as pasture. Hardwood trees grow along the stream channels. General cash grain farming is the main farm enterprise. The main crops are corn, soybeans, grain sorghum, and wheat. The main concerns of management are the poor natural drainage of the Osage soils and the occasional or frequent flooding on both of the major soils. Also, measures that maintain or improve fertility and tilth are needed.

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, Summit silty clay loam, 1 to 3 percent slopes, is one of several phases in the Summit 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 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. Clime-Sogn complex, 3 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.

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

Bd—Bates loam, 3 to 7 percent slopes. This moderately deep, well drained, moderately sloping soil is on side slopes and ridgetops in the uplands. Individual areas are irregular in shape and range from 5 to 50 acres in size.

Typically, the surface layer is very dark grayish brown loam about 8 inches thick. The subsurface layer is very dark grayish brown, friable loam about 7 inches thick. The subsoil is about 15 inches thick. The upper part is dark yellowish brown, friable loam, and the lower part is brown gravelly fine sandy loam. Sandstone is at a depth of about 30 inches. In a few small eroded areas, the surface layer is brown. In some places the depth to sandstone is more than 40 inches, and in other places it is less than 20 inches.

Included with this soil in mapping are small areas of Dennis, Eram, and Olpe soils, which make up about 10 percent of the unit. Eram and Olpe soils occur as areas intermingled with areas of the Bates soil. Eram soils have a clayey subsoil. The deep Olpe soils have a gravelly subsoil. The deep Dennis soils are on the lower side slopes

Permeability is moderate in the Bates soil. Available water capacity also is moderate. Surface runoff is medium. Organic matter content is moderately low. Root penetration is restricted by the bedrock at a depth of about 30 inches.

About 30 percent of the acreage is used for cultivated crops. This soil is better suited to small grain and grain sorghum than to corn or soybeans. If cultivated crops are grown, erosion is a hazard. It can be controlled, however, by minimum tillage, terraces, contour farming, and grassed waterways. Minimum tillage, crop rotations, a cover of crop residue, and applications of commercial fertilizer increase the organic matter content and improve fertility and tilth.

About 70 percent of the acreage is used as range, pasture, or hayland. This soil is suited to those uses. About 75 percent of the grassland supports native prairie grasses, and the rest supports cool-season tame grasses. The native vegetation is dominantly big bluestem and little bluestem. Proper stocking rates, timely deferment of grazing, and control of unwanted vegetation help to maintain or increase the amount of forage produced in the areas used for grazing. Native hay production can be maintained or increased by mowing when the dominant species reaches the boot stage, by selecting a cutting height of more than 4 inches, and by deferring grazing and mowing as needed to increase plant vigor and improve plant composition.

This soil is well suited to dwellings without basements and to local roads and streets. The depth to bedrock is a moderate limitation if the soil is used as a site for dwellings with basements, but the rock is rippable and can be excavated. Low strength is a limitation on sites for local roads and streets. Roads should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil.

This soil generally is unsuitable as a site for septic tank absorption fields and sewage lagoons because the depth to bedrock is a severe limitation. The deeper included soils on the lower side slopes are better sites for lagoons.

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

Cm—Clareson-Eram complex, 3 to 15 percent slopes. These moderately sloping and strongly sloping, moderately deep soils are on the convex tops and sides of ridges in the uplands. The well drained Clareson soil is on the steeper, upper side slopes. The moderately well drained Eram soil is on the lower side slopes. In places limestone rocks are on the surface. Individual areas are 100 to 500 feet wide and 1,000 feet to several miles long and range from 3 to 1,000 acres in size. They are 50 to 60 percent Clareson soil and 25 to 35 percent Eram soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Clareson soil has a very dark brown silty clay loam surface layer about 8 inches thick. The subsurface layer is dark brown, friable silty clay loam about 8 inches thick. The subsoil is dark reddish brown, firm very flaggy silty clay loam (fig. 5). Limestone is at a depth of about 24 inches. In some areas the depth to limestone is more than 40 inches.

Figure 5.—Profile of Clareson silty clay loam, in an area of Clareson-Eram complex, 3 to 15 percent slopes. The subsoil has many limestone rocks. Depth is marked in feet.

Typically, the Eram soil has a very dark grayish brown silty clay loam surface layer about 9 inches thick. The subsoil is about 19 inches thick. The upper part is very dark grayish brown and dark grayish brown, mottled, very firm silty clay, and the lower part is yellowish brown and strong brown, very firm silty clay loam. Shale is at a depth of about 28 inches.

Included with these soils in mapping are small areas of Bates soils and small areas where limestone crops out. The loamy Bates soils are on the lower side slopes. The limestone outcrops are on breaks on the steeper parts of the landscape. Included areas make up 10 to 20 percent of the unit.

Permeability is moderately slow in the Clareson soil and slow in the Eram soil. Available water capacity is low in both soils. Surface runoff is medium. A perched seasonal high water table is at a depth of 2 to 3 feet in the Eram soil. Root penetration is restricted by the bedrock at a depth of about 24 inches in the Clareson soil and 28 inches in the Eram soil. The shrink-swell potential is moderate in the subsoil of the Clareson soil and high in the subsoil of the Eram soil.

Most of the acreage is used as range or hayland. These soils are best suited to those uses. They generally are unsuited to cultivated crops because of a severe hazard of erosion. The native vegetation is dominantly big bluestem and little bluestem. Also, sideoats grama is abundant on the Clareson soil. In some areas the percentage of woody vegetation is large. Growing hay is not practical in areas where the surface layer is flaggy or limestone crops out. Proper stocking rates, timely deferment of grazing, and control of unwanted vegetation help to maintain or increase the amount of forage produced in the areas used as range.

Native hay production can be maintained or increased by mowing when the dominant species reaches the boot stage, by selecting a cutting height of more than 4 inches, and by deferring grazing and cutting as needed to increase plant vigor and improve plant composition.

These soils generally are unsuitable as sites for dwellings with basements and are poorly suited to dwellings without basements and to local roads and streets. The large stones in the Clareson soil and the shrink-swell potential of the Eram soil are severe limitations. Also, low strength in both soils is a severe limitation on sites for local roads and streets. Installing reinforced foundations below the depth of seasonal drying and providing foundation drains help to prevent the damage to buildings caused by shrinking and swelling. Roads should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soils. Providing coarser grained base material helps to prevent the road damage caused by shrinking and swelling.

These soils generally are unsuitable as sites for septic tank absorption fields and sewage lagoons, mainly because the depth to bedrock and slope are severe limitations. Suitable sites for lagoons generally are available in the areas of deep soils on the adjacent foot slopes.

The land capability classification is VIe. The Clareson soil is in the Shallow Flats range site, the Eram soil in the Clay Upland range site.

Cs—Clime-Sogn complex, 3 to 15 percent slopes. These moderately sloping and strongly sloping soils are on the upper side slopes and ridgetops in the uplands. The shallow or very shallow, somewhat excessively drained Sogn soil is on the steeper, upper convex side slopes. The moderately deep, well drained Clime soil is on the lower convex side slopes. Individual areas are irregular in shape and range from 3 to several hundred acres in size. They are 60 to 70 percent Clime soil and 15 to 30 percent Sogn soil. The two soils occur as areas so intricately mixed or are so small that mapping them separately is not practical.

Typically, the Clime soil has a very dark brown silty clay surface layer about 7 inches thick. The subsoil is very dark grayish brown, very firm, calcareous silty clay about 7 inches thick. The substratum is grayish brown and olive brown, calcareous silty clay loam. Shale is at a depth of about 32 inches. In some areas limestone fragments are on the surface. In other areas the soil is noncalcareous throughout.

Typically, the Sogn soil has a black silty clay loam surface layer about 8 inches thick. Limestone is at a depth of about 8 inches.

Included with these soils in mapping are small areas where rock crops out and small areas of Lula and Summit soils. These included areas make up 10 to 20 percent of the unit. Lula soils are 40 to 60 inches deep over limestone. They are on ridgetops. The moderately well drained Summit soils are on the lower side slopes. The areas where rock crops out are on breaks, on the steeper slopes, and on side slopes, generally below the Sogn soil.

Permeability is slow in the Clime soil and moderate in the Sogn soil. Available water capacity is low in the Clime soil and very low in the Sogn soil. Surface runoff is rapid on both soils. Root penetration is restricted by the bedrock at a depth of about 32 inches in the Clime soil and 8 inches in the Sogn soil. The shrink-swell potential is moderate in both soils.

Nearly all areas are used as range or hayland. Because of a severe hazard of erosion on both soils and the shallowness to limestone in the Sogn soil, this map unit generally is unsuited to cultivated crops. It is best suited to range. The native vegetation dominantly is little bluestem, big bluestem, and sideoats grama. Sideoats grama is more common on the shallow or very shallow Sogn soil than on the Clime soil. In severely overgrazed areas, the range has been invaded by annual bromegrass, annual broomweed, and other less desirable plants. An adequate plant cover conserves moisture by reducing the runoff rate. Brush control is needed in many areas. Proper stocking rates, a uniform distribution of grazing, timely deferment of grazing, timely burning, and rotation grazing help to keep the range in good condition and help to prevent the encroachment of brush.

Native hay production can be maintained or increased by mowing when the dominant species reaches the boot stage, by selecting a cutting height of more than 4 inches, and by deferring grazing and cutting as needed to increase plant vigor and improve plant composition.

The Clime soil is poorly suited to local roads and streets and to dwellings. The shrink-swell potential and the slope are limitations on sites for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling. Land shaping commonly is needed because of the slope. Although the depth to bedrock is a limitation on sites for dwellings with basements, the rock is soft and can easily be excavated. Low strength is a major limitation on sites for local roads and streets. Also, the slope is a limitation in the steeper areas. Roads should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. The less sloping areas are better sites for roads than the steeper areas. Building the roads on the contour reduces the hazard of erosion.

Because of the slow permeability and the depth to bedrock, the Clime soil generally is unsuitable as a septic tank absorption field. It is poorly suited to sewage lagoons because of the depth to bedrock and the slope. The depth to bedrock can be overcome by borrowing soil or ripping the bedrock when the lagoons are constructed. Sealing the bottom of the lagoon helps to prevent excessive seepage into fractures in the bedrock. If the less sloping areas are selected as sites for the lagoons, less leveling and banking will be needed during construction. The deep included soils on the lower side slopes can be used as sites for sewage lagoons.

The Sogn soil generally is unsuited to building site development because it is shallow over bedrock.

The land capability classification is VIe. The Clime soil is in the Limy Upland range site, the Sogn soil in the Shallow Limy range site.

Dn—Dennis silt loam, 2 to 6 percent slopes. This deep, moderately well drained, moderately sloping soil is on the lower convex side slopes and narrow ridgetops in the uplands. Individual areas are irregular in shape and range from 5 to several hundred acres in size.

Typically, the surface layer is very dark brown silt loam about 9 inches thick. The subsurface layer is very dark grayish brown, friable silty clay loam about 5 inches thick. The subsoil extends to a depth of more than 60 inches. The upper part is dark brown, mottled, firm silty clay loam; the next part is brown, mottled, very firm silty clay; and the lower part is dark yellowish brown and yellowish brown, mottled, firm silty clay. In some areas the upper part of the subsoil is very firm silty clay. In other areas the depth to sandstone or shale is 40 to 60 inches.

Included with this soil in mapping are small areas of Bates and Eram soils, which make up 5 to 10 percent of the unit. These moderately deep soils are on the upper side slopes.

Permeability is slow in the Dennis soil. Available water capacity is high. Surface runoff is medium. A perched seasonal high water table is at a depth of 2 to 3 feet. Organic matter content is moderate. The surface layer is friable and can be easily tilled. The shrink-swell potential is high in the subsoil.

About 60 percent of the acreage is used for cultivated crops. This soil is moderately suited to soybeans, wheat, grain sorghum, and corn. If cultivated crops are grown, erosion is a hazard. It can be controlled, however, by terraces, contour farming, and grassed waterways. Minimum tillage, crop rotations, a cover of crop residue, and applications of commercial fertilizer increase the organic matter content and improve fertility and tilth.

About 40 percent of the acreage is used as range, pasture, or hayland. This soil is suited to those uses. About 60 percent of the grassland supports native prairie grasses, and the rest supports cool-season tame grasses. The native vegetation dominantly is big bluestem, little bluestem, and indiangrass. In overused areas the range has been invaded by less desirable plants, such as tall dropseed, Baldwin ironweed, and western ragweed. Proper stocking rates, timely deferment of grazing, well distributed watering and salting facilities, and control of unwanted vegetation help to maintain or increase the amount of forage produced in the areas used as range.

Native hay production can be maintained or increased by mowing when the dominant species reaches the boot stage, by selecting a cutting height of more than 4 inches, and by deferring grazing and mowing as needed to increase plant vigor and improve plant composition. Tame hay production can be maintained or increased by timing the first cutting and selecting a cutting height according to species grown and by applying the most economical kinds and amounts of fertilizer.

This soil is moderately well suited to dwellings and local roads and streets. The shrink-swell potential is a limitation on sites for dwellings. Also, the wetness is a limitation on sites for dwellings with basements. Properly designing and reinforcing foundations, installing the foundations below the depth of seasonal drying, installing foundation drains, and backfilling with porous material around the foundation help to prevent the damage caused by shrinking and swelling and by wetness. Low strength and the shrink-swell potential are limitations on sites for local roads and streets. Roads should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to prevent the road damage caused by shrinking and swelling.

Because of the slow permeability and the wetness, this soil generally is unsuitable as a septic tank absorption field. It is well suited to sewage lagoons. Because of slope, however, some land shaping generally is needed.

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

Ds—Dwight silt loam, 0 to 3 percent slopes. This deep, nearly level, moderately well drained soil is on ridgetops and foot slopes in the uplands. Depressions less than 1 foot deep and less than 50 feet across are common. Individual areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the surface layer is very dark gray silt loam about 5 inches thick. The subsoil to a depth of more than 60 inches is very firm silty clay. The upper part is black, the next part is grayish brown and mottled, and the lower part is grayish brown and reddish brown.

Included with this soil in mapping are small areas of Lula, Dennis, and Summit soils, which make up about 10 percent of the unit. The well drained Lula soils are on ridgetops. Dennis and Summit soils are on foot slopes. The upper part of their subsoil is silty clay loam. The surface layer of the Summit soils also is silty clay loam.

Permeability is very slow in the Dwight soil. Available water capacity is moderate. Surface runoff is medium. Organic matter content is moderate. The shrink-swell potential is high in the subsoil. The content of sodium in the subsoil adversely affects the growth of most plants.

Only a few areas are cultivated. This soil is poorly suited to cultivated crops. Wheat, grain sorghum, and soybeans are the main crops. If cultivated crops are grown, erosion is a hazard. It can be controlled, however, by terraces, contour farming, and grassed waterways. Minimum tillage, crop rotations, a cover of crop residue, and applications of commercial fertilizer increase the organic matter content and improve fertility and tilth. Cultivation is difficult because of poor tilth in the surface layer.

Most of the acreage is used as range, pasture, or hayland. This soil is suited to those uses. About two-thirds of the grassland supports a mixture of tall, mid, and short native prairie grasses. Overused areas are dominated by short grasses, such as buffalograss and blue grama. Proper stocking rates, timely deferment of grazing, and control of unwanted vegetation help to maintain or increase the amount of forage produced in the areas used for grazing. Native hay production can be maintained or increased by mowing when the dominant species reaches the boot stage, by selecting a cutting height of more than 4 inches, and by deferring mowing or grazing as needed to increase plant vigor and improve plant composition.

Because of the extent of the shorter grasses, many areas of this soil are used as booming ground by prairie chickens. The nesting habitat for the prairie chickens can be improved by growing tall grasses in the nearby areas.

This soil is moderately well suited to dwellings and local roads and streets. The shrink-swell potential is a limitation. Also, low strength is a limitation on sites for local roads and streets. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling. Roads should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to prevent the road damage caused by shrinking and swelling.

Because of the very slow permeability, this soil generally is unsuitable as a septic tank absorption field. It is well suited to sewage lagoons.

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

Ed—Elmont loam, 3 to 7 percent slopes. This deep, moderately sloping, well drained soil is on upland side slopes. Individual areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the surface layer is very dark brown loam about 8 inches thick. The subsurface layer is very dark grayish brown, friable loam about 8 inches thick. The subsoil is firm and friable clay loam about 36 inches thick. The upper part is dark brown and mottled, the next part is brown and reddish brown, and the lower part is brown and light brownish gray. Sandstone is at a depth of about 52 inches. In some areas the lower part of the subsoil is silty clay. In other areas the depth to sandstone is less than 40 inches.

Included with this soil in mapping are small areas of Eram and Kenoma soils, which make up 10 to 15 percent of the unit. The moderately deep Eram soils are on the lower side slopes. The moderately well drained Kenoma soils are in the less sloping areas.

Permeability is moderately slow in the Elmont soil. Available water capacity is high. Surface runoff is medium. Organic matter content is moderate. Tilth is good. The shrink-swell potential is moderate in the subsoil.

About 60 percent of the acreage is used for cultivated crops, and the rest is used as range, pasture, or hayland. This soil is moderately well suited to soybeans, wheat, grain sorghum, and corn. If cultivated crops are grown, erosion is a hazard. Terraces, contour farming, and grassed waterways help to prevent excessive runoff and soil loss. Minimum tillage, crop rotations, a cover of crop residue, and applications of commercial fertilizer increase the organic matter content and improve fertility and tilth.

This soil is suited to range, pasture, and hay. About 60 percent of the grassland supports native prairie grasses, and the rest supports cool-season tame grasses. The native vegetation dominantly is big bluestem, little bluestem, and indiangrass. In overused areas the range has been invaded by less desirable plants, such as tall dropseed, Baldwin ironweed, and western ragweed. Proper stocking rates, timely deferment of grazing, well distributed watering and salting facilities, and control of unwanted vegetation help to maintain or increase the amount of forage produced in the areas used as range.

Native hay production can be maintained or increased by mowing when the dominant species reaches the boot stage, by selecting a cutting height of more than 4 inches, and by deferring grazing and cutting as needed to increase plant vigor and improve plant composition. Tame hay production can be maintained or increased by timing the first cutting and selecting a cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer.

This soil is well suited to dwellings and local roads and streets. The shrink-swell potential is a limitation on sites for dwellings, and low strength is a limitation on sites for roads. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling. Roads should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil.

This soil is moderately well suited to septic tank absorption fields and sewage lagoons. The moderately slow permeability is a limitation on sites for septic tank systems. Increasing the size of the absorption field or installing two absorption fields that are used alternately improves the functioning of the septic tank system. The depth to bedrock and the slope are limitations on sites for sewage lagoons. The depth to bedrock can be overcome by borrowing soil or ripping the bedrock during construction. Sealing the bottom of the lagoon helps to prevent excessive seepage into fractures in the bedrock. Because of the slope, some land shaping generally is needed when sites for lagoons are prepared.

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

En—Eram silty clay loam, 3 to 7 percent slopes. This moderately sloping, moderately well drained, moderately deep soil is on side slopes and narrow ridgetops in the uplands. Individual areas are long and narrow and range from 10 to 200 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 9 inches thick. The subsoil is about 19 inches thick. It is mottled. It is very dark grayish brown and dark grayish brown, very firm silty clay in the upper part and yellowish brown and strong brown, very firm silty clay loam in the lower part. Shale is at a depth of about 28 inches. In places the depth to shale is more than 40 inches. The surface layer is silty clay in areas where it has been mixed with the upper part of the subsoil by tillage. In some areas the subsoil is dark reddish brown and is underlain by limestone.

Included with this soil in mapping are small areas of Clareson, Dennis, and Elmont soils. The well drained Clareson soils are on the upper side slopes. The deep Dennis and Elmont soils are on the lower side slopes. Included soils make up 10 to 15 percent of the unit.

Permeability is slow in the Eram soil. Available water capacity is low. Surface runoff is medium. A perched seasonal high water table is 2 to 3 feet below the surface in the spring. Organic matter content is moderate. Root penetration is restricted by the bedrock at a depth of about 28 inches. Tilth is good. The shrink-swell potential is high in the subsoil.

About half of the acreage is used for cultivated crops, and half is used as range, pasture, or hayland. This soil is better suited to small grain and grain sorghum than to corn or soybeans. If cultivated crops are grown, erosion is a hazard. It can be controlled, however, by terraces, contour farming, and grassed waterways. Minimum tillage, crop rotations, a cover of crop residue, and applications of commercial fertilizer increase the organic matter content and improve fertility and tilth.

This soil is suited to range, pasture, and hay. About 65 percent of the grassland supports native prairie grasses, and the rest supports cool-season tame grasses. In the areas used as range, the native vegetation dominantly is big bluestem, little bluestem, switchgrass, and indiangrass. In overused areas the range is invaded by less productive vegetation, such as tall dropseed, western ragweed, and Baldwin ironweed.

Proper stocking rates, timely deferment of grazing, and control of unwanted vegetation help to maintain or increase the amount of forage produced on range. Native hay production can be maintained or increased by mowing when the dominant species reaches the boot stage, by selecting a cutting height of more than 4 inches, and by deferring grazing and cutting as needed to increase plant vigor and improve plant composition. Tame hay production can be maintained or increased by timing the first cutting and selecting a cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer. Proper stocking rates, rotation grazing, well distributed watering and salting facilities, applications of fertilizer, and control of unwanted vegetation help to maintain or increase the amount of forage produced on tame pasture.

This soil is moderately well suited to dwellings and local roads and streets. The shrink-swell potential is a limitation on sites for dwellings. Also, the wetness is a limitation on sites for dwellings with basements. Properly designing and reinforcing foundations, installing the foundations below the depth of seasonal drying, installing foundation drains, and backfilling with porous material around the foundations help to prevent the damage caused by shrinking and swelling and by wetness. Low strength and the shrink-swell potential are limitations on sites for local roads and streets. Roads should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to prevent the damage caused by shrinking and swelling.

Because of the depth to bedrock, the wetness, and the slow permeability, this soil generally is unsuitable as a septic tank absorption field. It is poorly suited to sewage lagoons because of the depth to bedrock. This limitation can be overcome by borrowing soil or ripping the bedrock during construction. Sealing the bottom of the lagoon helps to prevent excessive seepage into fractures in the bedrock. Some slope modification may be needed to keep surface water from entering the lagoon.

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

Er—Eram silty clay, 3 to 7 percent slopes, eroded. This moderately sloping, moderately well drained, moderately deep soil is on convex side slopes in the uplands. Individual areas are irregular in shape and range from 7 to 50 acres in size.

Typically, the surface layer is very dark gray silty clay about 6 inches thick. The subsoil is very firm silty clay about 19 inches thick. It is very dark grayish brown and mottled in the upper part and yellowish brown and strong brown in the lower part. Shale is at a depth of about 25 inches. In some areas the surface layer is silty clay loam. In other areas the depth to shale is more than 40 inches.

Included with this soil in mapping are small areas of Clareson, Kenoma, and Lebo soils. Clareson soils have a flaggy silty clay loam subsoil. They are on the upper side slopes. The deep Kenoma soils are in the less sloping areas. The well drained Lebo soils are on the upper side slopes.

Permeability is slow in the Eram soil. Available water capacity is low. Surface runoff is medium. A perched seasonal high water table is at a depth of 2 to 3 feet. Organic matter content is moderately low. Root penetration is restricted by the bedrock at a depth of about 25 inches. Tilth is fair. The shrink-swell potential is high in the subsoil.

About 30 percent of the acreage is used for cultivated crops, and the rest is used as range, pasture, or hayland. This soil is better suited to small grain and grain sorghum than to corn or soybeans. If cultivated crops are grown, further erosion is a hazard. It can be controlled, however, by terraces, contour farming, and grassed waterways. In small areas where limestone crops out, cultivation is difficult. Minimum tillage, crop rotations, a cover of crop residue, and applications of commercial fertilizer increase the organic matter content and improve fertility and tilth.

This soil is suited to range, pasture, and hay. About 75 percent of the grassland supports cool-season tame grasses, and the rest supports native prairie grasses. The native vegetation dominantly is big bluestem, little bluestem, and indiangrass. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition. Applications of fertilizer and control of unwanted vegetation help to maintain or increase the amount of forage produced on tame pasture. Tame hay production can be maintained or increased by timing the first cutting and selecting a cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer.

This soil is moderately well suited to dwellings and local roads and streets. The shrink-swell potential is a limitation on sites for dwellings. Also, the wetness is a limitation on sites for dwellings with basements. Installing reinforced foundations below the depth of seasonal drying, providing foundation drains, and backfilling with porous material around the foundation help to prevent the damage to buildings caused by shrinking and swelling and by wetness. Low strength and the shrink-swell potential are limitations on sites for local roads and streets. Roads should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to prevent the road damage caused by shrinking and swelling.

Because of the depth to bedrock, the wetness, and the slow permeability, this soil generally is unsuitable as a septic tank absorption field. It is poorly suited to sewage lagoons because of the depth to bedrock. This limitation can be overcome by borrowing soil or ripping the bedrock during construction. Sealing the bottom of the lagoon helps to prevent excessive seepage into fractures in the bedrock. Some slope modification may be needed to keep surface water from entering the lagoon.

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

Ke—Kenoma silt loam, 1 to 4 percent slopes. This deep, moderately well drained, gently sloping soil is on the lower side slopes and ridgetops in the uplands or is on terraces. Individual areas are irregular in shape and range from 3 to several hundred acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsoil is very firm, mottled silty clay about 45 inches thick. The upper part is very dark grayish brown, the next part is dark brown, and the lower part is light olive brown. Shale is at a depth of about 53 inches. In some areas the upper part of the subsoil is black. In other areas it is silty clay loam.

Included with this soil in mapping are small areas of Lula and Olpe soils, which make up 5 to 15 percent of the unit. These soils are on ridgetops. Lula soils have a dark reddish brown subsoil, and Olpe soils have a gravelly subsoil.

Permeability is very slow in the Kenoma soil. Available water capacity is moderate. Surface runoff is medium. Organic matter content is moderate. Tilth is good. The shrink-swell potential is high in the subsoil (fig. 6).

About 65 percent of the acreage is used for cultivated crops, and the rest is used as range, pasture, or hayland. This soil is moderately well suited to wheat, grain sorghum, and soybeans. It is poorly suited to corn. If cultivated crops are grown, erosion is a hazard. It can be controlled, however, by terraces, contour farming, and grassed waterways. The very firm silty clay subsoil somewhat restricts root growth and results in soil wetness after periods of heavy rainfall. Also, the soil is droughty in summer because the clayey subsoil absorbs and releases moisture slowly. Minimum tillage, a cover of crop residue, and timely applications of commercial fertilizer increase the organic matter content and improve fertility and tilth.

This soil is suited to range, pasture, and hay. About half of the grassland supports cool-season tame grasses, and half supports native prairie grasses. The native vegetation is dominantly big bluestem, little bluestem, indiangrass, and switchgrass (fig. 7). In severely overgrazed areas, these productive grasses are replaced by less desirable plants, such as tall dropseed, buffalograss, annual broomweed, and western ragweed. Proper stocking rates, timely deferment of grazing, and control of unwanted vegetation help to maintain or increase the amount of forage produced on range. Rotation grazing, well distributed watering and salting facilities, applications of fertilizer, and control of unwanted vegetation help to maintain or increase the amount of forage produced on tame pasture.

Tame hay production can be maintained or increased by timing the first cutting and selecting a cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer. Native hay

Figure 6.—Surface cracks in Kenoma silt loam, 1 to 4 percent slopes, are the result of shrinking in the subsoil during dry periods.

Figure 7.—Abundant bluestem in an area of Kenoma silt loam, 1 to 4 percent slopes, where the range is in good condition.

production can be maintained or increased by mowing when the dominant species reaches the boot stage, by selecting a cutting height of more than 4 inches, and by deferring grazing and cutting as needed to increase plant vigor and improve plant composition.

This soil is moderately well suited to dwellings and local roads and streets. The shrink-swell potential is a limitation on sites for dwellings. Properly designing and reinforcing foundations, installing the foundations below the depth of seasonal drying, installing foundation drains, and backfilling with porous material around the foundations help to prevent the structural damage caused by shrinking and swelling. Low strength and the shrink-swell potential are limitations on sites for local roads and streets. Roads should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to prevent the road damage caused by shrinking and swelling.

Because of the very slow permeability, this soil generally is unsuitable as a septic tank absorption field. It is only moderately well suited to sewage lagoons because of the depth to bedrock and the slope. The depth to bedrock can be overcome by borrowing soil or ripping the bedrock during construction. Sealing the bottom of the lagoon helps to prevent excessive seepage into fractures in the bedrock. Because of the slope, some land shaping generally is needed when sites for lagoons are prepared.

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

Ln—Lebo-Rock outcrop complex, 20 to 40 percent slopes. This steep map unit occurs as areas of a well drained, moderately deep Lebo soil intricately mixed with areas of Rock outcrop on upland side slopes. The Lebo soil is less steep than the Rock outcrop. Individual areas are narrow and range from 10 to 100 acres in size. They are 60 to 80 percent Lebo soil and 10 to 15 percent Rock outcrop. The Lebo soil and Rock outcrop occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Lebo soil has a very dark grayish brown stony silty clay loam surface layer about 6 inches thick. The subsoil is about 16 inches thick. It is very dark grayish brown, friable silty clay loam in the upper part and brown, friable shaly silty clay loam in the lower part. The substratum is olive and yellowish brown very shaly silt loam. Shale is at a depth of about 30 inches. In some areas the subsoil is silty clay.

Typically, the Rock outcrop is limestone. It supports little or no vegetation. The limestone formations generally are more than 5 feet thick.

Included with the Lebo soil and Rock outcrop in mapping are small areas of the moderately deep Clareson soils, which make up about 5 to 10 percent of the unit. These soils are on the upper side slopes.

Permeability is moderate in the Lebo soil. Available water capacity is low. Surface runoff is rapid. Root penetration is restricted by the bedrock at a depth of about 30 inches. The shrink-swell potential is moderate in the subsoil.

Nearly all of the acreage is used as range or wildlife habitat. Because of a severe hazard of erosion, the outcrops of limestone, and the steep slope, this map unit is unsuited to cultivated crops. It is best suited to range. The native vegetation is dominantly big bluestem, little bluestem, and indiangrass. Overgrazing reduces the extent of the plant cover and causes deterioration of the plant community. Under these conditions, the taller grasses are replaced by the less productive weeds and by brush. In many areas at least 50 percent of the vegetation is woody, mainly oak, elm, and ash. Proper stocking rates, timely deferment of grazing, and control of unwanted vegetation help to maintain or increase the amount of forage produced on range.

The Lebo soil generally is not productive as woodland. Some trees, however, are cut for firewood.

The vegetation commonly growing on the Lebo soil provides habitat for many wildlife species, including deer, quail, and many nongame birds. Proper stocking rates, brush control, and establishment of feed areas increase the wildlife population.

This map unit generally is unsuited to building site development because of the steep slope.

The land capability classification is VIIe. The Lebo soil is in the Loamy Upland range site.

Ls—Lebo-Summit silty clay loams, 7 to 12 percent slopes. These strongly sloping soils are on convex side slopes in the uplands. The deep, moderately well drained Summit soil is on the lower side slopes. The moderately deep, well drained Lebo soil is on the steeper, upper side slopes. Individual areas are 150 to 350 feet wide and more than 1,500 feet long and range from 7 to 100 acres in size. They are about 45 to 65 percent Lebo soil and 20 to 40 percent Summit soil. The two soils occur as areas so intricately mixed or so small or narrow that mapping them separately is not practical.

Typically, the Lebo soil has a very dark grayish brown silty clay loam surface layer about 6 inches thick. The subsoil is friable silty clay loam about 16 inches thick. It is very dark grayish brown in the upper part and brown in the lower part. The upper part of the substratum is olive brown and yellowish brown very shaly clay loam. The lower part is olive brown extremely shaly clay loam. Shale is at a depth of about 36 inches. In places the surface layer and subsoil are loam.

Typically, the Summit soil has a black silty clay loam surface layer about 8 inches thick. The subsoil extends to a depth of more than 60 inches. It is black, firm silty clay loam in the upper part; very dark gray and very dark grayish brown, mottled, very firm silty clay in the next part; and dark grayish brown and grayish brown, mottled, very firm silty clay in the lower part. In some areas the depth to shale is less than 40 inches. In other areas the surface layer is silty clay.

Included with these soils in mapping are small areas of Clareson soils and small areas where limestone crops out. These areas make up about 10 to 15 percent of the unit. They are on the upper side slopes. The moderately deep Clareson soils have a flaggy silty clay loam subsoil.

Permeability is moderate in the Lebo soil and slow in the Summit soil. Available water capacity is low in the Lebo soil and high in the Summit soil. Surface runoff is medium on both soils. A perched seasonal high water table is at a depth of 2 to 3 feet in the Summit soil. Organic matter content is moderate in both soils. Root penetration is restricted by the bedrock at a depth of about 30 inches in the Lebo soil. The shrink-swell potential is high in the subsoil of the Summit soil and moderate in the Lebo soil.

About 75 percent of the acreage is used as range, and the rest is used for cool-season tame grasses. Because of a severe hazard of erosion, these soils generally are unsuited to cultivated crops. They are well suited to range. The native grasses are dominantly big bluestem, little bluestem, and indiangrass. In some areas the vegetation includes a canopy of ash, oak, and elm. Proper stocking rates, timely deferment of grazing, and control of unwanted vegetation help to keep the range in good condition. Proper stocking rates, rotation grazing, well distributed watering and salting facilities, applications of fertilizer, and control of unwanted vegetation help to maintain or increase the amount of forage produced on tame pasture.

Native hay production can be maintained or increased by mowing when the dominant species reaches the boot stage, by selecting a cutting height of more than 4 inches, and by deferring grazing and cutting as needed to increase plant vigor and improve plant composition. Tame hay production can be maintained or increased by timing the first cutting and selecting a cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer.

These soils are poorly suited to dwellings. The shrink-swell potential and slope of both soils and the wetness of the Summit soil are limitations. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling and by wetness. Some land shaping commonly is needed when sites for buildings are prepared. The depth to bedrock in the Lebo soil is a limitation, but the shale bedrock is soft and can be easily excavated.

These soils are moderately well suited to local roads and streets. Low strength is a limitation. The shrink-swell potential of the Summit soil also is a limitation. The roads should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soils. Providing coarser grained base material helps to prevent the road damage caused by shrinking and swelling.

Because of the depth to bedrock in the Lebo soil and the slow permeability in the Summit soil, these soils generally are unsuitable as septic tank absorption fields. They generally are unsuited to sewage lagoons because of the slope. The less sloping included or adjacent soils on the lower side slopes are suitable sites for lagoons.

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

Lu—Lula silt loam, 1 to 3 percent slopes. This deep, well drained, gently sloping soil is on ridgetops above upland areas where limestone crops out. Individual areas are irregular in shape and range from 5 to several hundred acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsurface layer is dark reddish brown, firm silty clay loam about 6 inches thick. The subsoil is firm or very firm silty clay loam about 30 inches thick. The upper part is dark reddish brown, and the lower part is dark yellowish brown and mottled. Limestone is at a depth of about 44 inches. In some places the surface layer is silty clay loam. In other places the depth to limestone is less than 40 inches. In some areas the subsoil is flaggy silty clay loam.

Included with this soil in mapping are small areas of Dwight, Eram, and Kenoma soils, which make up 5 to 10 percent of the unit. The moderately well drained Dwight and Kenoma soils are on ridgetops above the Lula soil. The moderately deep Eram soils are on the lower side slopes.

Permeability and available water capacity are moderate in the Lula soil. Surface runoff is slow. Organic matter content is moderate. Tilth is good. Root penetration is restricted by the bedrock at a depth of about 44 inches. The shrink-swell potential is moderate in the subsoil.

Most areas are used for cultivated crops. This soil is well suited to soybeans, wheat, grain sorghum, and corn. If cultivated crops are grown, erosion is a hazard. It can be controlled, however, by terraces, contour farming, and grassed waterways. A cropping system that results in the most efficient use of the amount of available water is needed. Minimum tillage, crop rotations, a cover of crop residue, and applications of commercial fertilizer increase the organic matter content and improve fertility and tilth.

Some areas are used as range, pasture, or hayland. This soil is suited to those uses. About half of the grassland supports cool-season tame grasses, and half supports native prairie grasses. The native vegetation dominantly is big bluestem, little bluestem, and indiangrass. Proper stocking rates, timely deferment of grazing, and control of unwanted vegetation help to maintain or increase the amount of forage produced on range. Proper stocking rates, rotation grazing, well distributed watering and salting facilities, applications of fertilizer, and control of unwanted vegetation help to maintain or increase the amount of forage produced on tame pasture.

Tame hay production can be maintained or increased by timing the first cutting and selecting a cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer. Native hay production can be maintained or increased by mowing when the dominant species reaches the boot stage, by selecting a cutting height of more than 4 inches, and by deferring grazing and cutting as needed to increase plant vigor and improve plant composition.

This soil is moderately well suited to dwellings without basements and to local roads and streets. The shrink-swell potential is a limitation. Also, low strength is a limitation on sites for local roads and streets. Roads should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to prevent the road damage caused by shrinking and swelling. Properly designing and reinforcing foundations and backfilling with porous material help to prevent the damage to buildings caused by shrinking and swelling. The soil generally is unsuited to dwellings with basements because of the depth to bedrock. The deep included soils, however, are suitable sites.

This soil is moderately well suited to septic tank absorption fields and sewage lagoons. The depth to bedrock and the moderate permeability are limitations in septic tank absorption fields. Increasing the size of the absorption field or installing two absorption fields that are used alternately improves the functioning of the septic tank system. The depth to bedrock, seepage, and slope are limitations on sites for sewage lagoons. The depth to bedrock can be overcome by borrowing soil during construction. Sealing the bottom of the lagoon helps to prevent excessive seepage into fractures in the bedrock. Land shaping commonly is needed because of the slope.

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

Mb—Mason silt loam. This deep, nearly level, well drained soil is on terraces. It is subject to rare flooding of short duration. Individual areas are irregular in shape and range from 5 to 20 acres in size.

Typically, the surface layer is very dark brown silt loam about 7 inches thick. The subsurface layer is very dark brown silty clay loam about 8 inches thick. The subsoil to a depth of more than 60 inches is silty clay loam. The upper part is very dark grayish brown and friable, and the lower part is dark brown and firm.

Included with this soil in mapping are small areas of Osage and Dennis soils, which make up 5 to 10 percent of the unit. The poorly drained Osage soils are in the lower concave areas. The moderately well drained Dennis soils are on side slopes above the Mason soil.

Permeability is moderately slow in the Mason soil. Available water capacity is high. Surface runoff is slow. Organic matter content is moderate. Tilth is good. The shrink-swell potential is moderate in the subsoil.

Most areas are used for cultivated crops. This soil is well suited to soybeans, corn, wheat, and grain sorghum. The main management needs are measures that improve fertility and tilth. Minimum tillage, a cover of crop residue, and applications of commercial fertilizer increase the organic matter content and improve fertility and tilth.

Some areas support cool-season tame grasses. This soil is well suited to pasture and hay. Proper stocking rates, rotation grazing, well distributed watering and salting facilities, applications of fertilizer, and control of unwanted vegetation help to maintain or increase the amount of forage produced on tame pasture. Hay production can be maintained or increased by mowing when the dominant species reaches the boot stage, by selecting a cutting height of more than 4 inches, and by applying the most economical kinds and amounts of fertilizer.

A few areas support native hardwoods. This soil is suited to trees. Plant competition and seedling mortality are management concerns. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation and seedling mortality are controlled by adequate site preparation and by spraying or cutting. The important commercial species are black walnut and green ash.

This soil is poorly suited to dwellings because of the flooding. Onsite inspection and knowledge of the history of flooding in a given area are needed when building sites are selected. Levees and dikes help to overcome the flooding hazard.

This soil is moderately well suited to local roads and streets. Low strength is a limitation. Roads should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance.

This soil is well suited to sewage lagoons. It is only moderately well suited to septic tank absorption fields because the moderately slow permeability is a limitation. Increasing the size of the absorption field or installing two absorption fields that are used alternately helps to overcome this limitation.

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

Oe—Olpe-Kenoma complex, 1 to 5 percent slopes. These deep, moderately sloping soils are on side slopes and narrow ridgetops in the uplands. The Olpe soil is well drained, and the Kenoma soil is moderately well drained. Individual areas are irregular in shape and range from 5 to 50 acres in size. They are 55 to 65 percent Olpe soil and 25 to 35 percent Kenoma 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 very dark brown silty clay loam surface layer about 7 inches thick. The subsurface layer is very dark brown, firm extremely gravelly silty clay loam about 13 inches thick. The subsoil extends to a depth of more than 60 inches (fig. 8). The upper part is dark reddish brown, very firm extremely gravelly silty clay, and the lower part is dark reddish brown and yellowish red, mottled, very firm silty clay. In places the subsoil is flaggy silty clay loam.

Typically, the Kenoma soil has a very dark grayish brown silt loam surface layer about 8 inches thick. The subsoil to a depth of more than 60 inches is very firm silty clay. The upper part is very dark grayish brown and mottled, the next part is dark brown and mottled, and the lower part is dark brown and light olive brown. In some areas the upper part of the subsoil is silty clay loam.

Included with these soils in mapping are small areas of Bates, Eram, and Lula soils, which make up 10 to 15 percent of the unit. These included soils are on the lower side slopes. Bates and Eram soils are moderately deep. Lula soils are well drained.

Figure 8.—Profile of Olpe silty clay loam, in an area of Olpe-Kenoma complex, 1 to 5 percent slopes. The subsoil has many rounded chert fragments. Depth is marked in feet.

Permeability is very slow in the Kenoma soil and slow in the Olpe soil. Available water capacity is high in the Kenoma soil and moderate in the Olpe soil. Surface runoff is medium on both soils. Organic matter content is moderate. The shrink-swell potential is high in the subsoil of the Kenoma soil and in the lower part of the Olpe soil.

Only a few areas are cultivated. These soils are poorly suited to cultivated crops. If cultivated crops are grown, erosion is a hazard. It can be controlled, however, by terraces, contour farming, and grassed waterways. Minimum tillage, crop rotations, a cover of crop residue, and applications of commercial fertilizer increase the organic matter content and improve fertility and tilth. Cultivation is difficult in the more gravelly areas.

Most of the acreage is used as range, pasture, or hayland. These soils are suited to those uses. About two-thirds of the grassland supports native prairie grasses. In areas where the range is in good condition, the main grasses are big bluestem, little bluestem, and indiangrass. Proper stocking rates, timely deferment of grazing, and control of unwanted vegetation help to maintain or increase the amount of forage produced in the areas used for grazing. Native hay production can be maintained or increased by mowing when the dominant species reaches the boot stage, by selecting a cutting height of more than 4 inches, and by deferring grazing and mowing as needed to increase plant vigor and improve plant composition.

These soils are moderately well suited to dwellings and local roads and streets. The shrink-swell potential is a limitation. Also, low strength in the Kenoma soil is a limitation on sites for local roads and streets. Properly designing and reinforcing foundations, installing the foundations below the depth of seasonal drying, installing foundation drains, and backfilling with porous material around the foundations help to prevent the damage to buildings caused by shrinking and swelling. Roads should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the Kenoma soil. Providing coarser grained base material helps to prevent the road damage caused by shrinking and swelling.

Because of the slow or very slow permeability, these soils generally are unsuitable as septic tank absorption fields. They are only moderately well suited to sewage lagoons because of the slope. The less sloping areas are the better sites.

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

Op—Orthents, hilly. These soils are a mixture of soil material, rocks, and shale from coal mine spoil. They range from moderately sloping to steep. Individual areas are irregular in shape and range from 4 to 50 acres in size.

No one profile is typical of this map unit, but in many areas the soils are olive brown, red, and dark grayish brown shaly silty clay loam. The texture ranges from shaly silty clay loam to silty clay.

Included with these soils in mapping are areas of water, coal fragments, limestone, sandstone, and shale. These included areas make up about 10 to 25 percent of the unit.

Surface runoff is rapid on the slopes and ponded in the low areas. Available water capacity is low. Organic matter content also is low. Reaction ranges from strongly acid to moderately alkaline.

These soils are used for wildlife habitat, solid waste disposal, and recreational development. A few small areas are grazed by livestock. The vegetation is weeds, annual grasses, and trees. Many areas are bare.

These soils generally are not suited to cultivated crops or building site development because of the slope and the rock fragments. Onsite investigation is needed to determine the suitability of a given area for specific uses. Unless the slopes are extensively graded and shaped, establishing desirable grasses or trees is difficult.

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

Os—Osage silty clay loam. This deep, poorly drained, nearly level soil is on flood plains. It is occasionally flooded. Slopes are concave in places. Individual areas are irregular in shape and range from 3 to 150 acres in size.

Typically, the surface layer is very dark gray silty clay loam about 8 inches thick. The subsurface layer is black, firm silty clay loam about 8 inches thick. The subsoil to a depth of about 60 inches is very dark gray, mottled, very firm silty clay. In places the surface layer is silt loam.

Included with this soil in mapping are small areas of the well drained Mason and Verdigris soils, which make up 10 to 15 percent of the unit. Mason soils are on low terraces. Verdigris soils are nearer to stream channels than the Osage soil.

Permeability is very slow in the Osage soil. Surface runoff also is very slow. Available water capacity is moderate. A seasonal high water table is within a depth of 1 foot. Organic matter content is moderate. Tilth is good. The shrink-swell potential is very high in the subsoil.

Most areas are used for cultivated crops. This soil is well suited to soybeans, corn, grain sorghum, and wheat. The main concern of management is the excess water that runs in from the adjacent uplands. Also, the soil is wet after heavy rainfall because of the very slow runoff and permeability. Constructing diversions and terraces in the adjacent upland areas helps to keep water from running onto this soil. Drainage ditches and land grading also reduce the wetness of this soil. Leaving crop residue on the surface increases the rate of water infiltration. Minimum tillage and timely applications of commercial fertilizer increase the organic matter content and improve fertility and tilth. In some years fall tillage is needed to prepare a desirable seedbed for the crops planted early in the next growing season.

Some areas support cool-season tame grasses. This soil is well suited to pasture and hay. Proper stocking rates, rotation grazing, well distributed watering and salting facilities, applications of fertilizer, and control of unwanted vegetation help to maintain or increase the amount of forage produced on tame pasture. Hay production can be maintained or increased by timing the first cutting and selecting a cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer. Mowing hay and grazing during wet periods cause surface compaction and poor tilth.

A few areas are used as native woodland. This soil is suited to trees. Tree seeds, cuttings, and seedlings survive and grow well if competing plants are controlled. Because of the wetness, the equipment limitation and seedling mortality are moderate and plant competition is severe. The use of equipment is limited to dry periods. Adequate site preparation and spraying or cutting reduce the rate of seedling mortality and control plant competition. The important commercial species are pecan and bur oak.

This soil generally is unsuitable for building site development because of the flooding.

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

Ov—Osage silty clay. This deep, nearly level, poorly drained soil is on flood plains. It is occasionally flooded. Individual areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the surface layer is very dark gray, firm silty clay about 8 inches thick. The subsurface layer is black, mottled, very firm silty clay about 8 inches thick. The subsoil to a depth of about 60 inches is black, mottled, very firm silty clay.

Included with this soil in mapping are small areas of the well drained Verdigris soils, which make up about 10 percent of the unit. These soils are nearer to stream channels than the Osage soil.

Permeability is very slow in the Osage soil. Surface runoff also is very slow. Available water capacity is moderate. A seasonal high water table is within a depth of 1 foot during wet periods. Organic matter content is moderate. Tilth is poor. As a result, cultivation is difficult. The shrink-swell potential is very high.

Most of the acreage is used for cultivated crops. Some areas support tame grasses or trees. This soil is moderately well suited to wheat, grain sorghum, and soybeans. It is poorly suited to corn. The wetness and the flooding can delay fieldwork and reduce yields. Field drainage ditches, a bedding system, and land leveling help to remove excess surface water. The soil fails to release water readily to plants. As a result, yields are reduced during dry periods. Crop residue in the plow layer or on the surface improves tilth and increases the rate of water infiltration. Fall tillage improves the seedbed for the following spring.

This soil is suited to cool-season tame grasses for pasture or hay. Proper stocking rates, rotation grazing, well distributed watering and salting facilities, applications of fertilizer, and control of unwanted vegetation help to maintain or increase the amount of forage produced on tame pasture. Hay production can be maintained or increased by timing the first cutting and selecting a cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer.

A few areas support native hardwoods. This soil is moderately well suited to trees. Tree seeds, cuttings, and seedlings survive and grow well if competing plants are controlled. Because of the wetness, the equipment limitation is moderate and seedling mortality and plant competition are severe. The use of equipment is limited to dry periods. Adequate site preparation and spraying or cutting reduce the rate of seedling mortality and control plant competition. The important commercial species are pecan and pin oak.

This soil generally is unsuitable for building site development because of the flooding.

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

Ow—Osage silty clay, frequently flooded. This deep, nearly level, poorly drained soil is on flood plains at the upper ends of Melvern and Pomona Lakes. It not only is frequently flooded but also in most areas is periodically covered by water from the lakes. Individual areas are irregular in shape and range from 100 to 400 acres in size.

Typically, the surface layer is very dark gray silty clay about 8 inches thick. The subsurface layer is black, mottled, very firm silty clay about 8 inches thick. The subsoil to a depth of about 60 inches is black, mottled, very firm silty clay.

Included with this soil in mapping are small areas of the well drained Verdigris soils, which make up about 15 percent of the unit. These soils are nearer to stream channels than the Osage soil.

Permeability is very slow in the Osage soil. Surface runoff also is very slow. Available water capacity is moderate. A seasonal high water table is within a depth of 1 foot. Organic matter content is moderate. The surface layer is plastic and sticky when wet and very hard when dry. The shrink-swell potential is very high.

This soil is used mainly for wildlife habitat. Most areas are planted to wheat or grain sorghum. Part of the crop is harvested, and part is left in the field for the wildlife. The crops cannot be harvested in some years because of the flooding or the wetness. The vegetation on this soil and the nearby lakes provide good habitat for waterfowl, deer, furbearers, and quail.

This soil generally is unsuited to building site development because of the flooding.

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

Pt—Pits, quarries. This map unit occurs as areas from which the soil and much of the underlying limestone or shale have been removed. The underlying material is used as a source of gravel or limestone. The quarries generally are surrounded by vertical walls. Some are filled with water. Most support no plants, but some support scattered trees, shrubs, and clumps of grass. This unit has good potential for the development of upland wildlife habitat, fishing areas, and other recreation areas.

This map unit is not assigned to a land capability class or to a range site.

Sn—Summit silty clay loam, 1 to 3 percent slopes. This deep, moderately well drained, gently sloping soil is on foot slopes in the uplands. Individual areas are irregular in shape and range from 10 to 50 acres in size.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsoil extends to a depth of more than 60 inches. The upper part is black, firm silty clay loam; the next part is very dark gray and very dark grayish brown, mottled, very firm silty clay; and the lower part is dark grayish brown and grayish brown, mottled, very firm silty clay. In places the surface layer is silt loam.

Permeability is slow. Available water capacity is high. Surface runoff is medium. A perched seasonal high water table is at a depth of 2 to 3 feet during the spring. Organic matter content is moderate. Tilth is good. The shrink-swell potential is high in the subsoil.

Most areas are used for cultivated crops. This soil is well suited to soybeans, wheat, grain sorghum, and corn. If cultivated crops are grown, erosion is a hazard. It can be controlled, however, by terraces, contour farming, and grassed waterways. Minimum tillage, a cover of crop residue, and timely applications of commercial fertilizer increase the organic matter content and improve fertility and tilth.

Some areas support cool-season tame grasses. This soil is suited to pasture and hay. Proper stocking rates, rotation grazing, well distributed watering and salting facilities, applications of fertilizer, and control of unwanted vegetation help to maintain or increase the amount of forage produced on tame pasture. Hay production can be maintained or increased by timing the first cutting and selecting a cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer.

This soil is moderately well suited to dwellings and local roads and streets. The shrink-swell potential is a limitation on sites for dwellings. Also, the wetness is a limitation on sites for dwellings with basements. Installing reinforced foundations below the depth of seasonal drying, providing foundation drains, and backfilling with porous material help to prevent the damage to buildings caused by shrinking and swelling and by wetness. Low strength and the shrink-swell potential are limitations on sites for local roads and streets. Roads should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to prevent the road damage caused by shrinking and swelling.

Because of the slow permeability, this soil generally is unsuitable as a septic tank absorption field. It is well suited to sewage lagoons, but the slope is a limitation. Some slope modification may be needed to keep surface water from entering the lagoon.

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

So—Summit silty clay loam, 3 to 7 percent slopes. This deep, moderately well drained, moderately sloping soil is on convex upland side slopes, generally below areas where limestone crops out. Individual areas are irregular in shape and range from 3 to 200 acres in size.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is black, firm silty clay loam about 5 inches thick. The subsoil is mottled, very firm silty clay about 43 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. In some areas shale is within a depth of 40 inches. In other areas the surface layer is loam or silt loam.

Included with this soil in mapping are small areas of Clareson, Lebo, and Lula soils, which make up about 5 to 10 percent of the unit. The moderately deep Clareson and Lebo soils are on the upper side slopes. The well drained Lula soils are on the lower side slopes.

Permeability is slow in the Summit soil. Available water capacity is moderate. Surface runoff is medium. A perched seasonal high water table is at a depth of 2 to 3 feet during the spring. Organic matter content is moderate. Tilth is good. The shrink-swell potential is high in the subsoil.

About 60 percent of the acreage is used for cultivated crops, and the rest is used as range, pasture, or hayland. This soil is moderately well suited to soybeans, wheat, grain sorghum, and corn. If cultivated crops are grown, erosion is a hazard. It can be controlled, however, by terraces, contour farming, and grassed waterways. Minimum tillage, a cover of crop residue, and timely applications of commercial fertilizer increase the organic matter content and improve fertility and tilth.

This soil is suited to range, pasture, and hay. About two-thirds of the grassland supports native prairie grasses, and the rest supports cool-season tame grasses. The dominant vegetation on the range that is in good condition is big bluestem, little bluestem, and indiangrass. Proper stocking rates, timely deferment of grazing, and control of unwanted vegetation help to maintain or increase the amount of forage produced in the areas used as range. Proper stocking rates, rotation grazing, well distributed watering and salting facilities, applications of fertilizer, and control of unwanted vegetation help to maintain or increase the forage produced on tame pasture.

Native hay production can be maintained or increased by mowing when the dominant species reaches the boot stage, by selecting a cutting height of more than 4 inches, and by deferring grazing and cutting as needed to increase plant vigor and improve plant composition. Tame hay production can be maintained or increased by timing the first cutting and selecting a cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer.

This soil is moderately well suited to dwellings and local roads and streets. The shrink-swell potential is a limitation on sites for dwellings. Also, the wetness is a limitation on sites for dwellings with basements. Installing reinforced foundations below the depth of seasonal drying, providing foundation drains, and backfilling with porous material help to prevent the damage to buildings caused by shrinking and swelling and by wetness. Low strength and the shrink-swell potential are limitations on sites for local roads and streets. Roads should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to prevent the road damage caused by shrinking and swelling.

Because of the slow permeability, this soil generally is unsuitable as a septic tank absorption field. It is suited to sewage lagoons, but the slope is a limitation. Some slope modification may be needed to keep surface water from entering the lagoon.

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

Vb—Verdigris silt loam. This deep, nearly level, well drained soil is on flood plains. It is occasionally flooded for very brief periods. Individual areas are irregular in shape and range from 5 to several hundred acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 7 inches thick. The subsurface layer is very dark grayish brown, friable silt loam about 7 inches thick. The next 21 inches is dark brown, friable silt loam. The substratum to a depth of about 60 inches is brown silt loam. In some areas grayish brown mottles are below a depth of about 16 inches.

Included with this soil in mapping are small areas of Osage soils, which make up about 10 percent of the unit. These poorly drained soils are in concave areas.

Permeability is moderate in the Verdigris soil. Available water capacity is high. Surface runoff is slow. Organic matter content is moderate. Tilth is good. The shrink-swell potential is moderate.

Most of the acreage is used for cultivated crops. Some areas are used for pasture. This soil is well suited to corn, soybeans, grain sorghum, and wheat. Flooding, fertility, and tilth are the main management concerns. The flooding generally cannot be controlled but seldom causes serious crop damage. Minimum tillage, a cover of crop residue, and applications of commercial fertilizer increase the organic matter content and improve fertility and tilth.

This soil is suited to pasture and hay. Proper stocking rates, rotation grazing, well distributed watering and salting facilities, applications of fertilizer, and control of unwanted vegetation help to maintain or increase the amount of forage produced on tame pasture. Hay production can be maintained or increased by timing the first cutting and selecting a cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer.

This soil is well suited to trees. Flooding and plant competition are management concerns. Cuttings and seedlings grow well if competing vegetation is controlled. Adequate site preparation and spraying, cutting, or girdling help to control the undesirable vegetation. The important commercial species are black walnut, pecan, bur oak, hackberry, and green ash.

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

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

Vc—Verdigris silt loam, channeled. This deep, well drained, nearly level soil is along upland drainageways that are dissected by meandering channels (fig. 9). It is frequently flooded. Individual areas are 150 to 400 feet wide and range from 5 to 50 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 9 inches thick. The subsurface layer also is very dark grayish brown silt loam. It is about 8 inches thick. The next 33 inches is dark brown, friable silt loam. The substratum to a depth of about 60 inches is brown silty clay loam.

Included with this soil in mapping are small areas where rock crops out and small areas of Bates, Eram, and Osage soils. Included areas make up 10 to 15 percent of the unit. The moderately deep Bates and Eram soils are on short side slopes. The poorly drained Osage soils are in concave areas on flood plains. The areas where rock crops out are on steep side slopes.

Permeability is moderate in the Verdigris soil. Available water capacity is high. Surface runoff is slow. Organic matter content is moderate. The shrink-swell potential also is moderate.

Most areas are used as range, but a few are used as tame pasture or as woodland. This soil generally is unsuited to cultivated crops because the flooding is a hazard and because operating farm machinery is difficult along the meandering stream channels. In many areas where the range is overgrazed and in poor condition, the more desirable grasses have been replaced by less productive grasses and by weeds. The cattle tend to congregate around the watering facilities and shade trees near these areas. Rotation grazing and restricting grazing to the winter increase forage production.

A few areas support native hardwoods. This soil is well suited to trees. Flooding and plant competition are management concerns. Tree seeds, cuttings, and seedlings grow well if competing vegetation is controlled or removed. Proper site preparation and spraying, cutting, or girdling help to control the undesirable plants. The important commercial species are black walnut, pecan, bur oak, hackberry, and green ash.

The vegetation commonly growing on this soil provides habitat for many kinds of wildlife, including quail, deer, rabbits, and numerous songbirds. The wildlife population can be increased by establishing more fringe areas where woodland is adjacent to cropland.

This soil generally is unsuitable for 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.

Wo—Woodson silt loam, 0 to 2 percent slopes. This deep, somewhat poorly drained, nearly level soil is on the broad tops of upland ridges and on high terraces. Individual areas are irregular in shape and range from 20 to several hundred acres in size.

Typically, the surface layer is black silt loam about 8 inches thick. The subsoil is mottled, very firm silty clay about 28 inches thick. The upper part is black, the next part is very dark gray, and the lower part is dark grayish brown. The upper part of the substratum is brown, mottled silty clay loam. The lower part to a depth of about 60 inches is mottled grayish brown and reddish brown clay. In some areas the upper part of the subsoil is very dark grayish brown or dark brown. In other areas the depth to the silty clay subsoil is more than 15 inches. The surface layer is silty clay loam in areas where it has been mixed with the upper part of the subsoil by tillage.

Permeability is very slow. Available water capacity is moderate. Surface runoff is slow. A perched seasonal high water table is at a depth of 0.5 to 2.0 feet during the spring. Organic matter content is moderate. Tilth is good. The shrink-swell potential is high in the subsoil.

About 75 percent of the acreage is used for cultivated crops, and the rest supports native or tame grasses and is used for hay or grazing. This soil is well suited to wheat, soybeans, and grain sorghum but is not so well suited to corn. Crop yields can be reduced by the wetness. They also can be reduced during periods of drought because the clayey subsoil does not readily release water to plants. Minimum tillage and crop residue in the plow layer or on the surface increase the rate of water intake and improve tilth. Erosion is a hazard in the more sloping areas. Terraces and contour farming help to prevent excessive soil loss.

This soil is suited to pasture and range. Grazing when the soil is too wet, however, causes surface compaction

Figure 9.—An entrenched drainageway in an area of Verdigris silt loam, channeled.

and poor tilth. Proper stocking rates, restricted use during wet periods, and timely deferment of grazing help to keep the grassland in good condition. Applications of fertilizer generally are needed to improve the vigor of tame grasses. Timely mowing of these grasses for hay allows the plants to recover.

This soil is moderately well suited to dwellings. The wetness and the shrink-swell potential are limitations. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by wetness and by shrinking and swelling.

Because of low strength, the wetness, and the shrink-swell potential, this soil is only moderately well suited to local roads and streets. The roads should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to prevent the road damage caused by shrinking and swelling. Building the roads on raised fill material, establishing adequate side ditches, and installing culverts reduce the wetness.

This soil is well suited to sewage lagoons. Because of the very slow permeability, however, it is unsuitable as a septic tank absorption field.

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

Prime Farmland

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

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cropland, pasture, woodland, or other land, but it is not urban or built-up land or water areas. It either is used for food or fiber or is available for those uses. The soil qualities, growing season, and moisture supply are those needed for a well managed soil economically to produce a sustained high yield of crops. 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 usually 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 7 percent. More detailed information about the criteria for prime farmland is available at local offices of the Soil Conservation Service.

About 261,000 acres in Osage County, or nearly 57 percent of the total acreage, meets the soil requirements for prime farmland. This acreage occurs as areas throughout the county. The crops grown on this land, mainly soybeans, grain sorghum, and wheat, account for an estimated seven-eighths of the county's total crop income each year.

The map units considered prime farmland in Osage County are listed in this section. This list does not consititute 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 in the section "Detailed Soil Map Units."

On the following list, the Osage and Woodson soils, which have a seasonal high water table, qualify for prime farmland only in areas where the wetness has been sufficiently reduced. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures. The Woodson soil generally has been adequately drained, either through the application of drainage measures or through the incidental drainage that results from farming, roadbuilding, and other kinds of land development.

The map units that meet the soil requirements for prime farmland are:

Bd Bates loam, 3 to 7 percent slopes
Dn Dennis silt loam, 2 to 6 percent slopes
Ed Elmont loam, 3 to 7 percent slopes
Ke Kenoma silt loam, 1 to 4 percent slopes
Lu Lula silt loam, 1 to 3 percent slopes
Mb Mason silt loam
Os Osage silty clay loam (where drained)
Ov Osage silty clay (where drained)
Sn Summit silty clay loam, 1 to 3 percent slopes
So Summit silty clay loam, 3 to 7 percent slopes
Vb Verdigris silt loam
Wo Woodson silt loam, 0 to 2 percent slopes (where drained)

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.

Crops and Pasture

John C. Dark, 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.

According to the Conservation Needs Inventory, about 49 percent of the acreage in Osage County was used for cultivated crops in 1969 and 9 percent for tame grass pasture. During the period of 1970 to 1980, about 32 percent of the cropland was used for sorghum, 22 percent for soybeans, 18 percent for tame hay, 15 percent for wheat, 6 percent for corn, 3 percent for alfalfa, 1 percent for oats, and 3 percent for miscellaneous crops (*4*). During this 10-year period, the acreage used for wheat, soybeans, and hay increased, while the acreage used for sorghum, corn, and alfalfa decreased. About 900 acres was irrigated in 1980.

Productivity can be increased on most farms by applying the latest crop production technology. This soil survey can facilitate the application of such technology. The main management needs in the areas used for cultivated crops are measures that help to control erosion, that result in the most efficient use of the available water in the soils, and that maintain fertility and tilth. Also, a drainage system is needed in some areas.

Soil erosion is the major hazard on the cropland in Osage County if the slope is more than 1 percent. Erosion reduces the productivity of the soil. If the surface layer is lost through erosion, most of the available plant nutrients and organic matter, which has positive effects on soil structure, water infiltration, available water capacity, and tilth, are also lost. Loss of the surface layer is especially damaging on soils that have a clayey subsoil, such as Eram, Kenoma, and Woodson. Preparing a good seedbed and tilling are difficult in the clayey spots that remain after the original friable surface layer has eroded away.

In many areas erosion on farmland results in the pollution of streams by sediment, nutrients, and pesticides. Controlling erosion minimizes this pollution and improves the quality of water.

Various combinations of conservation practices are effective in controlling erosion. Terraces can be effective by reducing the length of slopes. Grassed waterways

Figure 10.—An area of Kenoma silt loam, 1 to 4 percent slopes, recently planted to wheat. Crop residue helps to control erosion.

used in combination with terrace systems help to remove surface water at a nonerosive velocity. Contour farming is effective in controlling erosion in many areas. Most of the slopes where terraces have been constructed should be farmed on the contour. Keeping crop residue on the surface increases the rate of water infiltration, thereby decreasing the amount of water that runs off the surface and the amount of sediment carried off by the water. Using noninversion tillage tools and reducing the number of tillage operations help to keep crop residue on the surface. A cropping sequence that keeps crop residue on the surface most of the year helps to control erosion and preserves the productivity of the soil (fig. 10). Including perennial crops, such as tame grasses and legumes, or close-growing crops, such as wheat, oats, and barley, in the cropping sequence helps to prevent excessive soil loss. Including legumes and tame grasses in the cropping sequence also increases the supply of nitrogen and improves tilth.

Soil tilth is the physical condition of the soil, especially the soil structure as related to the growth of plants. Soils with good tilth are granular and porous. Tilth has important effects on the infiltration of water into the soil and on seedbed preparation. It is a major concern affecting all soils, particularly Osage soils and eroded soils in which the clayey subsoil has been mixed with the surface layer. Tilth indirectly affects crop production through its effect on the amount of water available for plant growth. The available water capacity is especially important on Eram and other arable soils in which the underlying bedrock restricts root penetration.

Soil fertility is affected by reaction and by the supply of plant nutrients in the soil. Most of the soils in the survey area have a slightly acid or medium acid surface layer unless they have been limed. If lime is applied, the pH of these soils is raised and production of legumes, such as alfalfa, and other crops that grow well on neutral soils is increased. The amount of fertilizer and lime needed should be determined by the needs of the crop, the expected level of yields, the experience of farmers, and the results of soil tests. The Cooperative Extension

Service can help to determine the kinds and amounts of nutrients to be applied.

Drainage of excess water is needed before cultivated crop production can be sustained on Osage soils. Surface drains or a bedding system can be used to reduce the wetness.

The chief tame grasses grown in Osage County are smooth bromegrass and tall fescue. The main management needs in the areas used for tame grasses are measures that maintain or improve the quality and quantity of the forage, protect the surface, and reduce water loss. A good stand of tame grasses can be maintained by proper stocking rates, rotation grazing, well distributed salting and watering facilities, applications of fertilizer, and control of unwanted vegetation.

Further information about managing cropland can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

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 5. 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 table 5.

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 insures 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 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

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

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

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

Class I soils have few limitations that restrict their use.

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

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

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

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

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

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

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

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

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

The capability classification of each map unit is given in the section "Detailed Soil Map Units" and in table 5.

Rangeland

Lynn Gibson, range conservationist, Soil Conservation Service, helped prepare this section.

About 34 percent of the acreage in Osage County is classified as rangeland or native hayland. Other areas that support trees and an understory of grasses are grazed by livestock and have good potential for the plants used as forage. Range plants provide a significant amount of forage during the summer, when their protein and food value are high, but only a few ranchers depend entirely on native grasses to feed livestock. Tame pasture and crop residue supplement the forage grown on rangeland.

Most of the rangeland is in the western two-thirds of the county. Some small tracts, generally less than 100 acres in size, are in the other parts of the county. On most of the smaller tracts, the rangeland has been greatly depleted because of neglect and overgrazing, which have resulted in the invasion of brush, scrub trees, and weeds. The amount of forage produced on these tracts generally is less than half of that originally produced. Bates, Clareson, Clime, Eram, Lebo, and Sogn soils are the dominant soils in many of the depleted areas. If well managed, these soils can produce a large amount of high-quality forage.

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 6 shows, for nearly all the soils in the county, 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 6 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.

Woodland Management and Productivity

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

About 6 percent of the acreage in Osage County is classified as woodland. The wooded acreage has been steadily decreasing, mainly as a result of the conversion of woodland to cropland or pasture. The woodland is in scattered areas throughout the county. These areas generally are privately owned tracts making up a small acreage on farms. They occur as irregularly shaped tracts and narrow bands along streams and rivers, strips in upland drainageways, and steep areas of upland soils that are underlain by limestone and shale.

The woodland supports two forest cover types—hackberry-American elm-green ash and white oak-black oak-northern red oak. About 30 percent of the woodland is the bottom land in the Verdigris-Osage soil association and the upland drainageways, both of which support the hackberry-American elm-green ash forest cover type. Numerous associated species grow in these areas, mainly eastern cottonwood, black willow, black walnut, boxelder, Russian mulberry, bur oak, silver maple, pecan, Kentucky coffeetree, hickories, and Ohio buckeye (fig. 11).

The white oak-black oak-northern red oak forest cover type is on the shallow to moderately deep soils in the Eram-Lula-Summit soil association. Bur oak, Shumard oak, and chinkapin oak also grow in most areas of these soils. Other associated species include mainly American elm, hackberry, hickories, osageorange, green ash, and honeylocust.

Many of the trees, especially the bottom land species, have commercial value for wood products. Only a small part of the woodland, however, is managed for commercial wood production. A few trees are cut for fuel or for fenceposts. Some nuts are harvested from pecan and walnut trees. An estimated 95 percent of the woodland is grazed by livestock.

Many of the soils in the county have good potential for Christmas trees and for the trees used in the production of veneer, sawtimber, firewood, and other wood products. The bottom land soils along rivers and streams produce high-value hardwoods within a short period. In contrast, the upland soils produce low-value trees over a long period.

Table 7 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 suitable 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 important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: x, w, t, d, c, s, f, and r.

In table 7, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or in equipment; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree to which the soil affects the mortality of tree seedlings. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Ratings of *plant competition* indicate the degree to which undesirable plants are expected to invade where there are openings in the tree canopy. The invading plants compete with native plants or planted seedlings. A rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competition is expected to hinder the development of a fully stocked stand of desirable trees; *severe* indicates that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed to control undesirable plants.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index*. This 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.

Trees to plant are those that are suited to the soils and to commercial wood production.

Figure 11.—Black walnut and other trees growing on a Verdigris soil.

Windbreaks and Environmental Plantings

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

Trees grow on most of the farmsteads in Osage County. They either were already growing on the site when the farmstead was established or were planted by the landowners. They generally are grown as environmental plantings but also are grown in several farmstead windbreaks. Those in the windbreaks are mainly eastern redcedar. Numerous species are grown as environmental plantings. The most common ones are black walnut, green ash, oaks, hackberry, elms, silver maple, oriental arborvitae, Kentucky coffeetree, and lilac.

Only a few windbreaks are planted each year in the county, but many environmental plantings are established on farmsteads, on rural homesites, and in other areas. 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 in areas where farming is expanding.

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

In order for windbreaks and environmental plantings to fulfill their intended purpose, the soils on the site should be suited to the trees or shrubs selected for planting. Selecting suitable species helps to ensure survival and a maximum growth rate.

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.

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 insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 8 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 8 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 nursery.

Recreation

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

Osage County has several areas of scenic, geologic, and historic interest. The many farm ponds and the Marais des Cygnes River and its tributaries provide a few opportunities for water sports on private lands. Melvern, Pomona, and Osage State Lakes provide many opportunities for recreation on public lands.

The soils of the survey area are rated in table 9 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent or its suitability as a site for sewage lagoons 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 9, 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 9 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

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 Osage County are bobwhite quail, mourning dove, cottontail rabbit, fox squirrel, white-tailed deer, and several species of waterfowl. Furbearers are common along the Marais des Cygnes River and its tributaries. They are trapped on a limited basis.

Nongame species are numerous because the habitat types are diverse. Cropland, woodland, and grassland are interspersed throughout the county. Each of these types provides a habitat for a particular group of species.

Melvern, Pomona, and Osage State Lakes and the streams and farm ponds in the county provide good to excellent fishing. The species commonly caught in the ponds and streams are bass, bluegill, crappie, carp, channel cat, bullhead, flathead catfish, wipers, and walleye.

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

In table 10, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

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

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

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

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

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

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, poplar, black walnut, sycamore, maple, cottonwood, pecan, elm, mulberry, honeylocust, Ohio buckeye, pawpaw, sweetgum, hawthorn, dogwood, hickory, blackberry, and blueberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, plum, fragrant sumac, gooseberry, blackberry, 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 pine, spruce, and eastern redcedar.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of native shrubs are plum, buckbrush, 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, pheasant, mourning dove, meadowlark, coyote, rodents, cottontail rabbit, 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 owls, thrushes, woodpeckers, squirrels, opossum, raccoon, and white-tailed deer.

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

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include coyote, bobwhite quail, prairie chicken, hawks, and killdeer.

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

Engineering

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

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

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

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

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

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

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

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

Building Site Development

Table 11 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock 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, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock, 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 12 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 12 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, and flooding affect absorption of the effluent. Large stones and bedrock 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 12 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, 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 and bedrock 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 12 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, 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 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 13 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

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

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

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

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

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 13, 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 14 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 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, 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. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock 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 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.

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.

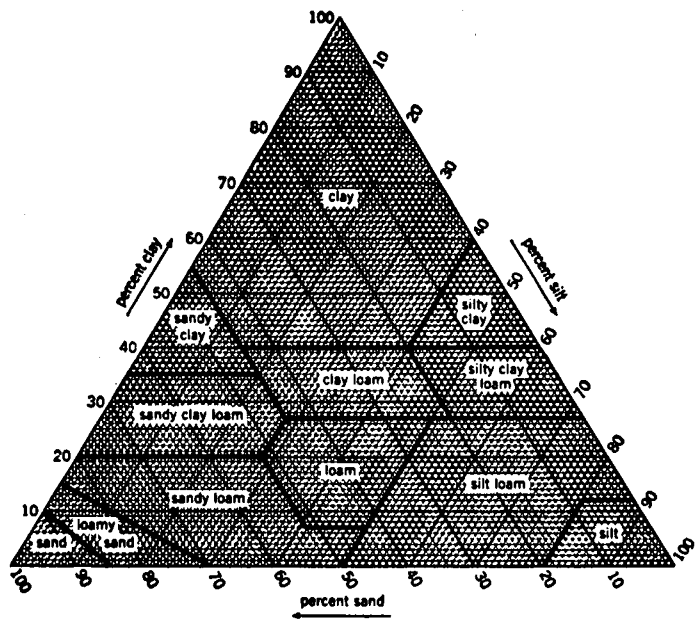


Figure 12.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Engineering Index Properties

Table 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

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

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

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

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

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

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

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

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

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

Physical and Chemical Properties

Table 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

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

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

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

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

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

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

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

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

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

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

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

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

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing and the amount of soil lost. 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 18 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 18 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 16, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

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

Soil and Water Features

Table 17 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

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

The four hydrologic soil groups are:

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

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

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

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

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

Table 17 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, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal 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 17 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 17. 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 specified as 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.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

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.

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 18 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 have a udic moisture regime).

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

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

Bates Series

The Bates series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from sandstone and loamy shale. Slope ranges from 3 to 7 percent.

Bates soils are similar to Elmont soils and commonly are adjacent to Dennis and Kenoma soils. Elmont soils are more than 40 inches deep over bedrock. Dennis and Kenoma soils are more clayey in the subsoil than the Bates soils. Also, Dennis soils are lower on the landscape. Kenoma soils are on ridgetops above the Bates soils.

Typical pedon of Bates loam, 3 to 7 percent slopes, 500 feet north and 125 feet east of the center of sec. 1, T. 14 S., R. 15 E.

A—0 to 8 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; moderate fine and medium granular structure; slightly hard, friable; many very fine roots; common worm casts; about 2 percent sandstone fragments less than 3 inches in diameter; medium acid; gradual smooth boundary.

AB—8 to 15 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; moderate fine and medium granular structure; slightly hard, friable; many very fine roots; common worm casts; about 2 percent sandstone fragments less than 3 inches in diameter; medium acid; gradual smooth boundary.

Bt—15 to 23 inches; dark yellowish brown (10YR 4/4) loam, yellowish brown (10YR 5/4) dry; weak medium subangular blocky structure; slightly hard, friable; common very fine and few fine roots; common worm casts; about 2 percent small sandstone fragments less than 3 inches in diameter; medium acid; clear wavy boundary.

BC—23 to 30 inches; brown (10YR 5/3) gravelly fine sandy loam, pale brown (10YR 6/3) dry; weak medium granular structure; soft, very friable; about 30 percent sandstone fragments 1/4 inch to 2 inches in diameter; few very fine roots; medium acid; clear wavy boundary.

Cr—30 inches; soft, fine grained sandstone.

The thickness of the solum and the depth to sandstone bedrock range from 20 to 40 inches. The solum is slightly acid or medium acid. The thickness of the mollic epipedon ranges from 8 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 2 or 3. It is dominantly loam, but the range includes fine sandy loam and clay 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 6. It is loam or clay loam.

Clareson Series

The Clareson series consists of moderately deep, well drained, moderately slowly permeable soils on uplands. These soils formed in material weathered from limestone. Slope ranges from 3 to 15 percent.

Clareson soils are similar to Olpe and Sogn soils and commonly are adjacent to Eram, Lebo, Lula, and Olpe soils. Olpe soils are more than 40 inches deep over bedrock. Sogn soils are less than 20 inches deep over bedrock. Eram and Lebo soils are lower on the landscape than the Clareson soils. Eram soils have a clayey subsoil that has few or no coarse fragments. Lebo soils do not have an argillic horizon. Lula soils are more than 40 inches deep over bedrock. They are higher on the landscape than the Clareson soils.

Typical pedon of Clareson silty clay loam, in an area of Clareson-Eram complex, 3 to 15 percent slopes, 2,600 feet east and 2,450 feet north of the southwest corner of sec. 13, T. 14 S., R. 16 E.

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

AB—8 to 16 inches; dark brown (7.5YR 3/2) silty clay loam, brown (7.5YR 4/2) dry; strong fine subangular blocky structure; slightly hard, friable; many very fine and fine roots; neutral; gradual smooth boundary.

Bt—16 to 24 inches; dark reddish brown (5YR 3/3) very flaggy silty clay loam, reddish brown (5YR 4/4) dry; moderate fine and medium subangular blocky structure; very hard, firm; common very fine roots; few black stains on faces of some peds; about 60 percent limestone fragments that range in size from channers in the upper 3 inches to flagstones in the lower part; neutral; abrupt irregular boundary.

R—24 inches; limestone.

The thickness of the solum and the depth to limestone bedrock range from 20 to 40 inches. The solum is slightly acid or neutral.

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 dominantly silty clay loam, but the range includes flaggy silty clay loam. The Bt horizon has hue of 7.5YR, 5YR, or 2.5YR, value of 3 or 4 (4 or 5 dry), and chroma of 3 to 5. It is very flaggy silty clay loam, very flaggy silty clay, extremely flaggy silty clay loam, or extremely flaggy silty clay. The content of limestone fragments in this horizon ranges from 35 to 85 percent.

Clime Series

The Clime series consists of moderately deep, well drained, slowly permeable soils on uplands. These soils formed in material weathered from calcareous shale. Slope ranges from 3 to 15 percent.

Clime soils commonly are adjacent to Eram, Sogn, and Summit soils. Eram soils do not contain lime. They are in positions on the landscape similar to those of the Clime soils. Sogn soils are less than 20 inches deep over limestone. They are higher on the landscape than the Clime soils. Summit soils are more than 40 inches deep over bedrock. They are lower on the landscape than the Clime soils.

Typical pedon of Clime silty clay, in an area of Clime-Sogn complex, 3 to 15 percent slopes, 1,200 feet east and 60 feet south of the northwest corner of sec. 13, T. 17 S., R. 13 E.

A—0 to 7 inches; very dark brown (10YR 2/2) silty clay, very dark gray (10YR 3/1) dry; strong fine and medium granular structure; hard, firm; many very fine and fine and common medium roots; mildly alkaline; gradual smooth boundary.

Bw—7 to 14 inches; very dark grayish brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; very hard, very firm; many very fine and common fine roots; slight effervescence at a depth of 10 inches; moderately alkaline; clear smooth boundary.

C—14 to 32 inches; grayish brown (2.5Y 5/2) and olive brown (2.5Y 4/4) silty clay loam, light olive brown (2.5Y 5/4) and light brownish gray (2.5Y 6/2) dry; massive; hard, firm; common very fine roots; common shale fragments; few lime concretions; strong effervescence; moderately alkaline; gradual smooth boundary.

Cr—32 inches; light brownish gray (2.5Y 6/2) and olive brown (2.5Y 4/6) calcareous shale.

The thickness of the solum ranges from 12 to 24 inches and the depth to shale bedrock from 20 to 40 inches. The depth to lime ranges from 0 to 10 inches. The mollic epipedon ranges from 7 to 20 inches in thickness. The soils are mildly alkaline or moderately alkaline silty clay 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 or 2. The Bw horizon has hue of 10YR or 2.5Y, value of 3 or 4 (4 or 5 dry), and chroma of 1 to 3. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4.

Dennis Series

The Dennis series consists of deep, moderately well drained, slowly permeable soils on uplands. These soils formed in silty and clayey material weathered from shale. Slope ranges from 2 to 6 percent.

Dennis soils are similar to Elmont, Kenoma, and Summit soils and commonly are adjacent to Bates, Elmont, and Kenoma soils. Elmont soils are less clayey in the subsoil than the Dennis soils. Kenoma soils do not have a BA horizon. Summit soils are grayer in the subsoil than the Dennis soils. Bates soils are higher on the landscape than the Dennis soils. They are 20 to 40 inches deep over bedrock.

Typical pedon of Dennis silt loam, 2 to 6 percent slopes, 60 feet south and 2,575 feet east of the northwest corner of sec. 1, T. 18 S., R. 14 E.

A1—0 to 9 inches; very dark brown (10YR 2/2) silt loam, very dark grayish brown (10YR 3/2) dry; moderate fine and medium granular structure; slightly hard, very friable; many very fine and fine roots; medium acid; gradual smooth boundary.

A2—9 to 14 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; slightly hard, friable; many very fine and fine roots; medium acid; clear smooth boundary.

BA—14 to 23 inches; dark brown (7.5YR 3/2) silty clay loam, brown (7.5YR 4/4) dry; few fine distinct yellowish brown (10YR 5/4) mottles; moderate fine subangular blocky structure; hard, firm; many very fine roots; medium acid; gradual smooth boundary.

Bt1—23 to 38 inches; brown (7.5YR 4/4) silty clay, brown (7.5YR 5/4) dry; few fine distinct dark grayish brown (10YR 4/2) mottles; moderate fine and medium subangular blocky structure; very hard, very firm; common very fine and fine roots; few black concretions and stains; medium acid; gradual smooth boundary.

Bt2—38 to 50 inches; dark yellowish brown (10YR 4/4) silty clay, brown (10YR 5/3) dry; many coarse prominent reddish brown (5YR 4/4) and common coarse prominent grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; very hard, firm; common very fine roots; few fine black concretions and stains; slightly acid; diffuse smooth boundary.

Bt3—50 to 60 inches; yellowish brown (10YR 5/6) silty clay, brownish yellow (10YR 6/6) dry; many coarse prominent reddish brown (5YR 4/4) and grayish brown (10YR 5/2) mottles; weak medium and coarse subangular blocky structure; very hard, firm; few very fine roots; few black concretions and stains; slightly acid.

The solum is more than 60 inches thick. The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 2 or 3. It is medium acid or strongly acid. It is dominantly silt loam and silty clay loam, but the range includes loam. 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 is silty clay loam or clay loam. It is medium acid or strongly acid. The Bt horizon has hue of 10YR, 7.5YR, or 2.5Y, value of 4 or 5 (5 or 6 dry), and chroma of 3 to 6. It is silty clay loam, clay, or silty clay. It ranges from slightly acid to strongly acid.

Dwight Series

The Dwight series consists of deep, moderately well drained, very slowly permeable, sodic soils on uplands. These soils formed in clayey sediments. Slope ranges from 0 to 3 percent.

Dwight soils are similar to Kenoma and Woodson soils and commonly are adjacent to Kenoma, Lula, and Woodson soils. The adjacent soils do not have a natric horizon. Also, their surface layer is thicker than that of the Dwight soils. Lula soils are on ridgetops above the Dwight soils.

Typical pedon of Dwight silt loam, 0 to 3 percent slopes, 950 feet east and 30 feet north of the southwest corner of sec. 23, T. 17 S., R. 15 E.

A—0 to 5 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; weak fine granular structure; slightly hard, friable; many very fine and fine roots; medium acid; abrupt smooth boundary.

Bt1—5 to 20 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate medium columnar structure parting to weak fine blocky; extremely hard, very firm; common very fine roots that are flattened along the faces of peds; thin clay films on faces of peds; few fine black concretions; neutral; clear smooth boundary.

Bt2—20 to 37 inches; grayish brown (10YR 5/2) silty clay, light brownish gray (10YR 6/2) dry; many medium distinct strong brown (7.5YR 5/6) mottles; weak medium and coarse blocky structure; very hard, very firm; few very fine roots; common gypsum accumulations; few black concretions; moderately alkaline; clear smooth boundary.

BC—37 to 60 inches; grayish brown (10YR 5/2) and reddish brown (5YR 4/4) silty clay, light brownish gray (10YR 6/2) and reddish brown (5YR 5/4) dry; weak fine and medium blocky structure; very hard, very firm; few very fine roots; gray coatings on faces of peds; few black concretions; moderately alkaline.

The depth to limestone or shale bedrock ranges from 40 to more than 60 inches. The mollic epipedon is 15 to 20 inches thick.

The A horizon has hue of 10YR, value of 2 or 3 (4 or 5 dry), and chroma of 1 or 2. It ranges from medium acid to neutral. It is dominantly silt loam, but the range includes silty clay loam. The Bt horizon has hue of 10YR, value of 2 to 5 (3 to 6 dry), and chroma of 1 to 3. It is silty clay or clay. It ranges from slightly acid to moderately alkaline.

Elmont Series

The Elmont series consists of deep, well drained, moderately slowly permeable soils on uplands. These soils formed in material weathered from shale. Slope ranges from 3 to 7 percent.

Elmont soils are similar to Bates and Dennis soils and commonly are adjacent to Bates and Eram soils. Bates and Eram soils are 20 to 40 inches deep over bedrock. They are higher on the landscape than the Elmont soils. Dennis soils are more clayey in the subsoil than the Elmont soils.

Typical pedon of Elmont loam, 3 to 7 percent slopes, 1,850 feet south and 50 feet east of the center of sec. 2, T. 14 S., R. 15 E.

A—0 to 8 inches; very dark brown (10YR 2/2) loam, dark gray (10YR 4/1) dry; moderate medium and fine granular structure; slightly hard, friable; many very fine and fine and common medium roots; medium acid; gradual smooth boundary.

AB—8 to 16 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; slightly hard, friable; many very fine and fine and few medium roots; medium acid; gradual smooth boundary.

Bt1—16 to 24 inches; dark brown (10YR 3/3) clay loam, brown (10YR 4/3) dry; few fine distinct reddish yellow (7.5YR 6/6) mottles; moderate medium subangular blocky structure; hard, firm; thin discontinuous clay films on faces of peds; many very fine and common fine roots; about 2 percent sandstone fragments less than 3 inches in diameter; medium acid; diffuse smooth boundary.

Bt2—24 to 32 inches; dark brown (10YR 4/3) clay loam, brown (10YR 5/3) dry; common fine distinct reddish yellow (7.5YR 6/6) mottles; moderate medium subangular blocky structure; hard, firm; thin discontinuous clay films on faces of peds; common very fine and few fine roots; about 5 percent sandstone fragments less than 3 inches in diameter; medium acid; gradual wavy boundary.

Bt3—32 to 42 inches; brown (7.5YR 4/4) and reddish brown (5YR 4/4) clay loam, brown (7.5YR 5/4) and reddish brown (5YR 5/4) dry; weak medium subangular blocky structure; hard, firm; few very fine roots; few fine black concretions; medium acid; gradual wavy boundary.

BC—42 to 52 inches; brown (7.5YR 4/4) and light brownish gray (10YR 6/2) clay loam, brown (7.5YR 5/4) and light gray (10YR 7/2) dry; weak coarse subangular blocky structure; slightly hard, friable; few very fine roots; medium acid; clear wavy boundary.

Cr—52 inches; fine grained sandstone.

The solum ranges from 30 to 60 inches in thickness. It is medium acid to neutral. The mollic epipedon ranges from 10 to 24 inches in thickness. The depth to shale bedrock ranges from 40 to 60 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 loam. The Bt horizon has hue of 10YR or 7.5YR, value of 3 or 4 (4 to 6 dry), and chroma of 2 to 4. It is silty clay loam or clay loam. The C horizon has hue of 5YR, 7.5YR, 10YR, or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 6. It is silty clay loam or 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 3 to 12 percent.

Eram soils are similar to Summit soils and commonly are adjacent to Clareson, Dennis, Lula, and Summit soils. The adjacent soils generally are higher on the landscape than the Eram soils. Clareson soils have many flagstones in the subsoil. Dennis, Lula, and Summit soils are more than 40 inches deep over bedrock.

Typical pedon of Eram silty clay loam, 3 to 7 percent slopes, 1,700 feet north and 100 feet west of the southeast corner of sec. 1, T. 17 S., R. 16 E.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium and fine granular structure; hard, firm; slightly acid; clear smooth boundary.

Bt1—9 to 13 inches; very dark grayish brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) dry; common medium prominent yellowish red (5YR 4/6) mottles; moderate medium and fine subangular blocky structure; very hard, very firm; thin clay films on faces of some peds; few small siltstone fragments; few fine black concretions and stains; slightly acid; gradual smooth boundary.

Bt2—13 to 24 inches; dark grayish brown (10YR 4/2) silty clay, grayish brown (10YR 5/2) dry; many medium prominent yellowish red (5YR 4/6) mottles; moderate fine and medium blocky structure; very hard, very firm; thin clay films on faces of most peds; few very fine and fine roots between peds; few fine black concretions; slightly acid; gradual smooth boundary.

BC—24 to 28 inches; yellowish brown (10YR 5/4) and strong brown (7.5YR 5/6) silty clay loam, light yellowish brown (10YR 6/4) and light brown (7.5YR 6/4) dry; common fine distinct grayish brown (10YR 5/2) mottles; weak medium blocky structure; very hard, very firm; thin clay films on faces of many peds; some visible voids and root holes coated with dark stains; few very fine and fine roots between peds; few siltstone and sandstone fragments; few black concretions; slightly acid; clear wavy boundary.

Cr—28 inches; light olive brown (2.5Y 5/4) shale that has thin laminae of sandstone.

The thickness of the solum and the depth to shale bedrock range from 20 to 40 inches. The thickness of the mollic epipedon ranges from 12 to 28 inches.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 2 or 3. It is silty clay loam, silt loam, or silty clay. It is slightly acid or medium acid. The Bt horizon has hue of 10YR or 2.5Y, value of 3 or 4 (4 or 5 dry), and chroma of 2 to 4. It ranges from neutral to medium acid. It is silty clay, clay, or silty clay loam. The content of shale and sandstone fragments in this horizon ranges from 0 to 15 percent.

Kenoma Series

The Kenoma series consists of deep, moderately well drained, very slowly permeable soils on uplands and high terraces. These soils formed in clayey material weathered from shale (fig. 13). Slope ranges from 1 to 5 percent.

Kenoma soils are similar to Dennis, Dwight, and Woodson soils and commonly are adjacent to Dennis, Lula, Olpe, and Woodson soils. Dennis soils have a BA horizon. Dwight soils have a natric horizon. Lula soils are lower on the landscape than the Kenoma soils. Also, they have a redder subsoil. Olpe soils have many rounded chert fragments in the subsoil. They are in positions on the landscape similar to those of the Kenoma soils. Woodson soils are grayer in the subsoil than the Kenoma soils.

Typical pedon of Kenoma silt loam, 1 to 4 percent slopes, 800 feet south and 100 feet east of the northwest corner of sec. 11, T. 16 S., R. 16 E.

A—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine and medium granular structure; slightly hard, very friable; medium acid; abrupt smooth boundary.

Bt1—8 to 23 inches; very dark grayish brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) dry; common fine prominent strong brown (7.5YR 4/6) mottles; moderate medium and coarse prismatic structure parting to weak medium and fine blocky; extremely hard, very firm; many very fine and fine roots between peds; few fine black concretions; medium acid; light gray coatings on peds in the upper 2 inches; thin clay films on most peds; gradual smooth boundary.

Bt2—23 to 38 inches; dark brown (7.5YR 4/4) silty clay, brown (7.5YR 5/4) dry; few dark grayish brown (10YR 4/2) silt coatings in the upper part; weak coarse prismatic structure parting to weak medium blocky; very hard, very firm; few very fine roots, mostly between peds; few fine black concretions; few lime accumulations; slightly acid; gradual smooth boundary.

BC—38 to 53 inches; light olive brown (2.5Y 5/4) silty clay, light yellowish brown (2.5Y 6/4) dry; common medium prominent brown (7.5YR 5/4) mottles; weak coarse blocky structure; very hard, very firm; few very fine roots; few fine black concretions; slightly acid; clear smooth boundary.

Cr—53 inches; light olive brown (2.5Y 5/4) shale.

The thickness of the solum ranges from 30 to 60 inches. In some pedons the content of waterworn chert gravel is as much as 20 percent. The depth to limestone or shale bedrock ranges from 40 to more than 60 inches.

Figure 13.—Profile of Kenoma silt loam. The arrow indicates the abrupt boundary between the silty surface layer and the clayey subsoil. Depth is marked in feet.

The A horizon has hue of 10YR, value of 2 or 3 (4 or 5 dry), and chroma of 1 to 3. It ranges from slightly acid to strongly acid. It is dominantly silt loam, but the range includes silty clay loam. The Bt horizon is silty clay or clay. It ranges from medium acid to mildly alkaline. In the upper part it has hue of 10YR or 7.5YR, value of 2 or 3 (4 or 5 dry), and chroma of 2 or 3. In the lower part it has hue of 10YR or 7.5YR, value of 3 to 6 (4 to 7 dry), and chroma of 2 to 6.

Lebo Series

The Lebo series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from shale (fig. 14). Slope ranges from 7 to 40 percent.

Lebo soils commonly are adjacent to Eram, Lula, and Summit soils. The adjacent soils have a higher content of clay and a lower content of coarse fragments in the subsoil than the Lebo soils. Also, they generally are less steep. Eram and Summit soils are lower on the landscape than the Lebo soils or are in similar positions, and Lula soils are higher on the landscape.

Typical pedon of Lebo silty clay loam, in an area of Lebo-Summit silty clay loams, 7 to 12 percent slopes, 2,500 feet south and 850 feet west of the northeast corner of sec. 13, T. 14 S., R. 16 E.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate fine and medium granular structure; slightly hard, friable; many very fine and fine roots; about 3 percent sandstone and siltstone fragments; neutral; gradual wavy boundary.

Bw—6 to 12 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; moderate fine and very fine subangular blocky structure; hard, friable; common worm casts; many very fine roots; about 5 percent fine shale and siltstone fragments; mildly alkaline; gradual wavy boundary.

BC—12 to 22 inches; brown (10YR 4/3) silty clay loam, light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure; hard, friable; common very fine roots; few worm casts; about 10 percent shale and siltstone fragments; mildly alkaline; gradual wavy boundary.

C1—22 to 30 inches; olive brown (2.5Y 4/4) and yellowish brown (10YR 5/6) very shaly clay loam, light olive brown (2.5Y 5/4) and brownish yellow (10YR 6/6) dry; massive; slightly hard, very friable; common very fine roots; about 50 percent soft shale and siltstone fragments; mildly alkaline; clear smooth boundary.

C2—30 to 36 inches; olive brown (2.5Y 4/4) extremely shaly clay loam, light olive brown (2.5Y 5/4) dry; massive; slightly hard, very friable; few very fine roots; about 80 percent soft shale and siltstone fragments; mildly alkaline; clear smooth boundary.

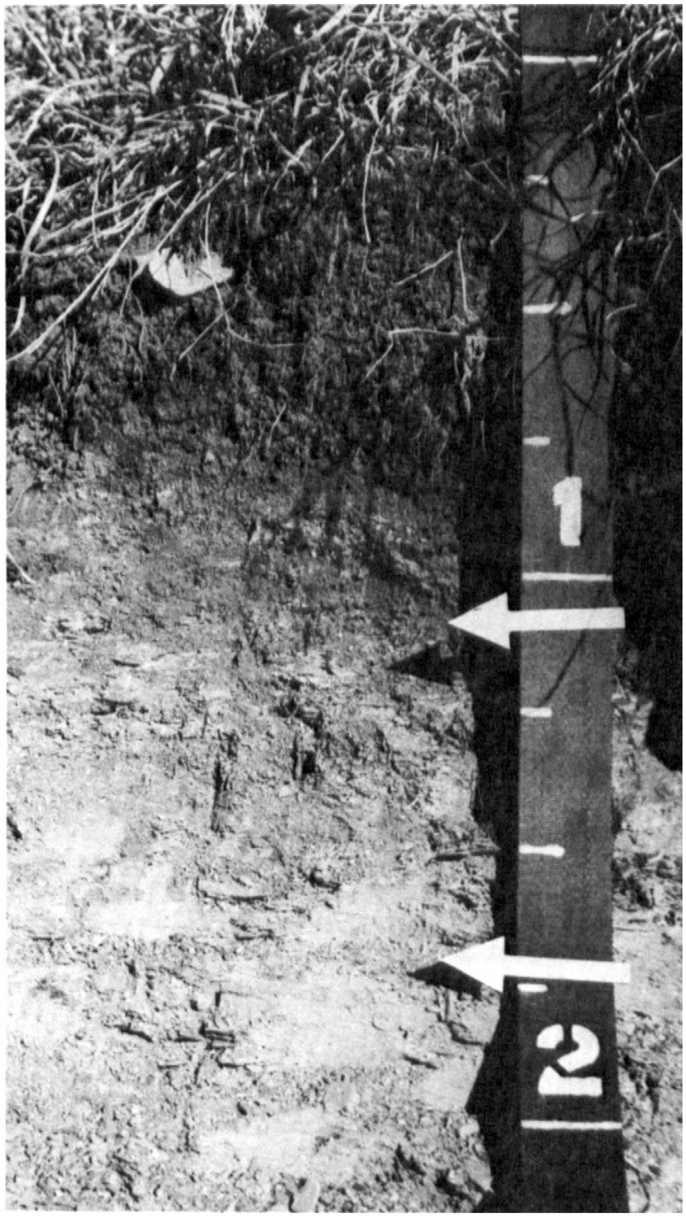


Figure 14.—Profile of Lebo soils. A shaly subsoil is between the arrows. Depth is marked in feet.

Cr—36 inches; shale; few very fine roots in joints and between laminae.

The thickness of the solum and the depth to shale bedrock range from 20 to 40 inches. The solum ranges from medium acid to mildly alkaline.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 2 or 3. It is commonly silty clay loam or stony silty clay loam, but the range includes silt loam, channery silty clay loam, shaly silty clay loam, and shaly silt loam. The Bw horizon has hue of 10YR, 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. It is very shaly silt loam, very shaly clay loam, extremely shaly silt loam, or extremely shaly clay loam.

Lula Series

The Lula series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from limestone and shale. Slope is 1 to 3 percent.

These soils are taxadjuncts to the Lula series because the content of clay in the control section is more than 35 percent. This difference, however, does not alter the use or behavior of the soils.

Lula soils are similar to Mason soils and commonly are adjacent to Clareson, Eram, Kenoma, and Woodson soils. Mason soils are more than 60 inches deep over bedrock. Clareson soils are less than 40 inches deep over limestone and have many flagstones in the subsoil. They are lower on the landscape than the Lula soils. Eram soils are less than 40 inches deep over shale. They are higher on the landscape than the Lula soils. Kenoma and Woodson soils also are higher on the landscape. They have an abrupt boundary between the A and Bt horizons.

Typical pedon of Lula silt loam, 1 to 3 percent slopes, 1,800 feet south and 250 feet east of the northwest corner of sec. 5, T. 15 S., R. 16 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 very fine and fine roots; few worm casts; slightly acid; clear smooth boundary.

AB—8 to 14 inches; dark reddish brown (5YR 3/2) silty clay loam, dark reddish gray (5YR 4/2) dry; strong very fine subangular blocky structure; hard, firm; common very fine roots; few worm casts; few fine black concretions; medium acid; gradual smooth boundary.

Bt1—14 to 22 inches; dark reddish brown (5YR 3/3) silty clay loam, reddish brown (5YR 4/3) dry; strong very fine subangular blocky structure; hard, firm; common very fine roots; thin clay films on most peds; few fine black concretions; black stains on peds; few worm casts; medium acid; gradual smooth boundary.

Bt2—22 to 38 inches; dark reddish brown (2.5YR 3/4) silty clay loam, reddish brown (2.5YR 4/4) dry; moderate fine subangular blocky structure; very hard, very firm; few very fine roots; thin clay films on peds; black stains on some peds; few fine black concretions; medium acid; gradual smooth boundary.

BC—38 to 44 inches; dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/6) dry;

common medium and coarse distinct brownish yellow (10YR 6/6) mottles; moderate fine subangular blocky structure; very hard, very firm; few very fine roots; thin clay films on some peds; dark stains on some peds; few fine black concretions; neutral; abrupt irregular boundary.

R—44 inches; limestone.

The thickness of the solum and the depth to limestone range from 40 to 60 inches. The mollic epipedon ranges from 10 to 26 inches in thickness. A few chert fragments are throughout some pedons.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3 (4 or 5 dry), and chroma of 2 or 3. The Bt horizon has hue of 5YR, 2.5YR, or 7.5YR, value of 3 or 4 (4 or 5 dry), and chroma of 3 to 6. It is medium acid or strongly acid.

Mason Series

The Mason series consists of deep, well drained, moderately slowly permeable soils on terraces. These soils formed in silty alluvium. Slope is 0 to 2 percent.

Mason soils are similar to Lula and Verdigris soils and commonly are adjacent to Osage and Verdigris soils. Lula soils are 40 to 60 inches deep over limestone bedrock. They are on uplands. Osage soils are poorly drained and are on flood plains. Verdigris soils also are on flood plains. They do not have an argillic horizon.

Typical pedon of Mason silt loam, 2,600 feet north and 1,800 feet west of the southeast corner of sec. 13, T. 14 S., R. 16 E.

Ap—0 to 7 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable; many very fine and fine roots; neutral; gradual smooth boundary.

A—7 to 15 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; many very fine and fine roots; common worm casts; slightly acid; gradual smooth boundary.

Bt—15 to 42 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; hard, friable; gray coatings and thin clay films on some peds; many very fine roots; common worm casts; many very fine and fine random pores; slightly acid; gradual smooth boundary.

BC—42 to 60 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 4/3) dry; moderate medium subangular blocky structure; hard, firm; common very fine roots; many very fine and common fine random pores; medium acid.

The thickness of the solum ranges from 40 to 60 inches. The mollic epipedon is more than 20 inches thick.

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

Olpe Series

The Olpe series consists of deep, well drained, slowly permeable soils on uplands. These soils formed in gravelly old alluvium. Slope ranges from 1 to 5 percent.

Olpe soils are similar to Clareson soils and commonly are adjacent to Bates, Dennis, and Kenoma soils. Clareson soils have flaggy limestone fragments in the subsoil. Bates and Dennis soils have few or no chert pebbles in the solum. They are lower on the landscape than the Olpe soils. Kenoma soils are on uplands and high terraces. The content of chert pebbles in their solum is less than 20 percent.

Typical pedon of Olpe silty clay loam, in an area of Olpe-Kenoma complex, 1 to 5 percent slopes, 250 feet south and 200 feet east of the northwest corner of sec. 6, T. 18 S., R. 15 E.

A—0 to 7 inches; very dark brown (10YR 2/2) silty clay loam, very dark gray (10YR 3/1) dry; strong fine granular structure; slightly hard, friable; many very fine and fine roots; about 12 percent chert pebbles; medium acid; gradual wavy boundary.

AB—7 to 20 inches; very dark brown (10YR 2/2) extremely gravelly silty clay loam, very dark grayish brown (10YR 3/2) dry; moderate fine granular structure; hard, firm; many very fine and fine roots; about 70 percent rounded chert pebbles; medium acid; gradual wavy boundary.

Bt1—20 to 50 inches; dark reddish brown (5YR 3/4) extremely gravelly silty clay, reddish brown (5YR 4/4) dry; moderate very fine subangular blocky structure; very hard, very firm; common very fine roots; about 80 percent rounded chert pebbles; medium acid; gradual wavy boundary.

2Bt2—50 to 60 inches; dark reddish brown (5YR 3/4) silty clay, reddish brown (5YR 4/4) dry; common medium distinct dark brown (7.5YR 3/2) mottles; moderate fine blocky structure; very hard, very firm; few very fine roots; about 10 percent rounded chert pebbles; few fine black concretions; medium acid; gradual smooth boundary.

2Bt3—60 to 72 inches; yellowish red (5YR 4/6) silty clay, yellowish red (5YR 5/6) dry; many medium prominent grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; very hard, very firm; few very fine roots; slightly acid.

The solum is more than 60 inches thick. It is slightly acid or medium acid. 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 dominantly silty clay loam, but the range includes silt loam, gravelly silt loam, and gravelly loam. The Bt horizon has hue of 7.5YR or 5YR, value of 3 or 4 (4 or 5 dry), and chroma of 4 to 6.

Osage Series

The Osage series consists of deep, poorly drained, very slowly permeable soils on flood plains (fig. 15). These soils formed in alluvium. Slope is 0 to 2 percent.

Osage soils commonly are adjacent to Mason and Verdigris soils. Mason soils are well drained and are on terraces. Verdigris soils are less clayey in the subsoil than the Osage soils. Also, they are closer to stream channels.

Typical pedon of Osage silty clay, 900 feet west and 75 feet south of the northeast corner of sec. 32, T. 17 S., R. 17 E.

Ap—0 to 8 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; weak fine granular structure; very hard, firm; few very fine and fine roots; few worm casts; slightly acid; clear smooth boundary.

A—8 to 16 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; few fine distinct brown (10YR 4/3) mottles; moderate fine subangular blocky structure; very hard, very firm; few worm casts; few fine black concretions; neutral; gradual smooth boundary.

Bg1—16 to 30 inches; black (2.5Y 2/1) silty clay, very dark gray (2.5Y 3/1) dry; few fine distinct dark brown (10YR 4/3) mottles; weak coarse blocky structure; very hard, very firm; few visible pores; few fine black concretions; neutral; diffuse smooth boundary.

Bg2—30 to 60 inches; black (2.5Y 2/0) silty clay, dark gray (2.5Y 4/0) dry; few fine distinct dark brown (10YR 4/3) mottles; weak coarse blocky structure; extremely hard, very firm; few fine black concretions; few slickensides; neutral.

The solum is more than 40 inches thick. It ranges from neutral to medium acid. The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is silty clay or silty clay loam.

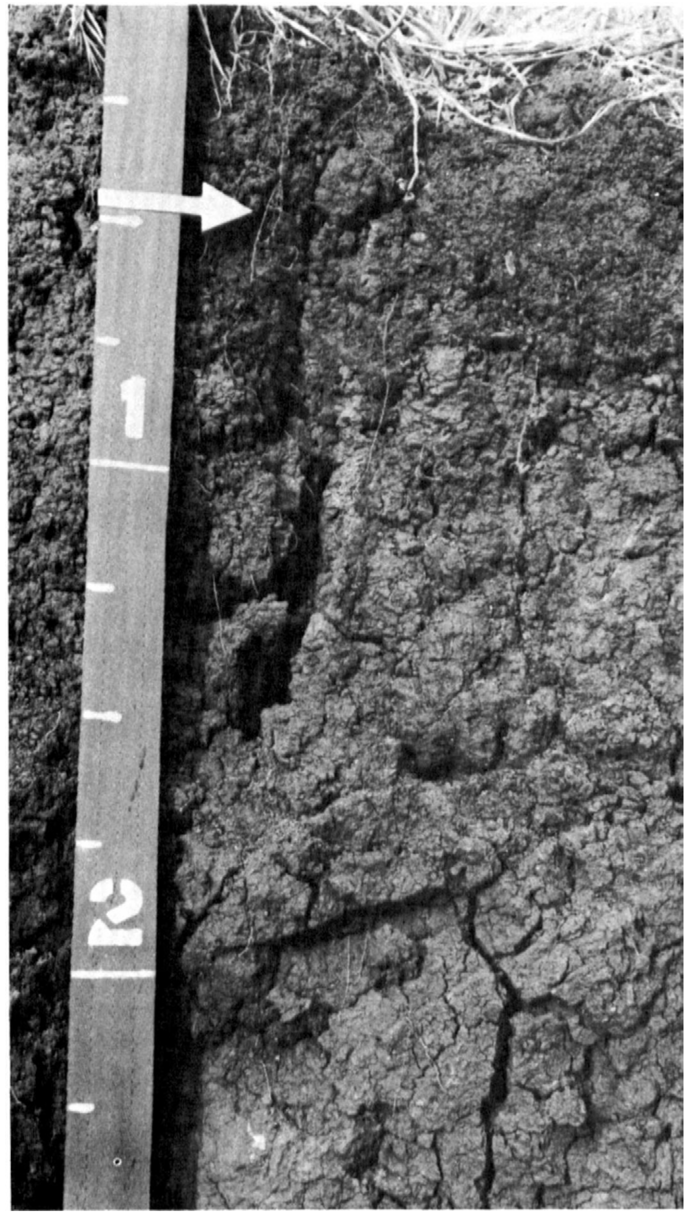


Figure 15.—Profile of Osage soils. The cracks in the subsoil are the result of shrinking. Depth is marked in feet.

Sogn Series

The Sogn series consists of shallow and very shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in material weathered from limestone. Slope ranges from 3 to 15 percent.

Sogn soils are similar to Clareson soils and commonly are adjacent to Clime and Lula soils. Clareson soils are 20 to 40 inches deep over bedrock. The calcareous Clime soils are 20 to 40 inches deep over shale. They generally are lower on the landscape than the Sogn soils. Lula soils are 40 to 60 inches deep over limestone. They are higher on the landscape than the Sogn soils.

Typical pedon of Sogn silty clay loam, in an area of Clime-Sogn complex, 3 to 15 percent slopes, 1,990 feet east and 50 feet north of the southwest corner of sec. 11, T. 17 S., R. 13 E.

A—0 to 8 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine and medium granular structure; slightly hard, friable; about 5 percent limestone fragments; many very fine roots; slight effervescence; moderately alkaline; abrupt smooth boundary.

R—8 inches; level-bedded hard limestone.

The thickness of the solum and the depth to bedrock range from 4 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 ranges from slightly acid to moderately alkaline.

Summit Series

The Summit 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 12 percent.

Summit soils are similar to Dennis and Eram soils and commonly are adjacent to Eram, Kenoma, Lebo, and Lula soils. Dennis soils are browner in the subsoil than the Summit soils. Eram soils are 20 to 40 inches deep over shale bedrock. Kenoma soils do not have an AB horizon. They are lower on the landscape than the Summit soils. Lebo and Lula soils are higher on the landscape than the Summit soils. Also, Lebo soils have a less clayey subsoil. They are 20 to 40 inches deep over bedrock. Lula soils are 40 to 60 inches deep over limestone bedrock.

Typical pedon of Summit silty clay loam, 3 to 7 percent slopes, 2,600 feet north and 100 feet west of the southeast corner of sec. 28, T. 17 S., R. 17 E.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine and medium granular structure; slightly hard, friable; few very fine roots; neutral; clear smooth boundary.

AB—8 to 13 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; strong fine subangular blocky structure; hard, firm; few very fine roots; few very fine black concretions; neutral; gradual smooth boundary.

Bt1—13 to 29 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; few fine prominent strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; very hard, very firm; few very fine roots; few fine black concretions; thin clay films on most peds; neutral; gradual smooth boundary.

Bt2—29 to 40 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; common fine distinct olive brown (2.5Y 4/4) and few fine prominent strong brown (7.5YR 5/6) mottles; moderate medium blocky structure; very hard, very firm; few very fine roots, commonly between peds; few fine black concretions; neutral; gradual smooth boundary.

BC—40 to 56 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; common medium faint light olive brown (2.5Y 5/4) mottles; weak medium blocky structure; very hard, very firm; few fine black concretions; mildly alkaline; gradual smooth boundary.

C—56 to 60 inches; grayish brown (2.5Y 5/2) silty clay, light brownish gray (2.5Y 6/2) dry; few fine prominent strong brown (7.5YR 5/6) and common medium distinct light olive brown (2.5Y 5/4) mottles; massive; very hard, very firm; few fine black concretions and stains; mildly alkaline.

The solum ranges from 50 to more than 60 inches in thickness. The mollic epipedon is more than 28 inches thick.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. It ranges from neutral to medium acid. The Bt horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 3. It is silty clay or clay in which the content of clay ranges from 40 to 50 percent. It ranges from mildly alkaline to medium acid.

Verdigris Series

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

Verdigris soils are similar to Mason soils and commonly are adjacent to Mason and Osage soils. Mason soils have an argillic horizon. They are on terraces. Osage soils have a clayey subsoil. They are in the lower areas on the flood plains.

Typical pedon of Verdigris silt loam, 50 feet north and 75 feet east of the southwest corner of sec. 34, T. 16 S., R. 16 E.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable; common very fine roots; neutral; clear smooth boundary.

A—7 to 14 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; hard, friable; common very fine roots; many continuous very fine and few fine pores; common worm casts; slightly acid; gradual smooth boundary.

AC—14 to 35 inches; dark brown (10YR 3/3) silt loam, brown (10YR 4/3) dry; weak medium granular structure; hard, friable; few very fine roots; common worm casts; many continuous very fine and few fine pores; slightly acid; gradual smooth boundary.

C—35 to 60 inches; brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; massive; slightly hard, friable; few very fine roots; many continuous very fine pores; common worm casts; slightly acid.

The thickness of the solum ranges from 24 to 60 inches. The mollic epipedon is more than 24 inches thick. The soils are neutral to medium acid silt loam or silty clay loam throughout.

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

Woodson Series

The Woodson series consists of deep, somewhat poorly drained, very slowly permeable soils on uplands and high terraces. These soils formed in clayey and silty sediments. Slope is 0 to 2 percent.

Woodson soils are similar to Dwight and Kenoma soils and commonly are adjacent to Kenoma and Lula soils. Dwight soils have a natric horizon. Kenoma soils are browner in the subsoil than the Woodson soils. Lula soils are 40 to 60 inches deep over bedrock. They are lower on the landscape than the Woodson soils.

Typical pedon of Woodson silt loam, 0 to 2 percent slopes, 100 feet east and 2,500 feet south of the northwest corner of sec. 23, T. 16 S., R. 15 E

A—0 to 8 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate fine granular structure; slightly hard, friable; many very fine and fine roots; slightly acid; abrupt smooth boundary.

Bt1—8 to 18 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate fine blocky structure; very hard, very firm; common very fine and fine roots, mostly between peds; thin clay films on peds; few fine black concretions; common very fine and few fine random pores; medium acid; gradual smooth boundary.

Bt2—18 to 28 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; few fine distinct dark yellowish brown (10YR 3/4) mottles; moderate fine and medium blocky structure; very hard, very firm; common very fine roots, mostly between peds; thin clay films on most peds; few fine black concretions; common very fine and few fine pores; medium acid; gradual smooth boundary.

BCg—28 to 36 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; common fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium blocky structure; very hard, very firm; few very fine roots between peds; few fine black concretions; common very fine and few fine pores; medium acid; gradual wavy boundary.

Cg1—36 to 54 inches; brown (10YR 5/3) silty clay loam, pale brown (10YR 6/3) dry; many fine prominent yellowish brown (10YR 5/6), reddish brown (5YR 4/4), and light brownish gray (10YR 6/2) mottles; massive; very hard, very firm; few black concretions and stains; many very fine and few fine random pores; neutral; diffuse wavy boundary.

Cg2—54 to 60 inches; coarsely mottled grayish brown (2.5Y 5/2) and reddish brown (5YR 4/4) clay; massive; very hard, very firm; few black concretions and stains; few fine siltstone particles; neutral.

The solum ranges from 36 to 60 inches in thickness. It is slightly acid or medium acid.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 or less. It is dominantly silt loam, but the range includes silty clay loam. The Bt horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 to 5 dry), and chroma of 1. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 to 3. It is silty clay loam or silty clay.

Formation of the Soils

Soil forms through processes that act on deposited or accumulated geologic material. As a result of these processes, it is constantly changing. The characteristics of the soil at any given point are determined by the interaction among five factors of soil formation—the physical and mineral composition of the parent material, the climate, the plant and animal life on and in the soil, the relief, and the length of time that the forces of soil formation have acted on the soil material. Each of these factors affects the formation of every soil, and each modifies the effects of the other four. The effects of the individual factors vary from place to place.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a soil that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material affects the kind of soil profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil. Generally, a long period is needed for the formation of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four.

Parent Material

The weathering of accumulated geologic material results in the parent material in which soils form. Parent material affects the texture and most other properties of the soil. The soils in Osage County formed in material weathered from the limestone, sandstone, and shale of the Upper Pennsylvanian and Permian Systems and in the sediment of the Tertiary and Quaternary Systems that was transported by water and wind.

The weathering of limestone, sandstone, and shale resulted in the parent material in which most of the soils in the county formed. Clime, Dennis, Eram, Lebo, and Summit soils formed in material weathered from silty and clayey shale. Bates and Elmont soils formed in material weathered from sandstone or shale. Clareson and Sogn soils formed in material weathered from limestone. Lula soils formed in material weathered from limestone and shale.

Old and recent alluvium is sediment that was transported by water. The old alluvial sediment of the Tertiary and Quaternary Systems is on the uplands or high terraces along the Marais des Cygnes River. Olpe and Woodson soils formed in this material. In some areas Woodson soils formed in a thin deposit of wind-transported silty sediment or have been modified by this sediment. Recent alluvial sediment is on the flood plains and low terraces along the Marais des Cygnes and Wakarusa Rivers and their tributaries. Mason, Osage, and Verdigris soils are on these flood plains or low terraces. Osage soils formed in silty and clayey sediment, and Mason and Verdigris soils formed in silty sediment.

Climate

Climate affects physical and chemical weathering and the biological forces at work in the parent material. The downward movement of water helps to transform the parent material into a soil that has distinct horizons. The amount of water that percolates through the soil depends on the temperature, the intensity of precipitation, the humidity, the relief, and the nature of the soil material. Soil-forming processes are most active when the soil is warm and moist. Soil structure is modified by freezing and thawing and by the frequently alternating wet and dry periods characteristic of the climate in the county.

Climate results in important differences among the soils throughout a wide region, but it results in only slight differences among the soils in a smaller area, such as one the size of Osage County.

Plant and Animal Life

Soil formation is accompanied by changes in plant and animal life. The biological life responds to changes in soil features and, in a given climatic region, to the other factors of soil formation. In turn, the plant and animal life affects soil formation.

Plants provide a protective cover, add organic material, and bring nutrients to the surface layer from lower layers. Organic matter forms when plant and animal micro-organisms decompose trunks, stems, leaves, and roots. It alters the soil physically and chemically by affecting color, structure, and other soil properties. Also, it creates a favorable environment for biological activity within the soil.

Most of the soils in Osage County formed under a cover of tall prairie grasses. Clareson and other soils formed under a mixture of tall and mid prairie grasses. The soils that formed in recent alluvium supported a cover of tall prairie grasses and hardwood trees.

Because they help to decompose organic material and weather the parent material, animals affect some soil properties. Worms, for example, affect the color and structure of the soil.

Human activities greatly affect soil formation. They tend to offset the normal soil-forming processes. In most areas they have increased the extent of erosion; increased or decreased the organic matter content; and, through land leveling and industrial or urban development, changed the relief.

Relief

Relief affects soil formation through its effect on runoff, drainage, and other factors related to the movement of water, including geologic and accelerated erosion. The amount of water that enters the soil depends partly on relief. Generally, less water enters the steeper soils and more soil material is lost through erosion. In most level or depressional areas, the amount of available moisture is increased by the runoff from higher lying areas. Because of this additional water, the upper layers of the soil are gray or mottled and tend to be thick. The profile of Kenoma, Woodson, and other nearly level or gently sloping soils generally is more strongly expressed than that of steeper soils, such as Lebo soils. Runoff is slowed on the nearly level soils, and more water moves through the profile or ponds on the surface. Most of the nearly level soils that formed in alluvium receive new sediment during periods of flooding.

Time

As water moves through the soil, soluble material and fine particles gradually are 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 penetrates 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 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 Woodson soils, which have been exposed to soil-forming processes for thousands of years, have well defined horizons.

References

(1) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vols., illus.

(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487-69. *In* 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

(3) Fenneman, N. M. 193l. Physiography of western United States. 534 pp., illus.

(4) Kansas State Board of Agriculture. 1980. 1979-1980 farm facts. Spec. Rep. Kans. Crop & Kans. Cattle Mark. Stat., 272 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

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Argillic horizon. A subsoil horizon characterized by an accumulation of illuvial clay.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedding system. A drainage system that consists of a series of broad beds made by plowing, grading, or otherwise elevating the surface of a flat field.

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.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Channery soil. A soil that is, by volume, more than 15 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches along the longest axis. A single piece is called a channer.

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.

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.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

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.

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.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:
Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.
Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.
Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.
Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.
Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.
Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.
Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

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.*

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 38 centimeters) long.

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.

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.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

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.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Mollic epipedon. A thick, dark, humus-rich surface horizon (or horizons) that has a high base saturation and pedogenic soil structure. It may include the upper part of the subsoil.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

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.

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.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

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

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor, on the basis of how much the present plant community has departed from the potential.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4

Strongly alkaline....................8.5 to 9.0
Very strongly alkaline....................9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rippable. Bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 draw bar horsepower rating.

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.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

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.

Slick spot. A small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

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 insure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

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.

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 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. Includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

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.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-1976 at Osage City, Kansas]

Month	Temperature: Average daily maximum	Temperature: Average daily minimum	Temperature: Average	Temperature: 2 years in 10 will have-- Maximum temperature higher than--	Temperature: 2 years in 10 will have-- Minimum temperature lower than--	Precipitation: Average	Precipitation: 2 years in 10 will have-- Less than--	Precipitation: 2 years in 10 will have-- More than--	Precipitation: Average number of days with 0.10 inch or more	Precipitation: Average snowfall
	°F	°F	°F	°F	°F	In	In	In		In
January----	40.1	18.5	29.3	69	-8	0.92	0.16	1.67	3	6.2
February---	46.0	23.5	34.8	73	-2	1.12	.18	1.75	2	4.3
March------	55.2	31.0	43.1	84	2	2.34	.91	3.63	5	3.8
April------	68.5	43.5	56.0	90	20	3.23	2.06	4.39	6	0.7
May--------	77.8	53.8	65.8	94	34	4.46	2.69	6.35	7	.0
June-------	85.8	62.6	74.2	101	45	4.96	2.33	8.31	7	.0
July-------	91.2	66.6	78.9	104	49	4.50	1.95	7.26	6	.0
August-----	89.9	64.7	77.3	105	48	3.92	1.88	5.54	5	.0
September--	81.7	56.5	69.1	98	36	4.23	.90	8.37	6	.0
October----	72.0	45.8	58.9	92	22	2.89	1.04	4.38	5	.0
November---	55.8	32.7	44.3	78	7	1.65	.15	2.80	3	1.2
December---	43.7	23.6	33.7	69	-3	1.30	.79	1.93	3	3.8
Year-----	67.3	43.6	55.5	107	-10	35.52	24.74	44.31	58	20.0

TABLE 2.--FREEZE DATES IN SPRING AND FALL

Probability	Minimum temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 9	April 21	May 5
2 years in 10 later than--	April 4	April 16	April 30
5 years in 10 later than--	March 26	April 6	April 20
First freezing temperature in fall:			
1 year in 10 earlier than--	October 23	October 13	October 5
2 years in 10 earlier than--	October 27	October 18	October 9
5 years in 10 earlier than--	November 6	October 27	October 19

TABLE 3.--GROWING SEASON

Probability	Length of growing season if daily minimum temperature is--		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	204	182	161
8 years in 10	211	190	168
5 years in 10	225	204	182
2 years in 10	239	218	196
1 year in 10	246	226	203

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

Map symbol	Soil name	Acres	Percent
Bd	Bates loam, 3 to 7 percent slopes	1,745	0.4
Cm	Clareson-Eram complex, 3 to 15 percent slopes	52,345	11.3
Cs	Clime-Sogn complex, 3 to 15 percent slopes	3,120	0.7
Dn	Dennis silt loam, 2 to 6 percent slopes	30,775	6.7
Ds	Dwight silt loam, 0 to 3 percent slopes	2,955	0.6
Ed	Elmont loam, 3 to 7 percent slopes	7,555	1.6
En	Eram silty clay loam, 3 to 7 percent slopes	67,250	14.6
Er	Eram silty clay, 3 to 7 percent slopes, eroded	9,110	2.0
Ke	Kenoma silt loam, 1 to 4 percent slopes	75,495	16.4
Ln	Lebo-Rock outcrop complex, 20 to 40 percent slopes	2,510	0.5
Ls	Lebo-Summit silty clay loams, 7 to 12 percent slopes	24,910	5.4
Lu	Lula silt loam, 1 to 3 percent slopes	31,135	6.8
Mb	Mason silt loam	3,200	0.7
Oe	Olpe-Kenoma complex, 1 to 5 percent slopes	3,935	0.9
Op	Orthents, hilly	1,440	0.3
Os	Osage silty clay loam	7,500	1.6
Ov	Osage silty clay	2,385	0.5
Ow	Osage silty clay, frequently flooded	3,035	0.7
Pt	Pits, quarries	440	0.1
Sn	Summit silty clay loam, 1 to 3 percent slopes	3,945	0.9
So	Summit silty clay loam, 3 to 7 percent slopes	43,810	9.5
Vb	Verdigris silt loam	36,530	7.9
Vc	Verdigris silt loam, channeled	17,035	3.7
Wo	Woodson silt loam, 0 to 2 percent slopes	16,870	3.7
	Water	11,578	2.5
	Total	460,608	100.0

TABLE 5.--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	Corn	Grain sorghum	Soybeans	Winter wheat	Tall fescue	Bromegrass-alfalfa
		Bu	Bu	Bu	Bu	AUM*	AUM*
Bd-------------- Bates	IIIe	45	50	20	30	4.5	4.0
Cm-------------- Clareson-Eram	VIe	---	---	---	---	4.5	---
Cs-------------- Clime-Sogn	VIe	---	---	---	---	---	---
Dn-------------- Dennis	IIIe	70	75	28	38	5.5	5.5
Ds-------------- Dwight	IVe	40	50	20	28	---	3.5
Ed-------------- Elmont	IIIe	80	84	32	38	6.0	5.5
En-------------- Eram	IVe	50	60	20	32	4.5	4.5
Er-------------- Eram	IVe	45	55	18	30	4.0	4.0
Ke-------------- Kenoma	IIIe	60	65	26	34	4.5	4.5
Ln-------------- Lebo-Rock outcrop	VIIe	---	---	---	---	4.0	---
Ls-------------- Lebo-Summit	VIe	---	---	---	---	4.5	---
Lu-------------- Lula	IIe	70	85	28	40	6.0	5.5
Mb-------------- Mason	I	100	105	34	44	7.0	7.0
Oe-------------- Olpe-Kenoma	IVe	45	50	---	30	4.5	4.5
Op**------------ Orthents	VIIs	---	---	---	---	---	---
Os-------------- Osage	IIw	75	80	34	35	6.5	6.5
Ov-------------- Osage	IIIw	60	65	30	30	6.0	6.0
Ow-------------- Osage	Vw	---	---	---	---	---	---
Pt**. Pits							
Sn-------------- Summit	IIe	70	75	30	38	5.5	6.0
So-------------- Summit	IIIe	65	70	28	34	5.5	5.5
Vb-------------- Verdigris	IIw	95	100	34	40	7.0	7.0

See footnotes at end of table.

TABLE 5.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Grain sorghum	Soybeans	Winter wheat	Tall fescue	Bromegrass-alfalfa
		Bu	Bu	Bu	Bu	AUM*	AUM*
Vc---------------- Verdigris	Vw	---	---	---	---	7.0	---
Wo---------------- Woodson	IIs	65	70	28	35	5.0	5.0

* 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 6.--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
Bd------------------ Bates	Loamy Upland------------------	Favorable	7,000	Big bluestem------------------	35
		Normal	5,500	Little bluestem---------------	25
		Unfavorable	4,500	Indiangrass-------------------	10
				Switchgrass-------------------	10
Cm*:					
Clareson----------	Shallow Flats-----------------	Favorable	5,000	Little bluestem---------------	30
		Normal	4,000	Big bluestem------------------	15
		Unfavorable	2,500	Sideoats grama----------------	15
				Indiangrass-------------------	10
				Switchgrass-------------------	5
				Tall dropseed-----------------	5
Eram--------------	Clay Upland-------------------	Favorable	6,000	Big bluestem------------------	30
		Normal	4,200	Little bluestem---------------	25
		Unfavorable	3,000	Switchgrass-------------------	10
				Indiangrass-------------------	10
Cs*:					
Clime-------------	Limy Upland-------------------	Favorable	5,000	Little bluestem---------------	30
		Normal	3,500	Big bluestem------------------	20
		Unfavorable	2,500	Sideoats grama----------------	15
				Indiangrass-------------------	5
				Switchgrass-------------------	5
				Blue grama--------------------	5
				Jersey tea--------------------	5
				Leadplant---------------------	5
Sogn--------------	Shallow Limy------------------	Favorable	3,500	Sideoats grama----------------	25
		Normal	2,500	Big bluestem------------------	15
		Unfavorable	1,500	Little bluestem---------------	15
				Indiangrass-------------------	5
				Switchgrass-------------------	5
				Tall dropseed-----------------	5
				Blue grama--------------------	5
Dn------------------ Dennis	Loamy Upland------------------	Favorable	7,000	Big bluestem------------------	35
		Normal	5,500	Little bluestem---------------	25
		Unfavorable	4,500	Indiangrass-------------------	10
				Switchgrass-------------------	5
Ds------------------ Dwight	Claypan-----------------------	Favorable	4,000	Big bluestem------------------	15
		Normal	3,000	Little bluestem---------------	10
		Unfavorable	2,000	Prairie dropseed--------------	10
				Tall dropseed-----------------	10
				Western wheatgrass------------	10
				Blue grama--------------------	10
				Switchgrass-------------------	5
				Sideoats grama----------------	5
				Buffalograss------------------	5
				Dotted gayfeather-------------	5
Ed------------------ Elmont	Loamy Upland------------------	Favorable	7,000	Big bluestem------------------	30
		Normal	5,500	Little bluestem---------------	20
		Unfavorable	4,000	Indiangrass-------------------	15
				Switchgrass-------------------	5
				Tall dropseed-----------------	5
En, Er-------------- Eram	Clay Upland-------------------	Favorable	6,000	Big bluestem------------------	30
		Normal	4,200	Little bluestem---------------	15
		Unfavorable	3,000	Switchgrass-------------------	15
				Indiangrass-------------------	10

See footnote at end of table.

TABLE 6.--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	Compo-sition
			Lb/acre		Pct
Ke---------------- Kenoma	Clay Upland-------------------	Favorable	6,000	Big bluestem------------------	25
		Normal	4,500	Little bluestem---------------	20
		Unfavorable	2,500	Indiangrass-------------------	15
				Switchgrass-------------------	15
				Tall dropseed-----------------	5
				Sideoats grama----------------	5
Ln*:					
Lebo--------------	Loamy Upland------------------	Favorable	5,500	Big bluestem------------------	25
		Normal	4,000	Little bluestem---------------	20
		Unfavorable	3,000	Indiangrass-------------------	15
				Switchgrass-------------------	5
Rock outcrop.					
Ls*:					
Lebo--------------	Loamy Upland------------------	Favorable	6,000	Big bluestem------------------	25
		Normal	5,000	Little bluestem---------------	20
		Unfavorable	4,000	Indiangrass-------------------	15
				Switchgrass-------------------	5
Summit------------	Loamy Upland------------------	Favorable	7,000	Big bluestem------------------	35
		Normal	5,500	Little bluestem---------------	25
		Unfavorable	4,500	Indiangrass-------------------	15
				Switchgrass-------------------	5
Lu---------------- Lula	Loamy Upland------------------	Favorable	7,000	Big bluestem------------------	35
		Normal	5,500	Little bluestem---------------	25
		Unfavorable	4,500	Indiangrass-------------------	15
				Switchgrass-------------------	10
Mb---------------- Mason	Loamy Lowland-----------------	Favorable	10,000	Big bluestem------------------	30
		Normal	9,400	Indiangrass-------------------	20
		Unfavorable	7,000	Switchgrass-------------------	10
				Eastern gamagrass-------------	10
Oe*:					
Olpe--------------	Loamy Upland------------------	Favorable	6,000	Big bluestem------------------	30
		Normal	5,000	Little bluestem---------------	20
		Unfavorable	4,000	Indiangrass-------------------	15
				Switchgrass-------------------	10
				Sideoats grama----------------	5
Kenoma------------	Clay Upland-------------------	Favorable	6,000	Big bluestem------------------	25
		Normal	4,500	Little bluestem---------------	20
		Unfavorable	2,500	Indiangrass-------------------	15
				Switchgrass-------------------	15
				Tall dropseed-----------------	5
				Sideoats grama----------------	5
Os, Ov, Ow-------- Osage	Clay Lowland------------------	Favorable	9,000	Prairie cordgrass-------------	40
		Normal	8,000	Switchgrass-------------------	15
		Unfavorable	6,000	Big bluestem------------------	15
				Indiangrass-------------------	5
				Eastern gamagrass-------------	5
Sn, So------------ Summit	Loamy Upland------------------	Favorable	7,000	Big bluestem------------------	35
		Normal	5,500	Little bluestem---------------	25
		Unfavorable	4,500	Indiangrass-------------------	15
				Switchgrass-------------------	5
Vb, Vc------------ Verdigris	Loamy Lowland-----------------	Favorable	10,000	Big bluestem------------------	30
		Normal	8,500	Indiangrass-------------------	15
		Unfavorable	6,000	Eastern gamagrass-------------	15
				Switchgrass-------------------	10
				Prairie cordgrass-------------	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site	Total production		Characteristic vegetation	Composition
		Kind of year	Dry weight		
			Lb/acre		Pct
Wo----------------- Woodson	Clay Upland-------------------	Favorable Normal Unfavorable	6,000 4,500 2,500	Big bluestem------------------ Little bluestem--------------- Indiangrass------------------- Switchgrass------------------- Tall dropseed-----------------	35 15 15 15 5

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--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				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Plant competition	Common trees	Site index	
Ln*:								
Lebo---------------	5x	Moderate	Moderate	Moderate	Slight	White oak----------- Shagbark hickory---- Green ash----------- Chinkapin oak------- Hackberry-----------	50 --- --- --- ---	White oak, green ash, hackberry.
Rock outcrop.								
Mb----------------- Mason	3o	Slight	Slight	Moderate	Moderate	Sweetgum------------ Northern red oak---- Green ash----------- Black walnut-------- Eastern cottonwood--	--- --- --- --- 90	Sweetgum, bur oak, green ash, black walnut, pecan, American sycamore.
Os----------------- Osage	4w	Slight	Moderate	Moderate	Severe	Pin oak------------- Pecan--------------- Eastern cottonwood-- Bur oak-------------	75 50 80 ---	Pin oak, pecan.
Ov----------------- Osage	4w	Slight	Moderate	Severe	Severe	Pin oak------------- Pecan--------------- Eastern cottonwood-- Bur oak-------------	75 50 80 ---	Pin oak, pecan.
Vb, Vc------------- Verdigris	3o	Slight	Slight	Slight	Moderate	Eastern cottonwood-- Pin oak------------- Shagbark hickory---- Hackberry----------- Black walnut-------- Silver maple-------- Green ash----------- White oak-----------	87 75 --- 69 69 --- 69 56	Eastern cottonwood, American sycamore, pin oak, black walnut, green ash.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--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
Bd----------------- Bates	Lilac, Peking cotoneaster, Amur honeysuckle, fragrant sumac.	---	Eastern redcedar, green ash, Austrian pine, bur oak, hackberry, Russian-olive.	Siberian elm, honeylocust.	---
Cm*: Clareson---------	Peking cotoneaster, Amur honeysuckle, lilac, fragrant sumac.	---	Austrian pine, eastern redcedar, green ash, Russian-olive, hackberry, bur oak.	Siberian elm, honeylocust.	---
Eram-------------	Lilac, Peking cotoneaster.	Manchurian crabapple, Amur honeysuckle, Siberian peashrub.	Eastern redcedar, hackberry, green ash, Austrian pine, Russian-olive.	Siberian elm, honeylocust.	---
Cs*: Clime------------	Fragrant sumac, Tatarian honeysuckle.	Siberian peashrub	Eastern redcedar, green ash, osageorange, Russian-olive, black locust, honeylocust, northern catalpa, bur oak.	Siberian elm------	---
Sogn.					
Dn----------------- Dennis	American plum, fragrant sumac, Peking cotoneaster, lilac.	---	Flowering dogwood, Russian mulberry, hackberry, eastern redcedar, green ash.	Honeylocust, Austrian pine, Scotch pine.	---
Ds----------------- Dwight	Lilac, silver buffaloberry, Tatarian honeysuckle, Siberian peashrub.	Eastern redcedar, Russian-olive, Siberian elm, green ash.	---	---	---
Ed----------------- Elmont	Peking cotoneaster	Lilac, fragrant sumac, Amur honeysuckle.	Eastern redcedar, Russian-olive, hackberry, green ash, bur oak.	Austrian pine, Scotch pine, honeylocust.	---
En, Er------------ Eram	Lilac, Peking cotoneaster.	Manchurian crabapple, Amur honeysuckle, Siberian peashrub.	Eastern redcedar, hackberry, green ash, Austrian pine, Russian-olive.	Siberian elm, honeylocust.	---
Ke----------------- Kenoma	Peking cotoneaster, lilac, fragrant sumac.	Amur honeysuckle, Manchurian crabapple.	Hackberry, Austrian pine, Russian-olive, eastern redcedar.	Green ash, Siberian elm, honeylocust.	---

See footnote at end of table.

TABLE 8.--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
Ln*:					
Lebo	Amur honeysuckle, common chokecherry.	Autumn-olive, Manchurian crabapple, Russian-olive.	Eastern redcedar, Russian mulberry, green ash, hackberry.	Austrian pine, honeylocust, Scotch pine.	---
Rock outcrop.					
Ls*:					
Lebo	Amur honeysuckle, fragrant sumac, lilac, Peking cotoneaster.	---	Eastern redcedar, Russian-olive, green ash, bur oak, Austrian pine, hackberry.	Siberian elm, honeylocust.	---
Summit	Lilac, American plum, common chokecherry, fragrant sumac.	Autumn-olive	Eastern redcedar, pin oak, hackberry, Russian-olive.	Green ash, honeylocust, Austrian pine.	---
Lu Lula	Skunkbush sumac	Amur honeysuckle, American plum, lilac.	Eastern redcedar, Austrian pine, redbud.	Chinese elm, honeylocust, hackberry, black locust, osageorange.	---
Mb Mason	---	American plum, Peking cotoneaster, lilac, Amur honeysuckle.	Eastern redcedar, hackberry.	Austrian pine, honeylocust, green ash, bur oak, eastern white pine.	Eastern cottonwood.
Oe*:					
Olpe	Fragrant sumac, Peking cotoneaster, Amur honeysuckle, lilac.	Russian-olive	Bur oak, eastern redcedar, hackberry, Austrian pine, green ash.	Siberian elm, honeylocust.	---
Kenoma	Peking cotoneaster, lilac, fragrant sumac.	Amur honeysuckle, Manchurian crabapple.	Green ash, hackberry, Austrian pine, Russian-olive, eastern redcedar.	Siberian elm, honeylocust.	---
Op*. Orthents					
Os, Ov, Ow Osage	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Norway spruce, honeylocust, green ash, silver maple, golden willow, northern red oak.	Eastern cottonwood.
Pt*. Pits					
Sn, So Summit	Lilac, American plum, common chokecherry, fragrant sumac.	Autumn-olive	Eastern redcedar, pin oak, hackberry, Russian-olive.	Green ash, honeylocust, Austrian pine.	---
Vb, Vc Verdigris	---	American plum, lilac, Peking cotoneaster, Amur honeysuckle.	Eastern redcedar	Austrian pine, honeylocust, eastern white pine, bur oak, green ash, hackberry.	Eastern cottonwood.

See footnote at end of table.

TABLE 8.--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
Wo----------------- Woodson	Peking cotoneaster, lilac, fragrant sumac.	Manchurian crabapple, Amur honeysuckle.	Green ash, hackberry, eastern redcedar, Russian-olive.	Austrian pine, honeylocust, Siberian elm.	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--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
Bd: Bates	Slight	Slight	Moderate: slope, small stones, depth to rock.	Slight.
Cm*:				
Clareson	Moderate: percs slowly, slope.	Moderate: slope, percs slowly.	Moderate: percs slowly.	Slight.
Eram	Moderate: wetness.	Moderate: wetness.	Severe: slope.	Slight.
Cs*:				
Clime	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: erodes easily.
Sogn	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Slight.
Dn: Dennis	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Severe: erodes easily.
Ds: Dwight	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Ed: Elmont	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight.
En: Eram	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Slight.
Er: Eram	Severe: too clayey.	Severe: too clayey.	Severe: too clayey.	Severe: too clayey.
Ke: Kenoma	Severe: percs slowly.	Severe: percs slowly.	Severe: percs slowly.	Severe: erodes easily.
Ln*:				
Lebo	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Severe: slope.
Rock outcrop.				
Ls*:				
Lebo	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Summit	Moderate: slope, wetness.	Moderate: slope, wetness.	Severe: slope.	Severe: erodes easily.
Lu: Lula	Slight	Slight	Moderate: slope.	Slight.
Mb: Mason	Severe: flooding.	Moderate: percs slowly.	Moderate: percs slowly.	Slight.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Oe*:				
Olpe	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, small stones.	Slight.
Kenoma	Severe: percs slowly.	Severe: percs slowly.	Severe: percs slowly.	Slight.
Op*. Orthents				
Os Osage	Severe: flooding, wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.
Ov Osage	Severe: flooding, wetness, percs slowly.	Severe: wetness, too clayey, percs slowly.	Severe: too clayey, wetness.	Severe: wetness, too clayey.
Ow Osage	Severe: flooding, wetness, percs slowly.	Severe: wetness, too clayey, percs slowly.	Severe: too clayey, wetness, flooding.	Severe: wetness, too clayey.
Pt*. Pits				
Sn, So Summit	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Severe: erodes easily.
Vb Verdigris	Severe: flooding.	Slight	Moderate: flooding.	Slight.
Vc Verdigris	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.
Wo Woodson	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--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
Bd------------------ Bates	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Cm*:												
Clareson-----------	Fair	Good	Good	Fair	Fair	Fair	Very poor.	Very poor.	Good	Fair	Very poor.	Fair.
Eram---------------	Fair	Good	Good	Good	Good	Fair	Very poor.	Very poor.	Good	Good	Very poor.	Fair.
Cs*:												
Clime--------------	Fair	Fair	Good	Poor	Poor	Fair	Very poor.	Very poor.	Fair	Poor	Very poor.	Fair.
Sogn---------------	Very poor.	Very poor.	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Very poor.	Poor	Very poor.	Poor.
Dn------------------ Dennis	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Ds------------------ Dwight	Fair	Fair	Fair	Poor	Poor	Fair	Poor	Fair	Fair	Poor	Poor	Fair.
Ed------------------ Elmont	Fair	Good	Good	Fair	Fair	Good	Poor	Very poor.	Good	Fair	Very poor.	Good.
En, Er-------------- Eram	Fair	Good	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Good	Fair	Very poor.	Fair.
Ke------------------ Kenoma	Good	Good	Fair	Fair	Fair	Fair	Poor	Fair	Good	Fair	Poor	Fair.
Ln*:												
Lebo---------------	Very poor.	Very poor.	Good	Good	Good	Fair	Very poor.	Very poor.	Fair	Good	Very poor.	Poor.
Rock outcrop.												
Ls*:												
Lebo---------------	Poor	Poor	Good	Good	Good	Fair	Very poor.	Very poor.	Fair	Good	Very poor.	Poor.
Summit-------------	Fair	Good	Fair	Good	Good	Good	Poor	Very poor.	Fair	Good	Very poor.	Fair.
Lu------------------ Lula	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Mb------------------ Mason	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Oe*:												
Olpe---------------	Good	Good	Good	Fair	Fair	Good	Poor	Very poor.	Good	Fair	Very poor.	Good.
Kenoma-------------	Good	Good	Fair	Fair	Fair	Fair	Poor	Fair	Good	Fair	Poor	Fair.
Op*. Orthents												
Os------------------ Osage	Fair	Fair	Fair	Good	Good	Fair	Good	Good	Fair	Good	Good	Fair.

See footnote at end of table.

TABLE 10.--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
Ov, Ow Osage	Fair	Fair	Fair	Good	Good	Fair	Poor	Good	Fair	Good	Fair	Fair.
Pt*. Pits												
Sn Summit	Good	Good	Fair	Good	Good	Good	Poor	Poor	Good	Good	Poor	Fair.
So Summit	Fair	Good	Fair	Good	Good	Good	Poor	Very poor.	Fair	Good	Very poor.	Fair.
Vb Verdigris	Good	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor	Good.
Vc Verdigris	Poor	Fair	Fair	Good	Good	Good	Poor	Fair	Fair	Good	Poor	Good.
Wo Woodson	Fair	Good	Fair	Poor	Poor	Fair	Poor	Good	Fair	Fair	Fair	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--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; it 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
Bd----------------- Bates	Moderate: depth to rock.	Slight-----------	Moderate: depth to rock.	Moderate: slope.	Moderate: low strength.
Cm*:					
Clareson---------	Severe: depth to rock, large stones.	Severe: large stones.	Severe: depth to rock, large stones.	Severe: slope, large stones.	Severe: low strength, large stones.
Eram-------------	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Cs*:					
Clime------------	Moderate: depth to rock, too clayey, slope.	Moderate: shrink-swell, slope.	Moderate: depth to rock, slope, shrink-swell.	Severe: slope.	Severe: low strength.
Sogn-------------	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.
Dn---------------- Dennis	Moderate: too clayey, wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Ds---------------- Dwight	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Ed---------------- Elmont	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
En, Er------------ Eram	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Ke---------------- Kenoma	Moderate: depth to rock, too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Ln*:					
Lebo-------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
Rock outcrop.					
Ls*:					
Lebo-------------	Moderate: depth to rock, slope.	Moderate: shrink-swell, slope.	Moderate: depth to rock, slope, shrink-swell.	Severe: slope.	Severe: low strength.
Summit-----------	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, shrink-swell.
Lu---------------- Lula	Moderate: depth to rock.	Moderate: shrink-swell.	Moderate: shrink-swell, depth to rock.	Moderate: shrink-swell.	Moderate: shrink-swell.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Mb----------------- Mason	Slight------------	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength.
Oe*:					
Olpe--------------	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.
Kenoma------------	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Op*. Orthents					
Os, Ov, Ow--------- Osage	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, wetness, flooding.
Pt*. Pits					
Sn, So------------- Summit	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Vb, Vc------------- Verdigris	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
Wo----------------- Woodson	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, low strength, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "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; it 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
Bd------------------ Bates	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Cm*:					
Clareson-----------	Severe: depth to rock, percs slowly, large stones.	Severe: depth to rock, slope, large stones.	Severe: depth to rock, too clayey, large stones.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Eram---------------	Severe: depth to rock, wetness, percs slowly.	Severe: depth to rock, slope.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Cs*:					
Clime--------------	Severe: depth to rock, percs slowly.	Severe: depth to rock, slope.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Sogn---------------	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Dn------------------ Dennis	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
Ds------------------ Dwight	Severe: percs slowly.	Slight-----------	Severe: too clayey, excess sodium.	Slight-----------	Poor: too clayey, hard to pack, excess sodium.
Ed------------------ Elmont	Severe: percs slowly.	Moderate: depth to rock, slope.	Severe: depth to rock, too clayey.	Moderate: depth to rock.	Poor: too clayey.
En, Er-------------- Eram	Severe: depth to rock, wetness, percs slowly.	Severe: depth to rock.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Ke------------------ Kenoma	Severe: percs slowly.	Moderate: depth to rock, slope.	Severe: depth to rock, too clayey.	Moderate: depth to rock.	Poor: too clayey, hard to pack.
Ln*:					
Lebo---------------	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: area reclaim, slope.
Rock outcrop.					
Ls*:					
Lebo---------------	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Summit-------------	Severe: wetness, percs slowly.	Severe: slope.	Severe: too clayey.	Moderate: wetness, slope.	Poor: too clayey, hard to pack.

See footnote at end of table.

TABLE 12.--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
Lu: Lula	Moderate: depth to rock, percs slowly.	Moderate: seepage, depth to rock, slope.	Severe: depth to rock.	Moderate: depth to rock.	Fair: too clayey, area reclaim, thin layer.
Mb: Mason	Severe: percs slowly.	Slight	Moderate: flooding, too clayey.	Moderate: flooding.	Fair: too clayey.
Oe*:					
Olpe	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, small stones.
Kenoma	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
Op*. Orthents					
Os, Ov, Ow: Osage	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
Pt*. Pits					
Sn, So: Summit	Severe: wetness, percs slowly.	Moderate: slope.	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
Vb, Vc: Verdigris	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
Wo: Woodson	Severe: percs slowly, wetness.	Slight	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey, wetness, hard to pack.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--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; it does not eliminate the need for onsite investigation]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Bd: Bates	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones, thin layer.
Cm*: Clareson	Poor: area reclaim, low strength, large stones.	Improbable: excess fines, large stones.	Improbable: excess fines, large stones.	Poor: large stones.
Eram	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, too clayey.
Cs*: Clime	Poor: area reclaim, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Sogn	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.
Dn: Dennis	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, thin layer.
Ds: Dwight	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Ed: Elmont	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
En: Eram	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, too clayey.
Er: Eram	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
Ke: Kenoma	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Ln*: Lebo	Poor: area reclaim, low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
Rock outcrop.				
Ls*: Lebo	Poor: area reclaim, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Ls*:				
Summit	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
Lu Lula	Fair: shrink-swell, area reclaim, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Mb Mason	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Oe*:				
Olpe	Fair: shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim.
Kenoma	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Op*. Orthents				
Os Osage	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Ov, Ow Osage	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
Pt*. Pits				
Sn, So Summit	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Vb, Vc Verdigris	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Wo Woodson	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--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; it does not eliminate the need for onsite investigation]

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Bd----------------- Bates	Moderate: seepage, depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Cm*:						
Clareson----------	Severe: slope.	Severe: large stones.	Deep to water	Large stones, droughty, percs slowly.	Slope, large stones, depth to rock.	Large stones, slope, droughty.
Eram--------------	Moderate: depth to rock, slope.	Moderate: thin layer, hard to pack, wetness.	Percs slowly, depth to rock, slope.	Wetness, percs slowly.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Cs*:						
Clime-------------	Severe: slope.	Moderate: thin layer, hard to pack.	Deep to water	Percs slowly, depth to rock.	Slope, depth to rock, erodes easily.	Slope, erodes easily, depth to rock.
Sogn--------------	Severe: depth to rock, slope.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
Dn----------------- 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.
Ds----------------- Dwight	Slight----------	Severe: excess sodium.	Deep to water	Percs slowly, erodes easily, excess sodium.	Erodes easily, percs slowly.	Excess sodium, erodes easily, percs slowly.
Ed----------------- Elmont	Moderate: depth to rock, slope.	Moderate: thin layer.	Deep to water	Slope-----------	Erodes easily	Erodes easily.
En----------------- Eram	Moderate: depth to rock, slope.	Moderate: thin layer, hard to pack, wetness.	Percs slowly, depth to rock, slope.	Wetness, percs slowly.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Er----------------- Eram	Moderate: depth to rock, slope.	Moderate: thin layer, hard to pack, wetness.	Percs slowly, depth to rock, slope.	Wetness, slow intake, percs slowly.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Ke----------------- Kenoma	Moderate: depth to rock.	Severe: hard to pack.	Deep to water	Percs slowly, erodes easily.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Ln*:						
Lebo--------------	Severe: slope.	Moderate: thin layer, large stones.	Deep to water	Depth to rock, slope.	Slope, large stones, depth to rock.	Large stones, slope, depth to rock.
Rock outcrop.						
Ls*:						
Lebo--------------	Severe: slope.	Moderate: thin layer.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
Summit------------	Severe: slope.	Severe: hard to pack.	Percs slowly, slope.	Wetness, percs slowly.	Slope, erodes easily, wetness.	Slope, erodes easily, percs slowly.

See footnote at end of table.

TABLE 14.--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
Lu----------------- Lula	Moderate: depth to rock, seepage.	Moderate: thin layer.	Deep to water	Favorable------	Favorable------	Favorable.
Mb----------------- Mason	Slight---------	Moderate: piping.	Deep to water	Erodes easily	Erodes easily	Erodes easily.
Oe*: Olpe--------------	Moderate: slope.	Slight---------	Deep to water	Droughty, percs slowly, slope.	Percs slowly---	Droughty.
Kenoma------------	Slight---------	Severe: hard to pack.	Deep to water	Percs slowly, erodes easily.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Op*. Orthents						
Os----------------- Osage	Slight---------	Severe: hard to pack, wetness.	Percs slowly, flooding.	Wetness---------	Wetness, percs slowly.	Wetness, percs slowly.
Ov, Ow------------- Osage	Slight---------	Severe: hard to pack, wetness.	Percs slowly, flooding.	Wetness, droughty, slow intake.	Wetness, percs slowly.	Wetness, droughty, percs slowly.
Pt*. Pits						
Sn----------------- Summit	Slight---------	Severe: hard to pack.	Percs slowly---	Wetness, percs slowly.	Erodes easily, wetness.	Erodes easily, percs slowly.
So----------------- Summit	Moderate: slope.	Severe: hard to pack.	Percs slowly, slope.	Wetness, percs slowly.	Erodes easily, wetness.	Erodes easily, percs slowly.
Vb, Vc------------- Verdigris	Moderate: seepage.	Moderate: piping.	Deep to water	Flooding--------	Favorable------	Favorable.
Wo----------------- Woodson	Slight---------	Severe: wetness.	Percs slowly---	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, percs slowly.	Percs slowly, wetness, erodes easily.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--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		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Bd---------------- Bates	0-15	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-100	80-100	55-90	20-40	3-15
	15-23	Loam, clay loam, sandy clay loam.	ML, CL, SC, SM	A-4, A-6, A-7	0	85-100	85-100	80-100	45-85	25-45	3-20
	23-30	Gravelly fine sandy loam.	SM, SC	A-4, A-2	0-3	75-85	65-75	45-65	30-50	<30	NP-10
	30	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Cm*: Clareson--------	0-8	Silty clay loam	CL	A-4, A-6	0-25	90-100	90-100	85-95	85-95	30-40	8-18
	8-16	Silty clay loam, flaggy silty clay loam.	CL	A-6, A-7	0-65	90-100	90-100	85-95	85-95	35-45	11-20
	16-24	Flaggy silty clay, flaggy silty clay loam.	CL, CH	A-7	50-85	85-100	85-100	80-95	80-95	41-60	18-35
	24	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Eram------------	0-9	Silty clay loam	CL	A-6, A-7	0	85-100	85-100	85-100	75-95	33-48	12-25
	9-28	Clay, silty clay, clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	90-100	85-98	37-65	15-35
	28	Weathered bedrock	---	---	---	---	---	---	---	---	---
Cs*: Clime-----------	0-7	Silty clay-------	CL	A-6, A-7-6	0-5	90-100	90-100	85-100	80-95	35-50	15-25
	7-32	Silty clay, clay, silty clay loam.	CH, CL	A-7, A-6	0	95-100	95-100	95-100	85-95	35-60	15-35
	32	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Sogn------------	0-8	Silty clay loam	CL, MH, CH, ML	A-6, A-7	0-10	85-100	85-100	85-100	70-100	25-55	10-25
	8	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Dn--------------- Dennis	0-9	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	96-100	65-97	20-37	1-15
	9-23	Silty clay loam, clay loam.	CL	A-6, A-7	0	98-100	98-100	94-100	75-98	33-48	13-25
	23-60	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
Ds--------------- Dwight	0-5	Silt loam--------	CL-ML, CL, ML	A-4, A-6	0	100	100	95-100	85-100	25-40	3-15
	5-20	Clay, silty clay	CH	A-7	0	100	100	95-100	90-100	50-70	25-40
	20-60	Clay, silty clay, silty clay loam.	CL, CH	A-7	0	100	100	95-100	85-100	45-60	25-40
Ed--------------- Elmont	0-16	Loam-------------	CL, CL-ML	A-4, A-6	0	100	100	90-100	75-100	25-40	6-15
	16-32	Silty clay loam, clay loam.	CL	A-6, A-7-6	0	100	100	95-100	85-100	35-45	15-25
	32-52	Silty clay loam, clay loam, silty clay.	CL	A-6, A-7-6	0	100	100	95-100	85-100	35-50	15-30
	52	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
En--------------- Eram	0-9	Silty clay loam	CL	A-6, A-7	0	85-100	85-100	85-100	75-95	33-48	12-25
	9-28	Clay, silty clay, silty clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	90-100	85-98	37-65	15-35
	28	Weathered bedrock	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 15.--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	
Er----------------- Eram	0-6	Silty clay--------	CH	A-7, A-6	0	95-100	95-100	90-100	85-98	35-50	15-30
	6-25	Clay, silty clay, clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	90-100	85-98	37-65	15-35
	25	Weathered bedrock	---	---	---	---	---	---	---	---	---
Ke----------------- Kenoma	0-8	Silt loam---------	CL, CL-ML	A-4, A-6	0	85-100	85-100	85-100	85-100	25-40	5-15
	8-53	Silty clay, clay	CH	A-7	0	85-100	85-100	85-100	85-100	50-75	30-50
	53	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ln*: Lebo--------------	0-6	Stony silty clay loam.	CL	A-6, A-7-6	25-50	75-95	55-75	55-70	50-65	35-50	15-25
	6-22	Silty clay loam, shaly silty clay loam.	CL	A-6, A-7-6	0-5	75-95	55-95	55-85	50-80	35-50	15-25
	22-30	Very shaly silty clay loam, very shaly silt loam.	SC	A-2-6, A-2-7	0-5	50-75	10-50	5-40	5-35	35-50	15-25
	30	Weathered bedrock	---	---	---	---	---	---	---	---	---
Rock outcrop.											
Ls*: Lebo--------------	0-6	Silty clay loam	CL	A-6, A-7-6	0-5	95-100	90-100	90-100	80-95	35-50	15-25
	6-22	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
	22-36	Very shaly clay loam, extremely shaly silt loam.	SC	A-2-7	0-5	50-75	10-50	5-40	5-35	35-50	15-25
	36	Weathered bedrock	---	---	---	---	---	---	---	---	---
Summit------------	0-8	Silty clay loam	CL, CH	A-6, A-7	0	90-100	90-100	85-100	80-99	35-60	11-30
	8-13	Silty clay, silty clay loam, clay.	CL, CH	A-7, A-6	0	85-100	85-100	80-100	80-99	37-65	15-35
	13-56	Clay, silty clay	CH, CL	A-7	0	85-100	85-100	80-100	80-98	41-70	18-40
	56-74	Clay, silty clay, silty clay loam.	CH, CL	A-7	0	98-100	98-100	96-100	80-98	41-70	18-40
Lu----------------- Lula	0-8	Silt loam---------	CL, ML, CL-ML	A-4, A-6	0	100	100	96-100	65-97	21-37	1-15
	8-14	Silty clay loam, clay loam, silt loam.	CL	A-6, A-4, A-7	0	100	100	96-100	65-98	30-43	9-20
	14-44	Silty clay loam, clay loam.	CL	A-6, A-7	0-30	85-100	85-100	80-100	70-98	33-50	12-26
	44	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Mb----------------- Mason	0-7	Silt loam---------	ML, CL	A-4, A-6	0	100	100	96-100	65-98	30-37	8-13
	7-60	Silty clay loam, clay loam, silt loam.	CL	A-6, A-4, A-7	0	98-100	98-100	96-100	65-98	30-43	9-20
Oe*: Olpe--------------	0-7	Silty clay loam	CL	A-6, A-4	0	80-100	75-100	65-95	60-90	25-40	7-20
	7-50	Extremely gravelly silty clay loam, extremely gravelly silty clay.	GC, SC, GP-GC, SP-SC	A-2, A-6, A-7	0	30-65	10-50	10-50	10-45	30-50	11-22
	50-60	Silty clay--------	CH, CL	A-7	0	100	100	95-100	90-100	40-80	20-50

See footnote at end of table.

TABLE 15.--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	
Oe*:											
Kenoma----------	0-8	Silt loam--------	CL, CL-ML, ML	A-4, A-6	0	85-100	85-100	85-100	85-100	25-40	3-18
	8-23	Silty clay, clay	CH	A-7	0	85-100	85-100	85-100	85-100	50-75	30-48
	23-60	Silty clay, silty clay loam.	CL, CH	A-7	0	85-100	85-100	75-100	75-95	45-65	25-44
Op*. Orthents											
Os--------------- Osage	0-16	Silty clay loam	CL	A-7	0	100	100	100	95-100	40-50	20-30
	16-60	Silty clay, clay, silty clay loam.	CH, CL	A-7	0	100	100	100	95-100	40-80	20-50
Ov, Ow----------- Osage	0-8	Silty clay-------	CH	A-7	0	100	100	100	95-100	50-75	30-55
	8-60	Silty clay, clay, silty clay loam.	CH, CL	A-7	0	100	100	100	95-100	40-80	20-50
Pt*. Pits											
Sn, So----------- Summit	0-8	Silty clay loam	CL, CH	A-6, A-7	0	90-100	90-100	85-100	80-99	35-60	11-30
	8-13	Silty clay, silty clay loam, clay.	CL, CH	A-7, A-6	0	85-100	85-100	80-100	80-99	37-65	15-35
	13-60	Clay, silty clay	CH, CL	A-7	0	85-100	85-100	80-100	80-98	41-70	18-40
Vb, Vc----------- Verdigris	0-7	Silt loam--------	CL, CL-ML, ML	A-4, A-6	0	100	100	95-100	65-100	22-38	2-13
	7-60	Silt loam, silty clay loam.	CL	A-4, A-6, A-7	0	100	100	95-100	80-100	30-45	8-23
Wo--------------- Woodson	0-8	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	90-100	85-100	25-40	5-20
	8-28	Silty clay, clay	CH	A-7-6	0	100	95-100	95-100	90-100	50-65	30-45
	28-60	Silty clay, clay, silty clay loam.	CH, CL	A-7-6	0	100	95-100	95-100	90-100	45-65	20-40

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH	mmhos/cm					Pct
Bd----------------- Bates	0-15	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
	15-23	18-35	1.50-1.60	0.6-2.0	0.15-0.19	5.1-6.5	<2	Low--------	0.28			
	23-30	5-20	1.50-1.60	2.0-6.0	0.14-0.16	5.1-6.5	<2	Low--------	0.28			
	30	---	---	---	---	---	---	----------	----			
Cm*: Clareson---------	0-8	15-30	1.25-1.35	0.6-2.0	0.16-0.22	5.6-7.3	<2	Moderate	0.32	2	7	1-4
	8-16	27-40	1.30-1.40	0.2-2.0	0.09-0.21	5.6-7.3	<2	Moderate	0.24			
	16-24	35-50	1.35-1.45	0.06-0.6	0.04-0.07	5.6-7.3	<2	Moderate	0.24			
	24	---	---	---	---	---	---	----------	----			
Eram-------------	0-9	27-40	1.30-1.60	0.2-0.6	0.15-0.19	5.6-6.5	<2	Moderate	0.37	3	7	1-3
	9-28	35-55	1.45-1.75	0.06-0.2	0.14-0.18	5.1-7.3	<2	High-------	0.37			
	28	---	---	---	---	---	---	----------	----			
Cs*: Clime------------	0-7	40-45	1.35-1.45	0.2-0.6	0.21-0.23	6.6-8.4	<2	Moderate	0.28	3	4L	2-4
	7-32	35-60	1.35-1.50	0.06-0.2	0.12-0.18	7.4-8.4	<2	Moderate	0.28			
	32	---	---	---	---	---	---	----------	----			
Sogn-------------	0-8	27-35	1.15-1.20	0.6-2.0	0.17-0.22	6.1-8.4	<2	Moderate	0.32	1	4L	---
	8	---	---	---	---	---	---	----------	----			
Dn----------------- Dennis	0-9	10-27	1.30-1.55	0.6-2.0	0.15-0.20	5.1-6.0	<2	Low--------	0.37	4	6	1-3
	9-23	27-35	1.45-1.70	0.2-0.6	0.15-0.20	4.5-6.0	<2	Moderate	0.37			
	23-60	35-55	1.35-1.65	0.06-0.2	0.15-0.20	5.1-8.4	<2	High-------	0.37			
Ds----------------- Dwight	0-5	18-30	1.20-1.35	0.6-2.0	0.21-0.24	5.6-7.3	<2	Low--------	0.43	3	6	2-4
	5-20	45-60	1.30-1.40	<0.06	0.10-0.14	6.1-8.4	<4	High-------	0.32			
	20-60	35-50	1.30-1.40	0.06-0.2	0.09-0.16	6.6-8.4	<8	High-------	0.32			
Ed----------------- Elmont	0-16	15-27	1.30-1.40	0.6-2.0	0.22-0.24	5.1-7.3	<2	Low--------	0.32	5	6	2-4
	16-32	27-35	1.30-1.45	0.2-0.6	0.18-0.20	5.1-7.3	<2	Moderate	0.43			
	32-52	27-42	1.40-1.55	0.2-0.6	0.14-0.20	5.1-7.3	<2	Moderate	0.43			
	52	---	---	---	---	---	---	----------	----			
En----------------- Eram	0-9	27-40	1.30-1.60	0.2-0.6	0.15-0.19	5.6-6.5	<2	Moderate	0.37	3	7	1-3
	9-28	35-55	1.45-1.75	0.06-0.2	0.14-0.18	5.1-7.3	<2	High-------	0.37			
	28	---	---	---	---	---	---	----------	----			
Er----------------- Eram	0-6	40-45	1.35-1.60	0.06-0.2	0.14-0.18	5.6-6.5	<2	High-------	0.32	3	7	1-2
	6-25	35-55	1.45-1.75	0.06-0.2	0.14-0.18	5.1-7.3	<2	High-------	0.37			
	25	---	---	---	---	---	---	----------	----			
Ke----------------- Kenoma	0-8	18-27	1.35-1.45	0.2-0.6	0.22-0.24	5.1-6.5	<2	Low--------	0.43	4	6	2-4
	8-53	40-60	1.40-1.50	<0.06	0.10-0.15	5.1-7.8	<2	High-------	0.32			
	53	---	---	---	---	---	---	----------	----			
Ln*: Lebo-------------	0-6	22-35	1.35-1.45	0.6-2.0	0.07-0.18	5.6-7.8	<2	Moderate	0.24	4	8	---
	6-22	22-35	1.40-1.50	0.6-2.0	0.15-0.18	5.6-7.8	<2	Moderate	0.24			
	22-30	22-35	1.45-1.65	0.6-2.0	0.07-0.10	5.6-7.8	<2	Moderate	0.24			
	30	---	---	---	---	---	---	----------	----			
Rock outcrop.												
Ls*: Lebo-------------	0-6	22-35	1.35-1.45	0.6-2.0	0.21-0.23	5.6-7.8	<2	Moderate	0.32	4	7	---
	6-22	22-35	1.40-1.50	0.6-2.0	0.15-0.18	5.6-7.8	<2	Moderate	0.24			
	22-36	22-35	1.45-1.65	0.6-2.0	0.07-0.10	5.6-7.8	<2	Moderate	0.24			
	36	---	---	---	---	---	---	----------	----			

See footnote at end of table.

TABLE 16.--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/cm3	In/hr	In/in	pH	mmhos/cm					Pct
Ls*:												
Summit----------	0-8	27-45	1.25-1.50	0.2-0.6	0.16-0.20	5.6-7.3	<2	Moderate	0.37	4	7	1-3
	8-13	32-45	1.35-1.65	0.2-0.6	0.10-0.18	5.6-7.3	<2	High------	0.37			
	13-56	40-60	1.35-1.60	0.06-0.2	0.10-0.18	5.6-8.4	<2	High------	0.32			
	56-74	35-55	1.40-1.65	0.06-0.2	0.10-0.18	6.6-8.4	<2	High------	0.32			
Lu---------------- Lula	0-8	15-27	1.30-1.55	0.6-2.0	0.16-0.20	5.6-6.5	<2	Low-------	0.32	4	6	1-3
	8-14	18-35	1.45-1.70	0.6-2.0	0.16-0.20	5.6-6.5	<2	Moderate	0.37			
	14-44	27-35	1.45-1.70	0.6-2.0	0.16-0.20	5.1-7.3	<2	Moderate	0.32			
	44	---	---	---	---	---	---	----------	----			
Mb---------------- Mason	0-7	12-27	1.30-1.50	0.6-2.0	0.16-0.20	5.1-7.3	<2	Low-------	0.32	5	6	1-3
	7-60	20-35	1.40-1.70	0.2-0.6	0.16-0.20	4.5-7.8	<2	Moderate	0.37			
Oe*:												
Olpe------------	0-7	15-30	1.25-1.35	0.6-2.0	0.20-0.23	5.1-6.5	<2	Low-------	0.32	3	6	1-3
	7-50	27-45	1.30-1.40	0.2-0.6	0.04-0.12	5.1-6.5	<2	Low-------	0.24			
	50-60	40-50	1.35-1.45	0.06-0.2	0.10-0.12	5.6-7.8	<2	High------	0.24			
Kenoma----------	0-8	18-27	1.35-1.45	0.2-0.6	0.22-0.24	5.1-6.5	<2	Low-------	0.43	4	6	2-4
	8-23	40-60	1.40-1.50	<0.06	0.10-0.15	5.1-7.8	<2	High------	0.32			
	23-60	30-50	1.35-1.45	0.06-0.2	0.18-0.20	6.1-8.4	<4	High------	0.32			
Op*. Orthents												
Os---------------- Osage	0-16	35-40	1.45-1.65	<0.06	0.21-0.23	5.1-7.3	<2	High------	0.37	5	7	1-4
	16-60	35-60	1.50-1.70	<0.06	0.08-0.12	5.6-7.8	<2	Very high	0.28			
Ov, Ow----------- Osage	0-8	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
	8-60	35-60	1.50-1.70	<0.06	0.08-0.12	5.6-7.8	<2	Very high	0.28			
Pt*. Pits												
Sn, So----------- Summit	0-8	27-45	1.25-1.50	0.2-0.6	0.16-0.20	5.6-7.3	<2	Moderate	0.37	4	7	1-3
	8-13	32-45	1.35-1.65	0.2-0.6	0.10-0.18	5.6-7.3	<2	High------	0.37			
	13-60	40-60	1.35-1.60	0.06-0.2	0.10-0.18	5.6-8.4	<2	High------	0.32			
Vb, Vc----------- Verdigris	0-7	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
	7-60	18-35	1.40-1.65	0.6-2.0	0.17-0.22	5.6-7.3	<2	Moderate	0.32			
Wo---------------- Woodson	0-8	18-27	1.25-1.45	0.2-0.6	0.22-0.24	5.6-6.5	<2	Low-------	0.43	4	6	1-4
	8-28	40-60	1.30-1.45	<0.06	0.12-0.15	5.6-7.3	<2	High------	0.32			
	28-60	30-50	1.35-1.45	0.06-0.2	0.10-0.15	5.6-7.8	<2	High------	0.32			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "frequent," "very brief," "apparent," and "perched" are explained in the text. The symbol > 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		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
Bd------------------ Bates	B	None---------	---	---	>6.0	---	---	20-40	Soft	---	Low-------	Moderate.
Cm*:												
Clareson-----------	C	None---------	---	---	>6.0	---	---	20-40	Hard	---	High------	Moderate.
Eram---------------	C	None---------	---	---	2.0-3.0	Perched	Dec-Apr	20-40	Soft	---	High------	Moderate.
Cs*:												
Clime--------------	C	None---------	---	---	>6.0	---	---	20-40	Soft	Moderate	High------	Low.
Sogn---------------	D	None---------	---	---	>6.0	---	---	4-20	Hard	Moderate	Low-------	Low.
Dn------------------ Dennis	C	None---------	---	---	2.0-3.0	Perched	Dec-Apr	>60	---	---	High------	Moderate.
Ds------------------ Dwight	D	None---------	---	---	>6.0	---	---	>60	---	Moderate	High------	Moderate.
Ed------------------ Elmont	B	None---------	---	---	>6.0	---	---	40-60	Soft	High------	Moderate	Low.
En, Er------------- Eram	C	None---------	---	---	2.0-3.0	Perched	Dec-Apr	20-40	Soft	---	High------	Moderate.
Ke------------------ Kenoma	D	None---------	---	---	>6.0	---	---	40-60	Hard	---	High------	Moderate.
Ln*:												
Lebo---------------	B	None---------	---	---	>6.0	---	---	20-40	Soft	---	Moderate	Low.
Rock outcrop.												
Ls*:												
Lebo---------------	B	None---------	---	---	>6.0	---	---	20-40	Soft	---	Moderate	Low.
Summit-------------	C	None---------	---	---	2.0-3.0	Perched	Dec-Apr	>60	---	---	High------	Low.
Lu------------------ Lula	B	None---------	---	---	>6.0	---	---	40-60	Hard	---	Moderate	Moderate.
Mb------------------ Mason	B	Rare---------	---	---	>6.0	---	---	>60	---	---	Moderate	Moderate.
Oe*:												
Olpe---------------	C	None---------	---	---	>6.0	---	---	>60	---	---	High------	Moderate.
Kenoma-------------	D	None---------	---	---	>6.0	---	---	>60	---	---	High------	Moderate.

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
Op*. Orthents												
Os, Ov----------- Osage	D	Occasional	Very brief to long.	Nov-May	0-1.0	Apparent	Nov-May	>60	---	---	High-----	Moderate.
Ow--------------- Osage	D	Frequent----	Very brief to long.	Nov-May	0-1.0	Apparent	Nov-May	>60	---	---	High-----	Moderate.
Pt*. Pits												
Sn, So----------- Summit	C	None--------	---	---	2.0-3.0	Perched	Dec-Apr	>60	---	---	High-----	Low.
Vb--------------- Verdigris	B	Occasional	Very brief	Dec-Jun	>6.0	---	---	>60	---	---	Low------	Low.
Vc--------------- Verdigris	B	Frequent----	Very brief	Dec-Jun	>6.0	---	---	>60	---	---	Low------	Low.
Wo--------------- Woodson	D	None--------	---	---	0.5-2.0	Perched	Dec-Apr	>60	---	Low------	High-----	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Bates	Fine-loamy, siliceous, thermic Typic Argiudolls
Clareson	Clayey-skeletal, mixed, thermic Typic Argiudolls
Clime	Fine, mixed, mesic Udorthentic Haplustolls
Dennis	Fine, mixed, thermic Aquic Paleudolls
Dwight	Fine, montmorillonitic, mesic Typic Natrustolls
Elmont	Fine-silty, mixed, mesic Typic Argiudolls
Eram	Fine, mixed, thermic Aquic Argiudolls
Kenoma	Fine, montmorillonitic, thermic Vertic Argiudolls
Lebo	Loamy-skeletal, mixed, thermic Typic Hapludolls
*Lula	Fine-silty, mixed, thermic Typic Argiudolls
Mason	Fine-silty, mixed, thermic Typic Argiudolls
Olpe	Clayey-skeletal, montmorillonitic, thermic Typic Paleudolls
Orthents	Clayey, mixed, nonacid, thermic Udorthents
Osage	Fine, montmorillonitic, thermic Vertic Haplaquolls
Sogn	Loamy, mixed, mesic Lithic Haplustolls
Summit	Fine, montmorillonitic, thermic Vertic Argiudolls
Verdigris	Fine-silty, mixed, thermic Cumulic Hapludolls
Woodson	Fine, montmorillonitic, thermic Abruptic Argiaquolls

* The soil is a taxadjunct to the series. See text for description of those characteristics of the soil that are outside the range of the series.

☆ U.S. GOVERNMENT PRINTING OFFICE:1985 O - 434-751 QL 3

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.