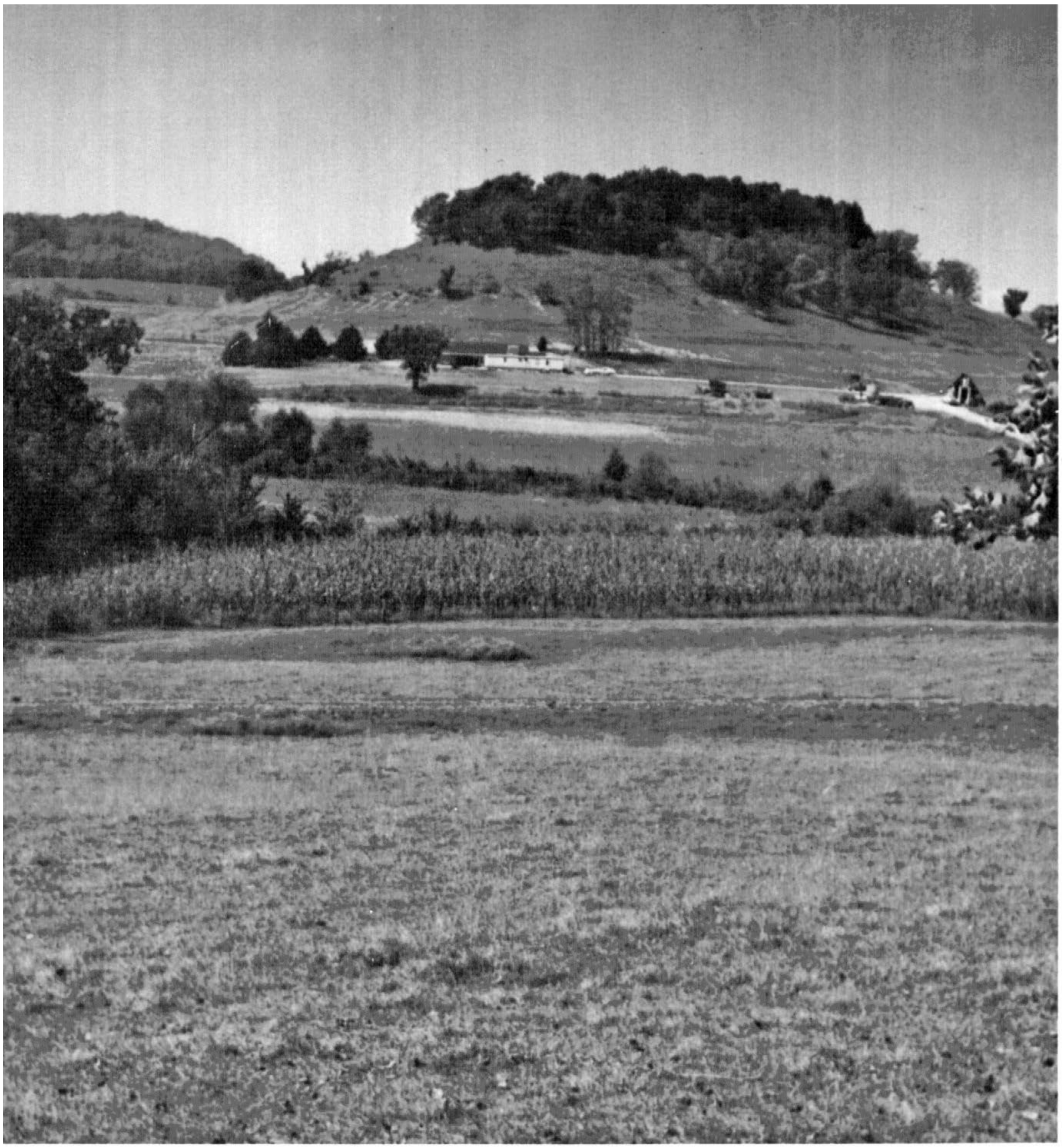
United States
Department of
Agriculture

Soil
Conservation
Service

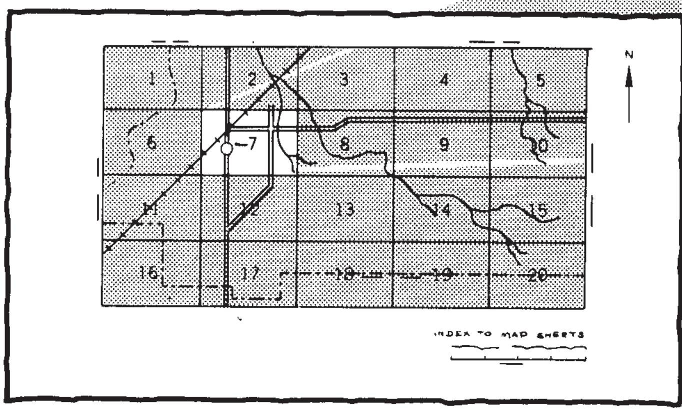
In cooperation with the
Missouri Agricultural
Experiment Station

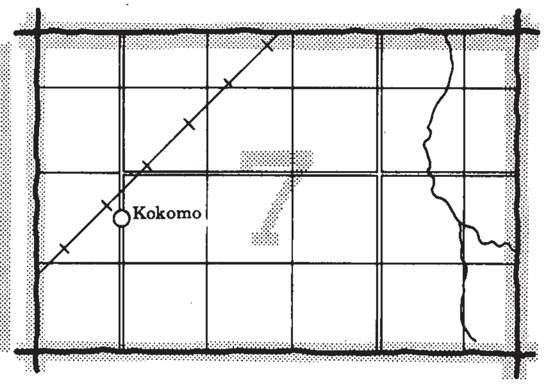
Soil Survey of Cass County, Missouri



HOW TO USE

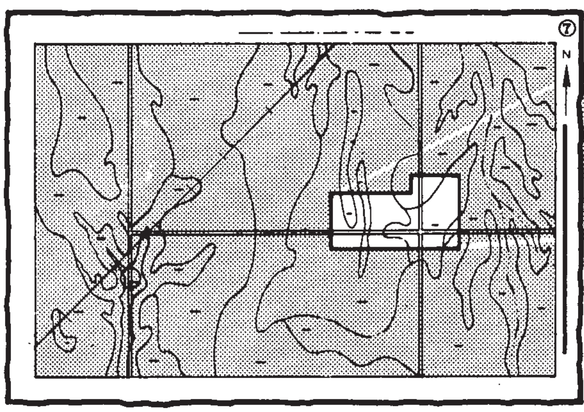
1. Locate your area of interest on the "Index to Map Sheets" (the last page of this publication).

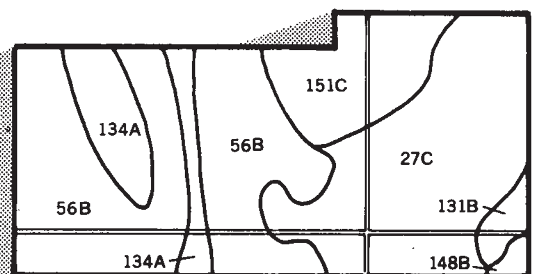




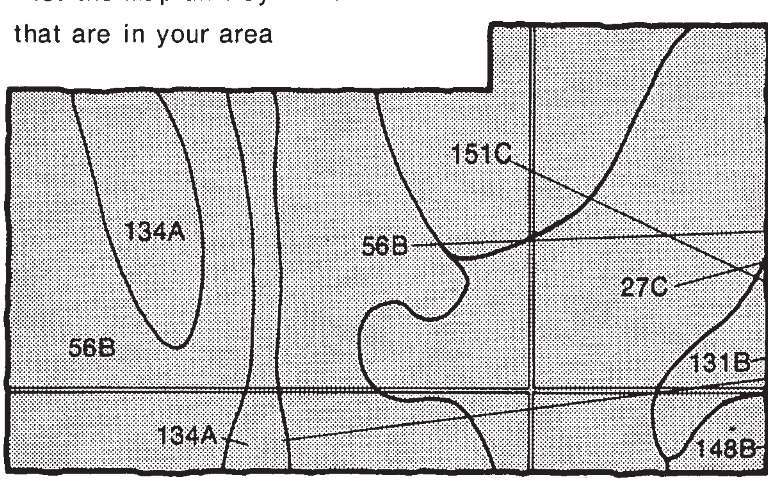
2. Note the number of the map sheet and turn to that sheet.

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





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



Symbols

27C
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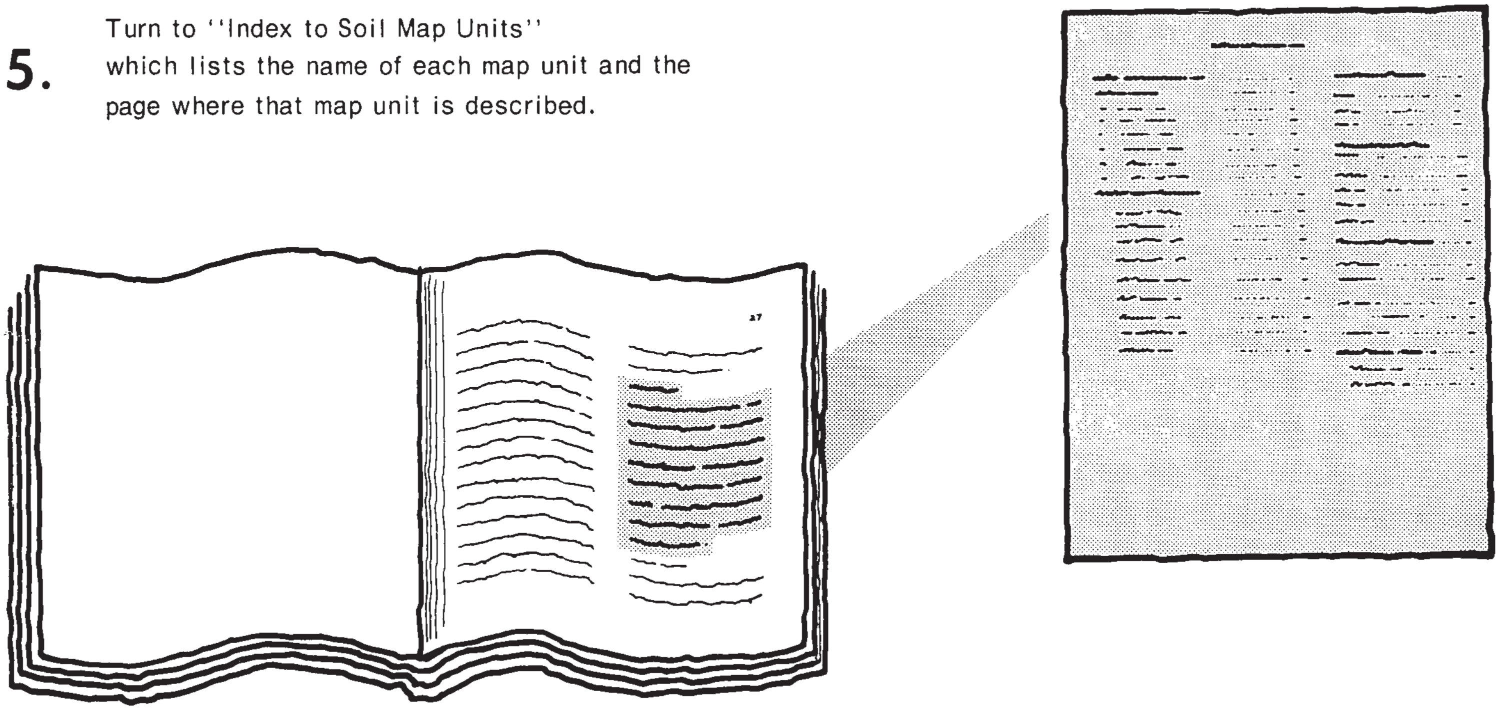
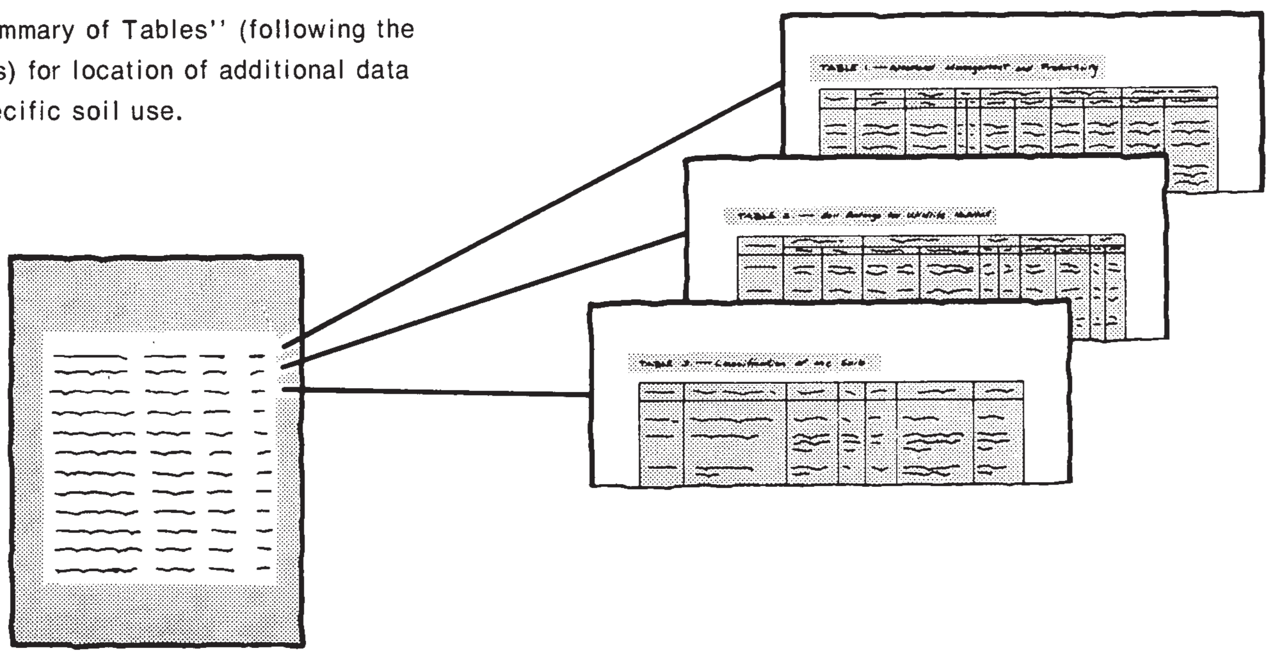
THIS SOIL SURVEY

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; for 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.

This soil survey was prepared by the United States Department of Agriculture, Soil Conservation Service, in cooperation with the Missouri Agricultural Experiment Station. It is part of the technical assistance furnished to the Cass County Soil and Water Conservation District. The County Court, through the Comprehensive Education and Training (CETA) program, provided personnel to assist with the fieldwork. The Missouri Department of Natural Resources provided a soil scientist to assist with the fieldwork and contributed funds to assist with the map finishing. Major fieldwork for this soil survey was completed in 1977-81. Soil names and descriptions were approved in 1981. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1981.

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.

This survey supercedes the soil survey of Cass County published in 1914 (*14*).

Cover: Mixed crops and pasture in an area of Snead-Polo-Oska association.

Contents

Soil Series

Issued May 1985

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Summary of Tables

Foreword

This soil survey contains information that can be used in land-planning programs in Cass County, Missouri. 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.

Paul F. Larson
State Conservationist
Soil Conservation Service

Soil Survey of
Cass County, Missouri

By George T. Simmons, Soil Conservation Service

Soils surveyed by George T. Simmons, Sybill J. Kizer, and Myra L. Duckworth, Soil Conservation Service; Scott Paterson, Missouri Department of Natural Resources; and Paul Bockelman, Cass County Soil and Water Conservation District

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

CASS COUNTY is in the west-central part of the state (fig. 1). It has a total area of 449,498 acres or 702.34 square miles, which includes about 1,050 acres of water areas more than 40 acres in size. Harrisonville, the county seat, is near the center of the county. The population of the county in 1970 was about 39,448.

The county is in the Cherokee Prairie Land Resource Area of the Central Feed Grains and Livestock Region of the United States (*3*). The South Grand River is the largest stream in the county. Most of the county drains to the south and east into the South Grand River and Big Creek, which is a tributary of the South Grand River. A minor part of the county drains northward into the Blue and Little Blue Rivers. Elevation ranges from about 730 feet, where the South Grand River leaves the county, to 1,120 feet above sea level near the town of Belton in the northwest corner of the county.

Farming is the main economic enterprise in the county. The climate is favorable for cash-grain and livestock farming. The major crops are corn, soybeans, grain sorghum, and wheat. Urban growth is very rapid in the northwestern part of the county and is increasing to some extent in all parts of Cass County.

Soil scientists determined that there are about 35 different kinds of soils in Cass County. The soils range widely in texture, natural drainage, and other characteristics. Most of the cultivated soils in this county are suited to the crops commonly grown. The need for erosion control on sloping cropland is the most important management concern in farming the soils of Cass County.

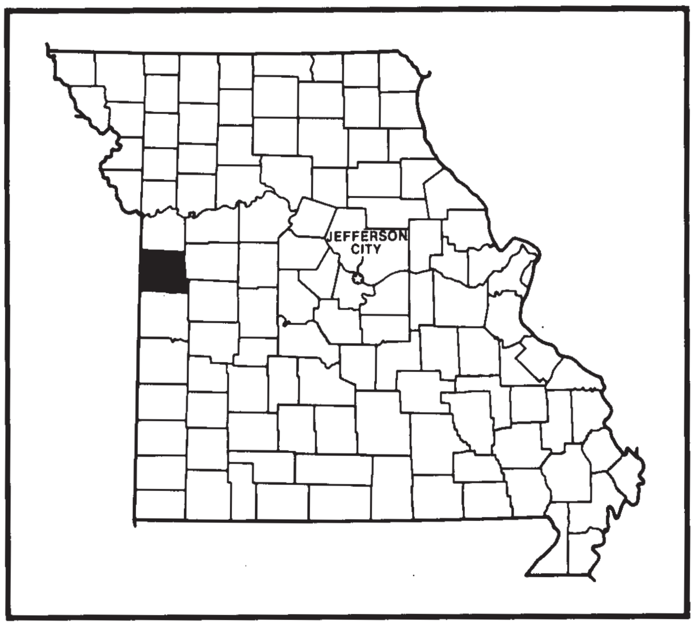

Figure 1.—Location of Cass County in Missouri.

General Nature of the County

This section gives general information concerning the area. Climate, natural resources, settlement and population, and farming are discussed.

Climate

Prepared by the National Climatic Center, Asheville, North Carolina.

The consistent pattern of climate in Cass County is one of cold winters and long and hot summers. Heavy rains occur mainly in spring and early in summer, when moist air from the Gulf of Mexico interacts with drier continental air. The annual rainfall is normally adequate for corn, soybeans, and all grain crops.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Harrisonville, Missouri, in the period 1951 to 1979. 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 degrees F, and the average daily minimum temperature is 22 degrees. The lowest temperature on record, which occurred at Harrisonville on February 9, 1979, is -15 degrees. In summer the average temperature is 77 degrees, and the average daily maximum temperature is 88 degrees. The highest recorded temperature, which occurred on July 14, 1954, is 115 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 36 inches. Of this, 25 inches, or 69 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 19 inches. The heaviest 1-day rainfall during the period of record was 4.85 inches at Harrisonville on September 23, 1970. Thunderstorms occur on about 53 days each year, and most occur in summer.

The average seasonal snowfall is 17 inches. The greatest snow depth at any one time during the period of record was 15 inches. On an average of 5 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year.

Tornadoes and severe thunderstorms strike occasionally but are local and of short duration. Damage varies and is spotty.

Hailstorms occur at times during the warmer part of the year but in an irregular pattern and in only small areas.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 75 percent of the time possible in summer and 60 percent in winter. The prevailing wind is from the south. Average windspeed is highest, 12 miles per hour, in spring.

Natural Resources

Soil is the most important natural resource in the county. Farm crops and livestock that graze the grassland depend on the soil.

Most soils on uplands in Cass County are suitable for the construction of ponds and small lakes for use as water supply for household purposes and livestock. Wells drilled to 400 feet yield 1 to 15 gallons of water per minute, which is for drinking water or watering livestock. Aquifers that feed wells drilled below 400 feet contain mineral water that according to the U.S. Public Health Service (*9*) is below the chemical drinking standards. The wells below 400 feet are used mostly for livestock. Some parts of the county are irrigated. Shallow lakes are a source of this water.

Limestone is another natural resource of significance in Cass County. In the Bethany Falls and the Higginsville geologic formations, it is quarried for concrete aggregate, road material, and building stones and for farm uses.

Oil and natural gas are also produced commercially. Two named areas of oil and gas production and some unnamed individual wells in the county produce noncommercial gas only.

Settlement and Population

The first settlers came to the area in 1828 and settled along Big Creek in the northeastern part of the county. In 1835, the county was organized and named after Martin Van Buren, a President of the United States. In 1849, the Missouri Legislature changed the name to Cass County in honor of General Lewis Cass (*12*).

Settlement was slow but steady until the Civil War in 1863 when General Ewing of the Union army issued Order Number Eleven, which called for the evacuation of the county (*11*). After the war, people resettled in the county, and population and farming increased rapidly. Many of the expanding railroad lines radiated out of Kansas City and crossed Cass County (*12*). These railroads contributed significantly to the expansion and development of many of the towns in the county.

The county is crossed from east to west by State Routes 2, 7, and 58 and from north to south by State Route 291 and U.S. Highway 71. It is also served by three railroads. There are several small airstrips in the county.

In 1970, the total population of Cass County was 39,448, of which 27,994 was urban and 11,454 rural

(*18*). Harrisonville, the county seat, had a population of 5,052.

Farming

The first settlers in Cass County located along small streams, principally along Big Creek and the headwaters of Grand River, which were bordered on both sides by forested areas that ranged to as much as 3 miles in width. The settlers cleared a few acres of land, using the timber for fuel, fences, and the construction of log cabins. Because they thought breaking the turf of the prairie was impossible, it was used as rangeland. Corn and vegetables were grown in patches for food. Corn soon became the principal crop, though wheat, flax, oats, and rye and some tobacco and hemp were grown.

The extensive rangeland of the county made the raising of livestock profitable. In the early 1900's, corn growing was expanded; but due to lack of markets, the crop was difficult to sell. Feeding hogs and cattle for market was undertaken and developed rapidly into a profitable industry. Today, many of the farmers raise beef cattle. The combination of livestock raising and grain production is the prevailing type of agriculture in the county. The major cash crops are corn, wheat, grain sorghum, and soybeans.

Most of the acreage in the county is used for farming. According to the Census of Agriculture (*18*), there were 1,718 farms in 1978, compared to 1,721 in 1974. While the total number of farms decreased, the average size farm decreased from 211 to 207 acres.

The Soil Conservation District legislation enacted in 1937 stirred the interest of many landowners. The Cass County Soil and Water Conservation District, organized in 1966, was the 64th Soil Conservation District in Missouri.

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.

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 broad areas called soil associations that have a distinctive pattern of soils, relief, and drainage. Each soil association on the general soil map is a unique natural landscape. Typically, a soil 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 other associations but in a different pattern.

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

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

The descriptions, names, and delineations of soils in this survey do not fully agree with soil maps of adjacent counties published at a different date. The differences are the result of additional soil data, intensity of mapping, and modifications in correlation that reflect local variations. In some places it is more feasible to combine small acreages of similar soils that respond to use and management in much the same way than it is to separate these soils and give them different names.

Descriptions of Associations

1. Snead-Polo-Oska Association

Moderately deep and deep, gently sloping to steep, moderately well drained and well drained soils formed in residuum or in loess and residuum; on uplands

This association consists of soils on narrow ridgetops and side slopes (fig. 2). Exposures of limestone are on the steeper parts of this association. Slopes range from about 2 to 30 percent.

This association makes up about 33 percent of the county. It is about 22 percent Snead soils, 15 percent Polo and similar soils, 11 percent Oska soils, and 52 percent minor soils.

Snead soils are moderately sloping to steep, moderately deep, and moderately well drained. Snead soils and exposures of Rock outcrop are on side slopes. Typically, the surface layer is very dark gray, friable silty clay loam. The subsurface layer is very dark grayish brown, friable silty clay loam. The subsoil is very dark grayish brown, firm silty clay loam in the upper part and olive, mottled, firm silty clay in the lower part. Weakly consolidated shale is at a depth of about 25 inches.

The Polo soils are gently sloping and moderately sloping, deep, and well drained. These soils are on narrow ridgetops and side slopes. Typically, the surface layer is very dark grayish brown, friable silt loam, and the subsurface layer is dark brown, very friable silt loam. The subsoil is dark brown and brown, friable silty clay loam in the upper part, and it is brown and yellowish red, firm silty clay loam in the lower part.

The Oska soils, which are moderately sloping, moderately deep, and well drained, are on side slopes. Typically, the surface layer is dark brown, friable silty clay loam. The subsoil is dark reddish brown, friable silty clay loam in the upper part and reddish brown, firm silty clay in the lower part. The underlying material is hard, fractured limestone.

Of minor extent in this association are Haig, Kenoma, Macksburg, Mandeville, Norris, Sampsel, Verdigris, and Weller soils. The poorly drained Haig, somewhat poorly drained Macksburg, and moderately well drained, clayey Kenoma soils are on broad, nearly level and gently sloping ridgetops. The moderately well drained Mandeville and shallow Norris soils are on side slopes. The plant cover under which these soils formed was mainly trees. The poorly drained Sampsel soils are on concave side slopes. The Verdigris soils are on narrow flood plains along drainageways. The moderately well drained Weller soils are on narrow ridgetops near streams and formed under plant cover consisting mainly of trees.

The soils in this association are used mainly for crops and pasture. Some areas are used for housing developments. Some of the steeper areas and the areas along streams are wooded. Corn, soybeans, grain sorghum, small grains, and pasture plants are the main crops. Erosion by water is a hazard. Controlling erosion and maintaining fertility and tilth are the main concerns in managing the major soils.

The soils on ridgetops and some of the soils on the upper part of side slopes generally are well suited to cultivated crops. The rest of the soils generally are not suited to crops.

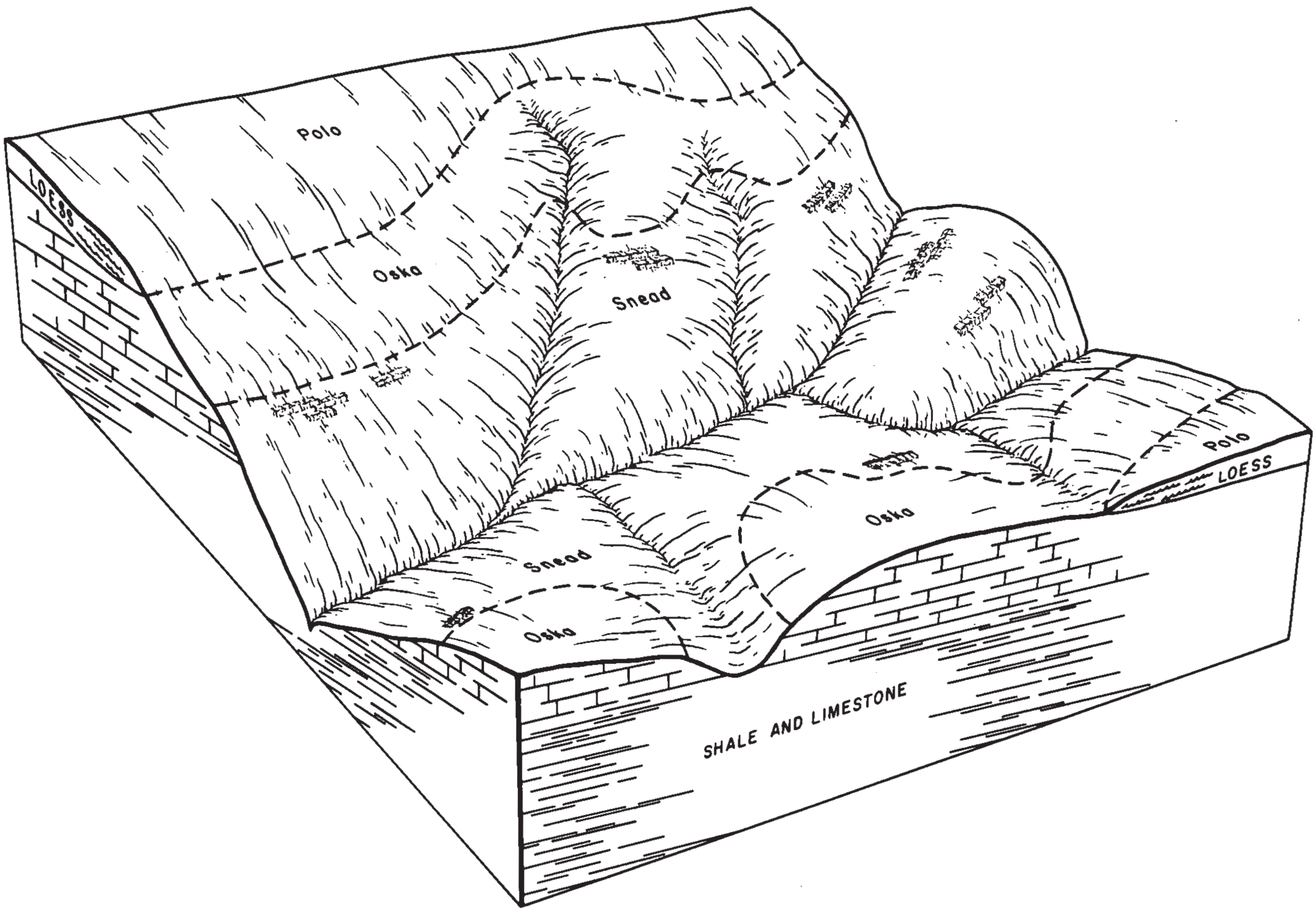

Figure 2.—Pattern of soils and underlying material in the Snead-Polo-Oska association.

The soils of this association generally are suited to building site development and sanitary facilities. Slope and depth to rock are the main limitations to those uses.

2. Zook-Blackoar-Verdigris Association

Deep, nearly level, poorly drained and moderately well drained soils formed in silty and clayey alluvium; on flood plains

This association consists of soils on flood plains of the larger streams in the county (fig. 3). It makes up about 12 percent of the county. It is about 34 percent Zook and similar soils, 29 percent Blackoar soils, 29 percent Verdigris soils, and 8 percent minor soils.

The Zook soils are poorly drained and commonly are adjacent to the uplands and in depressional areas. Typically, the surface layer is black, friable silty clay loam. The subsurface layer is black and very dark gray over very dark grayish brown, firm silty clay loam. The subsoil is very dark gray, firm silty clay loam. The substratum is very dark gray, mottled, firm silty clay loam.

The Blackoar soils are poorly drained and are between stream channels and the uplands. Typically, the surface layer is very dark grayish brown, very friable silt loam, and the subsurface layer is very dark gray, very friable silt loam. The subsoil is dark gray, mottled, very friable and friable silt loam.

Verdigris soils are moderately well drained and are along the stream channels. Typically, the surface layer is very dark grayish brown, very friable silt loam. The subsurface layer is very dark brown and very dark grayish brown, friable silty clay loam. Below this layer is a transitional layer of dark brown, friable silty clay loam. The substratum is dark brown, friable clay loam.

Of minor extent in this association are Freeburg and Moniteau soils. The nearly level, somewhat poorly

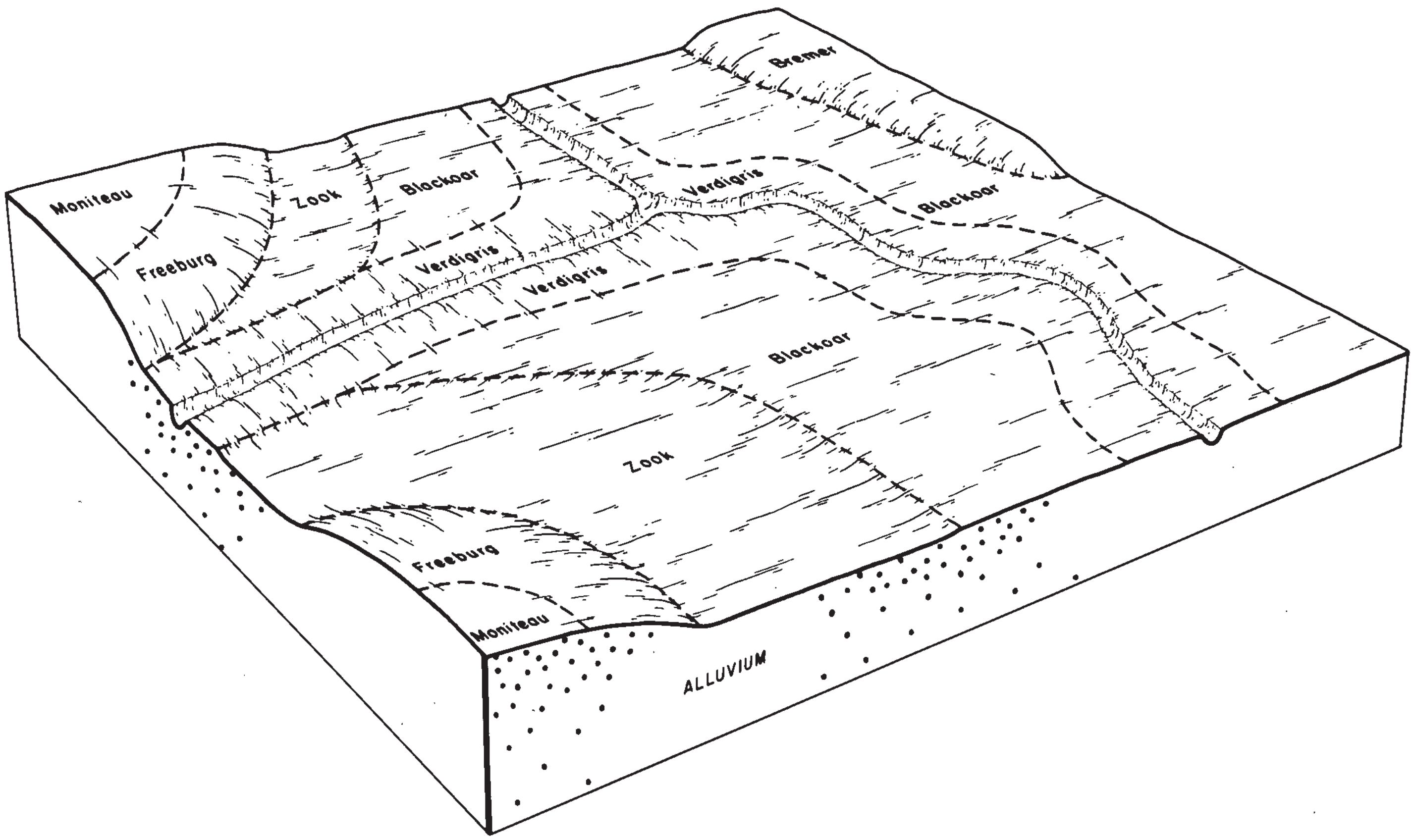

Figure 3.—Pattern of soils and underlying material in the Zook-Blackoar-Verdigris association.

drained, light colored Moniteau and Freeburg soils are on terraces.

The soils in this association are used mainly for cultivated crops. Corn, soybeans, grain sorghum, and small grains are the main crops. Flooding is the main hazard. Controlling flooding, improving surface drainage, and maintaining tilth and fertility are the main concerns in managing the major soils.

In most areas these soils are well suited to cultivated crops if flooding can be controlled. The soils generally are unsuitable for building site development and sanitary facilities because of the flood hazard.

3. Macksburg-Sampsel-Greenton Association

Deep, gently sloping and moderately sloping, somewhat poorly drained and poorly drained soils formed in loess and residuum; on uplands

This association consists of soils on broad ridgetops and long side slopes (fig. 4). Slopes range from about 2 to 9 percent.

This association makes up about 24 percent of the county. It is about 30 percent Macksburg soils, 22 percent Sampsel soils, 18 percent Greenton and similar soils, and 30 percent minor soils.

The Macksburg soils are somewhat poorly drained and are on broad ridgetops. Typically, the surface layer is very dark brown and black, very friable silt loam. The subsurface layer is very dark gray, friable silty clay loam. The subsoil is dark grayish brown and grayish brown, mottled, firm silty clay loam. The substratum is grayish brown, mottled, friable silty clay loam.

The Sampsel soils are poorly drained soils on side slopes and in concave heads of drainageways. The surface layer is black, very friable silty clay loam, and the subsurface layer is very dark gray, very friable silty clay loam. The subsoil is very dark gray and dark gray, mottled, friable and firm silty clay loam in the upper part; mottled, dark grayish brown, dark gray, and dark brown, firm silty clay in the middle part; and mottled, yellowish brown and grayish brown, firm silty clay in the lower part.

Greenton soils are somewhat poorly drained soils on ridgetops and side slopes. Typically, the surface soil is very dark grayish brown, very friable silty clay loam. The subsoil is very dark grayish brown, friable silty clay loam in the upper part; dark brown, mottled, firm silty clay in

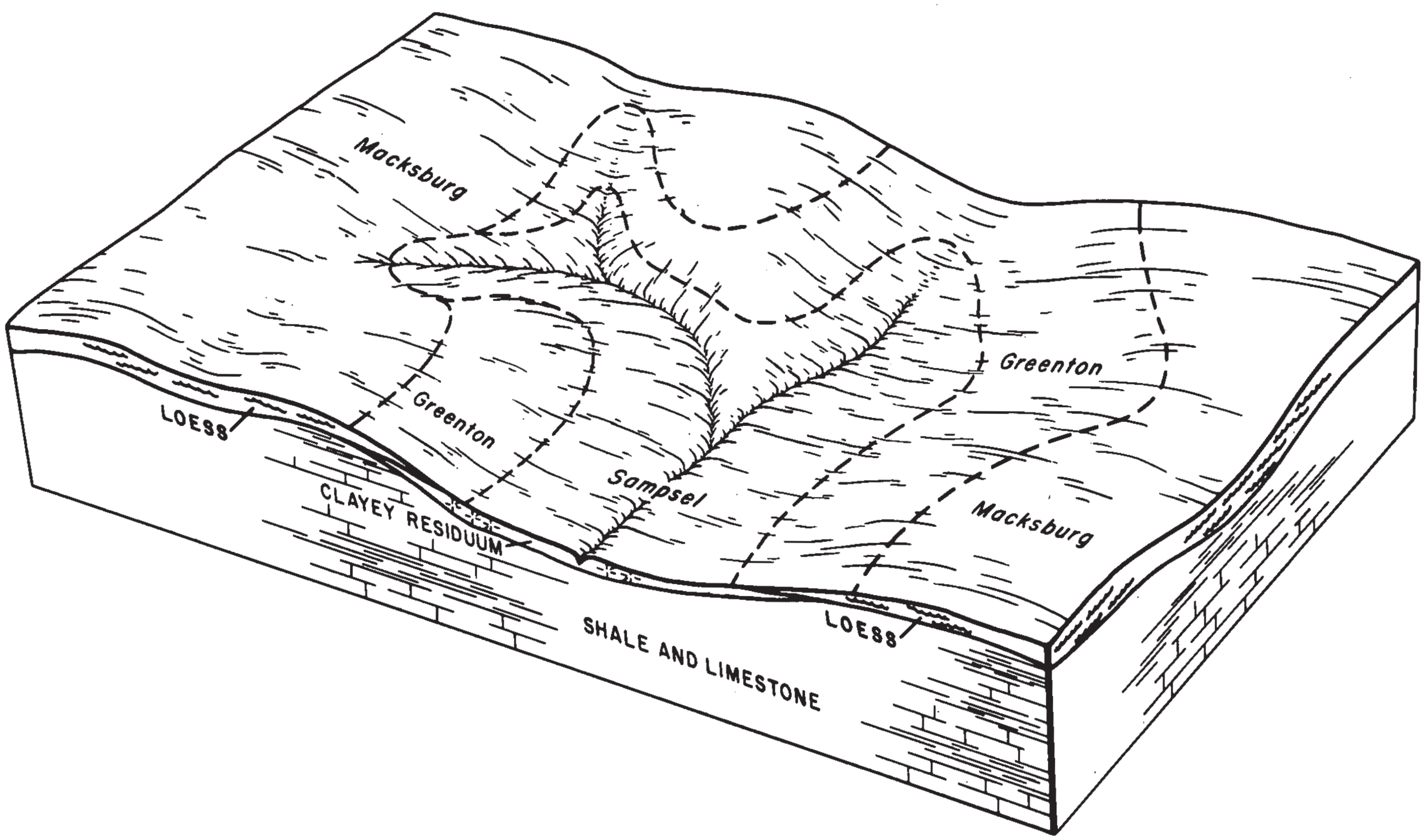

Figure 4.—Pattern of soils and underlying material in the Macksburg-Sampsel-Greenton association.

the middle part; and reddish brown, firm silty clay in the lower part.

Of minor extent in this association are Haig, Oska, and Snead soils. The moderately deep Oska and Snead soils are on side slopes where the soil material is thinner. The nearly level Haig soils are on the broad ridgetops.

The soils in this association are used mainly for crops and pasture; in some areas they are used for housing developments. Corn, soybeans, grain sorghum, small grains, and grasses and legumes for hay and pasture are the main crops. Erosion by water is a hazard. Controlling erosion and maintaining fertility and tilth are the main concerns in managing the major soils.

In most areas these soils generally are suited to cultivated crops if erosion is controlled. These soils generally are suited to building site development and sanitary facilities. Wetness and high shrink-swell potential of the soils are severe limitations to those uses.

4. Kenoma-Haig-Deepwater Association

Deep, nearly level to moderately sloping, moderately well drained and poorly drained soils formed in old alluvium, loess, or residuum; on uplands

This association consists of soils on broad ridgetops and side slopes (fig. 5). Slopes range from about 0 to 9 percent.

This association makes up about 23 percent of the county. It is about 46 percent Kenoma and similar soils, 22 percent Haig soils, 20 percent Deepwater soils, and 12 percent minor soils.

The Kenoma soils are moderately well drained and are on broad ridgetops and side slopes. Typically, the surface layer is very dark grayish brown, very friable silt loam. The subsoil is very dark grayish brown, firm silty clay in the upper part; dark grayish brown, mottled, very firm silty clay in the next part; and yellowish brown, mottled, very firm silty clay in the lower part.

The Haig soils are nearly level and poorly drained and are on broad ridgetops. Typically, the surface soil is black, very friable silt loam. The subsoil is very dark gray, friable silty clay loam in the upper part; very dark gray and dark grayish brown, firm and very firm silty clay in

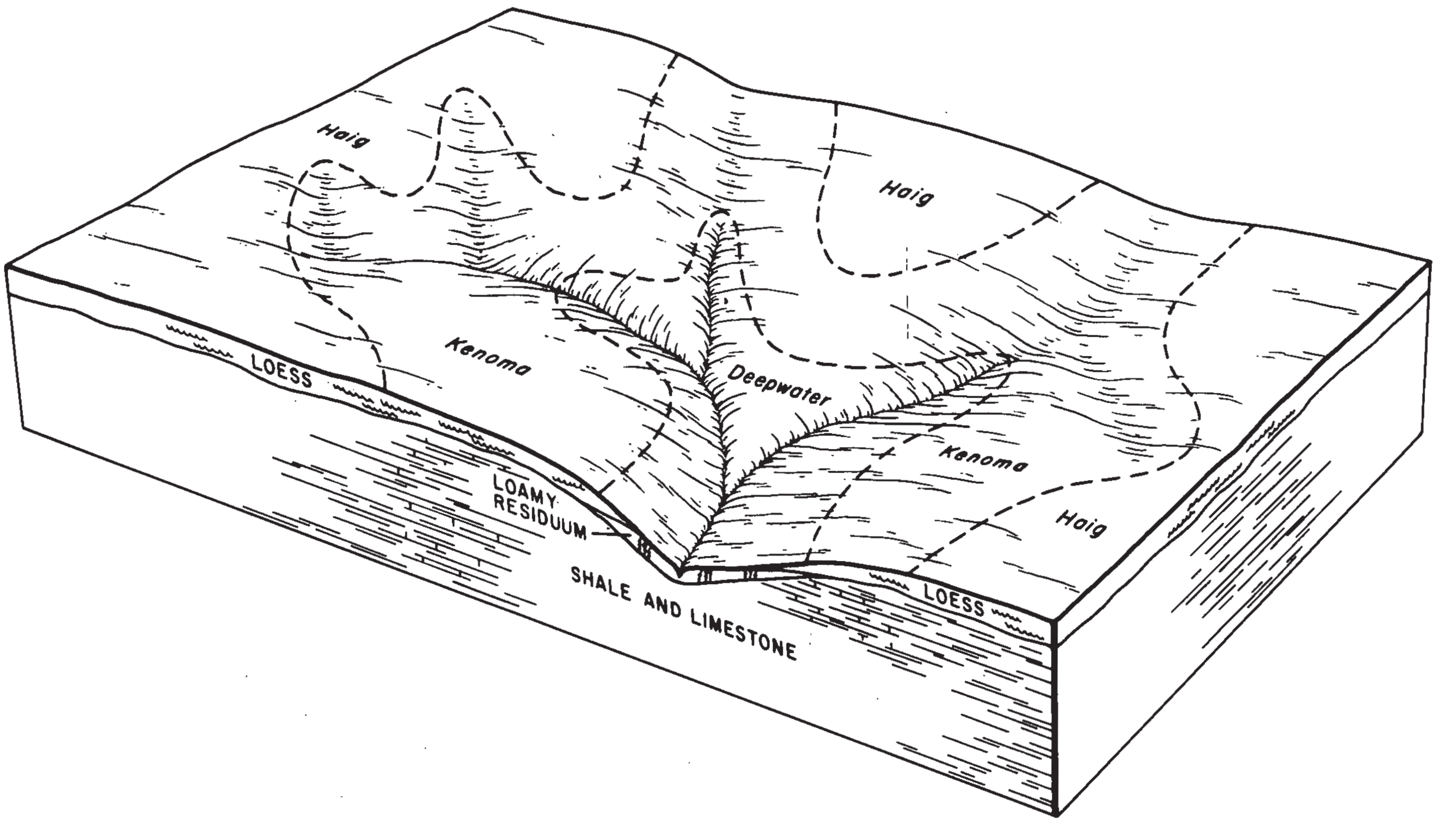

Figure 5.—Pattern of soils and underlying material in the Kenoma-Haig-Deepwater association.

the middle part; and grayish brown, mottled, firm silty clay loam in the lower part.

The Deepwater soils are moderately well drained and are on narrow ridgetops and side slopes. Typically, the surface layer is very dark gray, very friable silt loam. The upper part of the subsoil is dark brown and brown, mottled, friable silty clay loam; the middle part is dark yellowish brown and dark brown, mottled, friable and firm silty clay loam; and the lower part is dark grayish brown, mottled, firm silty clay.

Of minor extent in this association are Eram, Snead, and Verdigris soils. The moderately deep Eram soils are on convex side slopes. The moderately deep Snead soils are on the steeper side slopes and are associated with small amounts of Rock outcrop. The silty Verdigris soils are on narrow valley flood plains.

The soils in this association are used mainly for cultivated crops and pasture. Some areas are irrigated with sprinkler systems from shallow lakes. Corn, soybeans, grain sorghum, and small grains are the main crops. Erosion by water is the main hazard. Controlling erosion and maintaining fertility and tilth are the main concerns in managing the major soils.

In most areas these soils generally are suited to cultivated crops if erosion is controlled. These soils are suited to building site development and sanitary facilities. Wetness and high shrink-swell potential of the soils are the main limitations to those uses.

5. Summit-Eram-Kenoma Association

Deep and moderately deep, gently sloping to strongly sloping, moderately well drained soils formed in residuum, old alluvium, or loess; on uplands

This association consists of soils that are mainly on ridgetops and side slopes (fig. 6). Slopes range from about 2 to 14 percent.

This association makes up about 8 percent of the county. It is about 39 percent Summit soils, 20 percent Eram soils, 18 percent Kenoma soils, and 23 percent minor soils.

The Summit soils are deep and are on narrow ridgetops and side slopes. Typically, the surface soil is black, firm silty clay loam. The subsoil is very dark gray, very firm silty clay loam in the upper part; multicolored, firm and very firm silty clay in the middle part; and multicolored, firm silty clay loam in the lower part.

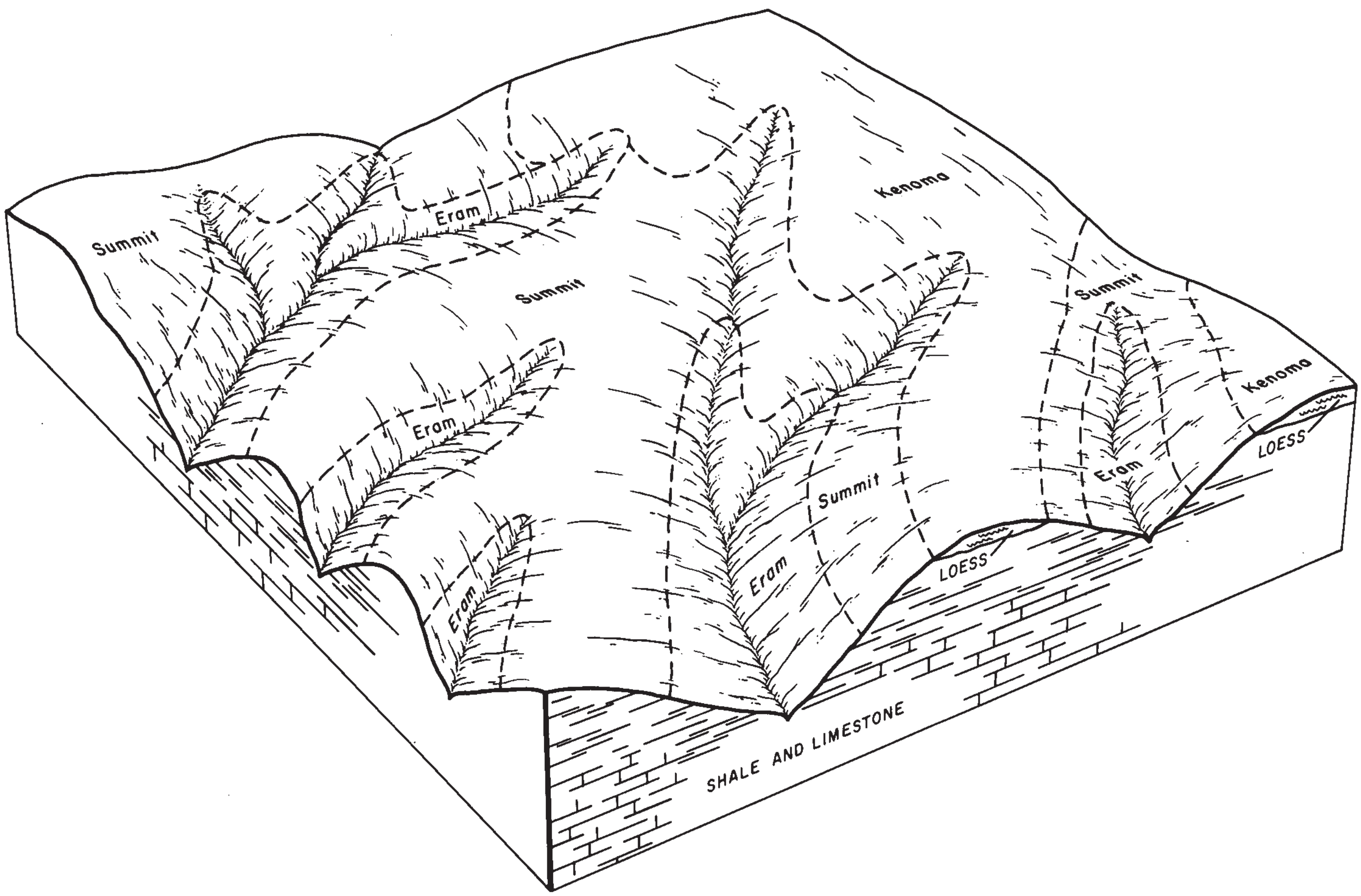

Figure 6.—Pattern of soils and underlying material in the Summit-Eram-Kenoma association.

The Eram soils are moderately deep soils, and they are on side slopes and in some places on mounds. Typically, the surface layer is very dark grayish brown, friable silty clay loam. The subsoil is dark brown, firm and very firm silty clay loam in the upper part; yellowish brown, very firm clay in the middle part; and mottled, grayish brown, dark yellowish brown, and dark gray, very firm silty clay in the lower part. The underlying material is yellowish brown, weathered shale.

The Kenoma soils are deep and moderately well drained soils on broad ridgetops and side slopes. Typically, the surface layer is very dark grayish brown, very friable silt loam. The subsoil is very dark grayish brown, firm silty clay in the upper part; dark grayish brown, mottled, very firm silty clay in the middle part; and yellowish brown, mottled, very firm silty clay in the lower part.

Of minor extent in this association are Barco, Deepwater, Norris, and Polo soils. The coarser textured Barco soils are on ridgetops and mounds. The shallow Norris soils are on side slopes. The well drained Polo and silty Deepwater soils are on ridgetops and side slopes.

The soils in this association are used mainly for pasture. Some of the less sloping major soils and some minor soils are used for cultivated crops. Corn, soybeans, grain sorghum, and small grains are the main crops. Erosion is a hazard on areas used for cultivated crops. Controlling erosion and maintaining fertility and tilth are the main concerns in managing the soils.

In most areas the soils in this association are suited to grasses and legumes for hay and pasture. The gently sloping soils are better suited to building site development and sanitary facilities than the other soils. The slope, high shrink-swell potential of the soils, and wetness are the main limitations to those uses.

Broad Land Use Considerations

The soils of Cass County vary widely in their suitability for major land uses. Approximately 24 percent of the land in the county is used for cultivated crops, mainly corn, soybeans, grain sorghum, and wheat. This cropland is scattered throughout the county, but it is dominantly in soil associations 2, 3, and 4. Soils in association 2, mainly Verdigris, Blackoar, and Zook soils, are flooded occasionally, principally in winter and spring. The flooding causes slight to moderate crop damage on all three soils. Wetness is a major limitation for crops on Blackoar and Zook soils. The soils in associations 3 and 4 are on uplands; the hazard of erosion is the main limitation for crops. Deepwater, Greenton, Haig, and Macksburg soils are the main soils in associations 3 and 4 that are used for cultivated crops.

About 27 percent of the acreage is in pasture. The major soils in associations 1, 3, 4, and 5 are well suited to grasses and legumes. These are Deepwater, Greenton, Haig, Kenoma, Macksburg, Polo, Oska, Sampsel, and Snead soils.

Approximately 8 percent of the acreage is in woodland. The productivity for hardwoods is high in the soils in associations 1, 2, and 5.

About 12 percent of the county is classified as urban or built-up land. In general, the nearly level to moderately sloping Macksburg and Greenton soils are suited to urban uses. These soils are mainly in soil association 3. In the other associations, low strength, wetness, and steep slope are the principal soil limitations. The soils on flood plains, such as those in association 2, are generally unsuitable for urban uses because of flooding. The soils in association 4 have low suitability for urban uses because of low strength and high shrink-swell potential. Some of the soils in associations 1 and 5 are poorly suited because of steep slope and shallowness to bedrock. Sites that are suitable for houses or small commercial buildings, however, generally are available in these areas (fig. 7).

The suitability for recreation use depends on the intensity of the expected use and the properties of the soil. The soils in associations 1, 3, and 5 generally have only fair suitability for intensive recreation development because of clay in the soil or the steepness of slope. The soils in association 2 are poorly suited because of flooding. All these soils, however, are suitable for recreation uses, such as hiking or horseback riding.

Figure 7.—In this developed area of Snead soils and Rock outcrop, the rocks are used for landscaping.

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 underlying material, 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 underlying material. 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, Kenoma silt loam, 1 to 4 percent slopes, is one of two phases in the Kenoma series.

Some map units are made up of two or more major soils. These map units are called soil complexes.

A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Snead-Rock outcrop complex, 5 to 14 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

2C—Higginsville silt loam, 5 to 9 percent slopes. This deep, gently sloping, somewhat poorly drained soil is on the convex to slightly concave upper part of side slopes. Individual areas are irregular in shape and range from 5 to 40 acres or more.

Typically, the surface layer is very dark grayish brown, very friable silt loam about 9 inches thick. The subsoil is about 41 inches thick. The upper part of the subsoil is very dark grayish brown, friable silty clay loam; the next part is dark brown, mottled, friable silty clay loam. The lower part is multicolored, friable silty clay loam. The substratum to 65 inches is multicolored, friable silty clay loam. In some small areas, the soil is very dark grayish brown to a depth of less than 10 inches.

Included with this soil in mapping are small areas of moderately well drained Sharpsburg soils and poorly drained Sampsel soils. Sharpsburg soils are on the broad ridgetops, and Sampsel soils are on the lower part of the drainageways. In some places, erosion has completely removed the original surface layer, and the silty clay loam subsoil is exposed on the surface. The included soils make up about 10 percent of the areas mapped.

In this Higginsville soil, permeability is moderate, and surface runoff is medium. Available water capacity is high. Reaction ranges from slightly acid to strongly acid in the subsoil. It varies widely in the surface layer as a result of local liming practices. Natural fertility is high, and the organic matter content is moderate, except in small places where erosion has removed most of the surface layer. The surface layer is very friable and easily tilled throughout a fairly wide range in moisture content; however, it tends to crust and puddle after hard rains in areas where the plow layer contains subsoil material. The seasonal high water table is at a depth of 1.5 to 3.0 feet in winter and spring. The shrink-swell potential is moderate.

Most of the acreage of this soil is used for cultivated crops, hay, and pasture. This soil is suited to corn, soybeans, grain sorghum, small grain, and grasses and legumes for hay and pasture. If the soil is used for cultivated crops, there is a hazard of further erosion. Using a conservation tillage system, or no-tillage, which leaves large amounts of crop residue on the surface, and in some places, installing terraces and waterways help control erosion. These practices maintain organic matter content, improve tilth, increase water infiltration, and reduce fertility losses.

This soil is well suited to grasses and legumes for hay and pasture. The varieties selected need to be able to tolerate the moderately high water table. Growing grasses and legumes for pasture and hay is effective in controlling erosion and improving soil fertility. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, rotational grazing of pasture, timely deferment of grazing, and restricted use during wet periods help keep the pasture and the soil in good condition.

This soil is suitable for building sites and onsite waste disposal; however, wetness, shrink-swell potential, and slope limit the development of such sites. If dwellings are constructed on this soil, foundations and footings should be designed and reinforced to prevent structural damage caused by the shrinking and swelling of the soil. Foundation drains can be installed around the buildings to help prevent the damage caused by excessive wetness. This soil is suitable for sewage lagoons. Sites will need leveling, and the bottoms of the lagoons may need sealing to prevent contamination of ground water.

Grading local roads and streets to shed water and providing adequate side ditches and culverts help to prevent the damage resulting from frost action and shrinking and swelling of the soil. Providing suitable base material helps to prevent the damage resulting from low strength and shrinking and swelling.

This soil is in capability subclass IIIe.

5B—Macksburg silt loam, 2 to 5 percent slopes. This deep, gently sloping, somewhat poorly drained soil is on broad, long ridgetops. Individual areas are fairly wide. They occupy the entire length of the ridge and range from 10 to 100 acres.

Typically, the surface layer is very dark brown and black, very friable silt loam about 12 inches thick. The subsurface layer is very dark gray, friable silty clay loam about 7 inches thick. The subsoil, about 39 inches thick, is mottled, firm silty clay loam. It is dark grayish brown in the upper part and grayish brown in the lower part. The substratum to a depth of 72 inches is grayish brown, mottled, friable silty clay loam. In some places, on narrow ridgetops, the soil is browner and is moderately well drained.

Included with this soil in mapping are small areas of somewhat poorly drained Greenton soils and moderately well drained Sharpsburg soils and some areas of poorly drained Haig soils. The Greenton soils are on the lower part of side slopes, and the Sharpsburg soils are on the mounds, narrow ridgetops, and points of broader ridges. The Haig soils are on broader ridgetops. The included soils make up about 8 percent of the mapped areas.

In this Macksburg soil, permeability is moderately slow, and surface runoff is slow. Available water capacity is high. Reaction is slightly acid or medium acid in the subsoil and varies widely in the surface layer as a result of local liming practices. Organic matter content is moderate, and natural fertility is high. The surface layer is very friable and easily tilled throughout a wide range in moisture conditions; however, it tends to crust or puddle after hard rains. A seasonal high water table is at a depth of 2 to 4 feet in spring. The shrink-swell potential is high.

Most areas are used for cultivated crops, pasture, and hay. Some areas are used for houses. This soil is well suited to corn, soybeans, grain sorghum, small grains, and grasses and legumes for hay and pasture. If the soil is used for cultivated crops, the erosion hazard is moderate. Using a conservation tillage system, or no-tillage, which leaves large amounts of crop residue on the soil, and in some places, installing terraces and waterways help control erosion. These practices maintain organic matter content, improve tilth, increase water infiltration, and reduce fertility losses.

The use of the soil for pastureland or hayland also effectively controls erosion and improves soil fertility. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, rotational grazing of pasture, timely deferment of grazing, and restricted use during wet periods help keep the pasture and the soil in good condition.

This Macksburg soil is suitable for building sites and onsite waste disposal, but wetness and high shrink-swell potential limit its use for dwellings and sanitary facilities. If buildings are constructed on this soil, foundations and footings should be designed and reinforced to prevent structural damage caused by the shrinking and swelling of the soil. Tile drains should be provided around the footings and foundations to help prevent damage caused by excessive wetness. This soil is suitable for sewage lagoons. Sites will need leveling, and the bottom of the lagoon may need sealing to prevent contamination of the ground water.

Grading local roads and streets to shed water and providing adequate side ditches and culverts help to prevent the damage resulting from frost action and shrinking and swelling of the soil. Providing suitable base material helps to prevent the damage resulting from low strength and shrinking and swelling.

This soil is in capability subclass IIe.

6B—Sharpsburg silty clay loam, 2 to 5 percent slopes. This deep, gently sloping, moderately well drained soil is on convex ridgetops and upland divides. Areas are rounded or rectangular in shape and range from 5 to 60 acres.

Typically, the surface layer is very dark grayish brown, very friable silty clay loam about 9 inches thick. The subsurface layer, about 7 inches thick, is similar to the surface layer, except it is friable in the lower part. The subsoil, which extends to a depth of 60 inches, is brown and dark yellowish brown, firm silty clay loam in the upper part and is dark yellowish brown, mottled, firm silty clay loam in the lower part. In some places, the subsoil is silty clay. A few areas are not mottled in the lower part of the subsoil and contain less clay. In other places, erosion has removed part of the original, thick surface layer. In these areas the plow layer is now brown, firm silty clay loam because it contains subsoil material.

Included with this soil in mapping are a few small areas of somewhat poorly drained Macksburg and well drained Polo soils. The Macksburg soils are nearly level soils in saddles, and the Polo soils are in positions on the landscape similar to those of the Sharpsburg soil. The included soils make up about 10 percent of the map unit.

In this Sharpsburg soil, permeability is moderate, and surface runoff from cultivated areas is medium. Available water capacity is high. Reaction ranges from medium acid to strongly acid in the subsoil and varies widely in the surface layer as a result of local liming practices. Natural fertility is high, and the organic matter content is moderate. The surface layer is very friable and easily tilled throughout a fairly wide range in moisture content; however, it tends to crust or puddle after hard rains, especially in areas where the plow layer contains subsoil material. The shrink-swell potential is moderate.

In most areas this soil is used for cultivated crops. This soil is suited to corn, soybeans, small grains, and grasses and legumes for hay and pasture. If the soil is used for cultivated crops, the erosion hazard is moderate. Using a conservation tillage system, or no-tillage, which leaves large amounts of crop residue on the soil, and in some places, installing terraces and waterways help control erosion. These practices maintain organic matter content, improve tilth, increase water infiltration, and reduce fertility losses.

The use of this soil for pastureland or hayland is also effective in controlling erosion and improving soil fertility. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, rotational grazing of pasture, and timely deferment of grazing help keep the pasture and the soil in good condition.

This soil is suitable for building sites and onsite waste disposal, but the moderate shrink-swell potential limits its use as a site for dwellings. If buildings are constructed on the soil, foundations and footings should be designed and reinforced to prevent structural damage caused by the shrinking and swelling of the soil. The moderately slow permeability is a limitation to the use of this soil as a site for septic tank absorption fields. Using a larger than normal absorption field or mounding the absorption field improves the ability of the septic system to function.

Grading local roads and streets to shed water and providing adequate side ditches and culverts help to prevent the damage resulting from frost action and shrinking and swelling of the soil. Providing suitable base material helps to prevent the damage resulting from low strength and shrinking and swelling.

This soil is in capability subclass IIe.

7B—Deepwater silt loam, 2 to 5 percent slopes. This deep, gently sloping, moderately well drained soil is on convex ridgetops and side slopes. Areas are irregular in shape and range from 10 to 70 acres.

Typically, the surface layer is very dark gray, very friable silt loam about 10 inches thick. The subsurface layer is very dark grayish brown, friable silt loam about 3 inches thick. The subsoil is about 40 inches thick. The upper part of the subsoil is brown, friable silty clay loam; the next part is yellowish brown, mottled, friable silty clay loam; and the lower part is gray, mottled, friable silty clay loam. The substratum to a depth of 67 inches is brown, mottled, friable silty clay loam. In some places, shale bedrock is at a depth of less than 48 inches.

Included with this soil in mapping are some small areas of the well drained Barco and Polo soils. Also included are some areas of clayey Kenoma soils. The Barco soils, on mounds, are moderately deep over sandstone bedrock. Polo soils are in similar areas. The Kenoma soils are on some of the broader, higher parts of the ridgetops. The included soils make up about 10 percent of the map unit.

In this Deepwater soil, permeability is moderate, and surface runoff is medium. Available water capacity is high. Reaction is strongly acid in the upper part of the subsoil, but ranges from medium acid to slightly acid in the lower part. The reaction varies widely in the surface layer as a result of local liming practices. Natural fertility is high, and organic matter content is moderate. The surface layer is very friable and is easily tilled throughout a fairly wide range in moisture content. A seasonal high water table is at a depth of 3.0 to 4.5 feet in winter and spring. The shrink-swell potential is moderate.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, grain sorghum, small grain, and grasses and legumes for hay and pasture. Using a conservation tillage system, or no-tillage, which leaves large amounts of crop residue on the soil, and in some places, installing terraces and waterways help control erosion, maintain organic matter content, improve tilth, increase water infiltration, and reduce fertility losses.

The use of this soil for the production of grasses and legumes for pasture and hay is also effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, rotational grazing of pasture, timely deferment of grazing, and restricted use during wet periods keep the pasture and the soil in good condition.

This soil is suitable for building sites and onsite waste disposal if proper design and installation procedures are used. Foundations and footings should be reinforced to prevent structural damage caused by the shrinking and swelling of the soil. Tile drains can be installed around footings to help prevent damage caused by excessive wetness. The seasonal high water table is a limitation for septic tank absorption fields. This limitation can be overcome by use of a properly constructed mound system. Slope is a limitation for sewage lagoons, but this limitation can be overcome by leveling. The bottom of the lagoon may need sealing to prevent sewage effluent from contaminating the ground water.

Suitable base material is needed for local roads and streets to prevent damage caused by low strength and shrinking and swelling of the soil.

This soil is in capability subclass IIe.

7C—Deepwater silt loam, 5 to 9 percent slopes. This deep, moderately sloping, moderately well drained soil is on convex side slopes and steeper ridge points. Individual areas are irregular in shape and range from 5 to 50 acres or more.

Typically, the surface layer is very dark gray, very friable silt loam about 11 inches thick. The subsoil extends to a depth of about 62 inches. The upper part of the subsoil is dark brown and brown, mottled, friable silty clay loam; the next part is dark yellowish brown and dark brown, mottled, friable and firm silty clay loam; and the lower part is dark grayish brown, mottled, firm silty clay. In some areas, the surface layer is dark brown silty clay loam because the upper part of the subsoil has been mixed with the surface soil by plowing.

Included with this soil in mapping are some small areas of well drained Barco and Polo soils. Also included are some small areas of more clayey Kenoma soils. The Barco and Polo soils are on higher positions on the side slopes and on ridge breaks. The Kenoma soils are on wide ridgetops. The included soils make up about 10 percent of the mapped areas.

In this Deepwater soil, permeability is moderate, and surface runoff is medium. Available water capacity is high. Reaction is medium acid in the upper part of the subsoil and strongly acid to slightly acid in the lower part. The reaction varies widely in the surface layer as a result of local liming practices. Natural fertility is high, and organic matter content is moderate. The surface layer is very friable and easily tilled throughout a wide range in moisture content. In areas where the plow layer is mixed with the subsoil, however, it tends to crust or puddle after hard rains. The seasonal high water table is at a depth of 3.0 to 4.5 feet in spring. The shrink-swell potential is moderate.

Most of the acreage of this soil is in crops or pasture. This soil is suited to corn, soybeans, grain sorghum, small grain, and grasses and legumes for hay and pasture. The erosion hazard is severe if this soil is used for cultivated crops. Installing terraces and waterways and the use of a conservation tillage system, or no-tillage, which leaves large amounts of crop residue on the soil, help control erosion, maintain organic matter content, improve tilth, increase water infiltration, and reduce fertility losses.

This soil is suited to grasses and legumes for pasture and hayland, and use of the soil for these crops is effective in controlling erosion. Adequate fertility should be maintained for maximum growth. Grazing or haying when the soil is too wet will cause surface compaction and poor tilth. Proper stocking rates, rotational grazing of pasture, timely deferment of grazing, and restricted use during wet periods keep the pasture and the soil in good condition.

This soil is suitable for building site development and onsite waste disposal systems if proper design and installation procedures are used. Foundations and footings should be reinforced to prevent structural damage caused by shrinking and swelling of the soil. Tile drains can be installed around footings to help prevent the damage caused by excessive wetness. The high water table is a limitation for septic tank absorption fields. This limitation can be overcome by properly constructing a mound system above the water table. Slope is a limitation for sewage lagoons but can be overcome by leveling. Also, the bottom of the lagoon may need to be sealed to prevent sewage effluent from contaminating the ground water.

Suitable base material is needed for local roads and streets to prevent damage caused by low strength and shrinking and swelling of the soil.

This soil is in capability subclass IIIe.

8—Pits, quarries. This miscellaneous area consists mainly of piles of rock and open excavations where the soil and underlying material have been removed. Some of the pits are filled with water during all or part of the year. Individual areas of this map unit range from 5 to 20 acres.

Included in mapping are areas of dumps. Dumps are accumulations of limestone aggregates that have been mixed with some excavated soil material.

Steep slopes, large stones, and exposed rock restrict the use of this miscellaneous area. Virtually no vegetation can be produced in the pits. Many of the pits can be developed into a source of water for wildlife, irrigation, or livestock. Some quarries typically are open on one end and do not contain enough water to be economically important. The smaller quarries could be reclaimed at a minimum cost to produce an adequate vegetative cover. As the size and intensity of mining operations increase, the difficulty of reclamation increases. The dumps are suited to grasses and legumes if leveled and shaped prior to seeding.

Pits, quarries, generally is unsuitable for developing building sites and sanitary facilities. An onsite investigation would be needed to determine other anticipated land uses.

This miscellaneous area is not assigned to a capability subclass or woodland ordination group.

9D—Snead silty clay loam, 5 to 14 percent slopes. This moderately deep, moderately sloping and strongly sloping, moderately well drained soil is on convex side slopes. Areas of this map unit are irregular in shape and range from 6 to 80 acres.

Typically, the surface layer is black, firm silty clay loam about 7 inches thick. The subsoil is about 31 inches thick. The upper part is black, firm silty clay loam; the middle part is very dark gray, very firm silty clay; and the lower part is olive brown, mottled, very firm silty clay. At a depth of 38 inches is weakly consolidated, weathered shale. In a few areas, flat limestone fragments are scattered throughout the surface layer. In a few areas, thin layers of limestone bedrock are at or near the surface. In some places, the soil is strongly acid in the subsoil, and in other areas, the soil is less than 20 inches deep.

Included with this soil in mapping are small areas of well drained Polo and Oska soils and poorly drained Sampsel soils. The deep Polo soils and moderately deep Oska soils are on higher convex areas. The deep Sampsel soils are slightly higher or slightly lower on the landscape than the Snead soil. The included soils make up less than 10 percent of the mapped areas.

In this Snead soil, permeability is slow, and surface runoff from pasture and timbered areas is medium to rapid. Available water capacity is low. Organic matter content is moderate, and natural fertility is medium. Reaction ranges from neutral to moderately alkaline in the subsoil, and free carbonates are common in the lower part of the subsoil and in the substratum. The surface layer typically ranges from slightly acid to neutral, but reaction may vary according to the depth to limestone bedrock. The seasonal high water table is at a depth of 2 to 3 feet in winter and spring. The shrink-swell potential is high. Root development is restricted below a depth of about 20 to 40 inches by limestone and shale bedrock.

This soil is about equally divided in use. Approximately half the acreage is planted to grass for pasture and hay, and the rest is in poor quality timber and shrubs. This soil is poorly suited to corn, soybeans, and small grain. If the soil is used for cultivated crops, the hazard of erosion is severe because of the steepness of slope. Low available water capacity is an additional limitation for cultivated crops. Returning crop residue to the soil or regularly adding other organic material helps improve fertility and increase water infiltration.

Grasses and legumes grow well on this soil. The use of the soil for pastureland or hayland is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, rotational grazing of pasture, timely deferment of grazing, and restricted use during wet periods help keep the pasture and the soil in good condition.

This soil is suited to some trees, and some of the areas still remain in native hardwoods. Despite the limitation of a shallow rooting depth imposed by the limestone flagstones and bedrock, native black walnut grows on this soil. Harvestable logs and nut crops can be expected. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed by site preparation, by prescribed burning, or by spraying or cutting. Logging roads and skid trails should be on the contour, where possible, to prevent gullying.

This soil generally is unsuitable for building site development or onsite waste disposal. Wetness, steepness of slope, high shrink-swell potential, and the depth to shale bedrock or thin layers of limestone bedrock are limitations that are difficult to overcome.

This soil is in capability subclass IVe.

10D—Snead-Rock outcrop complex, 5 to 14 percent slopes. This map unit consists of moderately deep, moderately sloping and strongly sloping, moderately well drained Snead soils and Rock outcrop. It is on complex side slopes. Areas are commonly long and narrow and meander through the landscape at about the same elevation. They range from 5 to more than 300 acres.

This map unit is about 70 percent Snead soils and 15 percent Rock outcrop. The Snead soils are on the convex middle and lower parts of side slopes. Rock outcrop typically is on the upper part of side slopes but can be anyplace on the slope. The Snead soils and Rock outcrop are so intricately mixed that it was not practical to map them separately at the scale used.

Typically, the Snead soils have a surface layer that is very dark grayish brown, friable, flaggy silty clay loam about 5 inches thick. The subsoil is about 19 inches thick. The upper part is very dark grayish brown, firm, flaggy silty clay loam, and the middle part is olive brown, firm, flaggy silty clay loam. The lower part is light olive brown, firm silty clay loam. Weakly consolidated, weathered shale is at a depth of 24 inches. Chert fragments rather than limestone fragments are in some places.

Typically, Rock outcrop consists of thin to thick beds of limestone. In some places, it forms ledges, and in other places, it is gently sloping and smooth. In places, Rock outcrop has a thin covering of soil. A few limestone boulders are in areas where the limestone ledge has broken and a large rock has fallen downslope.

Included with this complex in mapping are small areas of moderately deep, well drained Barco and Oska soils and deep Greenton and Summit soils. Barco and Oska soils are on higher convex areas above Rock outcrop. In some places, the Barco soils are on mounds above Rock outcrop. The Greenton and Summit soils are just below the Snead soils on the landscape. These soils make up about 15 percent of the map unit.

In Snead soils, permeability is slow, and available water capacity is low. Surface runoff from pasture and from timbered areas is medium to rapid. The organic matter content is moderate, and natural fertility is medium. Reaction is neutral or slightly acid in the surface layer and neutral to moderately alkaline in the subsoil. The shrink-swell potential in the subsoil is high. The seasonal high water table is at a depth of 2 to 3 feet in winter and spring. Root development is restricted below a depth of about 20 to 40 inches by shale and limestone bedrock.

The acreage of this map unit is nearly equally pasture and forest. The soils in this unit are suited to grasses and legumes for hay and pasture. The growth of deep-rooted plants, however, is limited because of the moderate depth to shale bedrock. Also, use of machinery is limited by areas of Rock outcrop and some areas of loose rock on the surface. Other problems of management are the hazard of erosion and the low available water capacity. Pasture management that maintains an adequate plant cover and ground mulch helps prevent excessive soil loss and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing pasture reduce the protective plant cover, thus causing deterioration of the plant community. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and planned grazing help keep the pasture and the soil in good condition.

The soils in this unit are poorly suited to trees. Some areas remain in native hardwoods. Despite the restricted rooting depth, native black walnut grows on the Snead soils.

The Snead soils generally are not suited to building site development and onsite waste disposal because of slope, shrink-swell potential, wetness, and restricted depth to limestone and shale bedrock.

The soils in this map unit are in capability subclass VIs.

10F—Snead-Rock outcrop complex, 14 to 30 percent slopes. This map unit consists of moderately deep, moderately steep and steep, moderately well drained Snead soils and Rock outcrop. It is on complex side slopes. Areas are commonly long and narrow and meander through the landscape at about the same elevation. They range from 20 to more than 300 acres.

This map unit is about 65 percent Snead soils and 20 percent Rock outcrop. The Snead soils are on the convex middle and lower parts of side slopes. Rock outcrop typically is on the upper part of the side slopes but can be anyplace on the slope. The Snead soils and Rock outcrop are so intricately mixed that it was not practical to map them separately at the scale used.

Typically, the Snead soils have a surface layer that is very dark gray, friable, flaggy silty clay loam about 6 inches thick. The subsurface layer is very dark grayish brown, friable, flaggy silty clay loam about 5 inches thick. The subsoil is about 14 inches thick. The upper part is dark grayish brown, firm, flaggy silty clay loam. The lower part is olive, mottled, firm silty clay. Weakly consolidated, weathered shale is at a depth of about 25 inches. Coarse chert fragments rather than limestone fragments are in some places.

Rock outcrop consists of thin to thick beds of limestone that crop out at the surface. In places, it forms ledges, and in others, it is nearly level or gently sloping. In places, the outcrop is covered with 2 to 5 inches of soil. A few limestone boulders have fallen downslope where the limestone ledge has broken (fig. 8).

Included with this complex in mapping are small areas of well drained Barco, Norris, and Oska soils and deep, somewhat poorly drained Greenton and moderately well drained Summit soils. The Barco and Oska soils are on higher, convex ridgetops and side slopes above Rock outcrop. In some places, the Barco soils are on mounds above Rock outcrop. The Greenton, Norris, and Summit soils are just below the Snead soils. The included soils make up about 15 percent of the map unit.

Snead soils have slow permeability and rapid surface runoff. Available water capacity is low, and organic matter content is moderate. Reaction ranges from neutral to moderately alkaline in the subsoil. Free carbonates are in the lower part of the subsoil and around Rock outcrop. The surface layer is slightly acid or neutral in the Snead soils. Natural fertility is medium. In winter and spring, a seasonal high water table is at a depth of 2 to 3 feet. The shrink-swell potential is high. Root development is restricted at a depth of 20 to 40 inches by limestone and shale bedrock.

In most areas the soils of this unit are used for hardwood forest. Trees generally grow slowly and rot or develop hollow places before they reach harvestable size. Some areas are suited to harvestable trees; however, if trees are grown, aspect will determine the most suitable sites. Logging roads and skid trails should be constructed on the contour.

Figure 8.—Limestone boulders on Snead-Rock outcrop complex, 14 to 30 percent slopes.

The soils in this unit are suited to pasture. Major concerns of pasture management are the hazard of erosion and the low available water capacity. The soil tends to be droughty as a result of the low available water capacity and the water loss caused by runoff. Maintaining an adequate plant cover and ground mulch helps prevent excessive soil loss and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing pasture reduce the protective plant cover and cause deterioration of the plant community. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and planned grazing help keep the pasture and the soil in good condition.

These soils generally are not suitable for building site development and onsite waste disposal, but some areas are being developed because of the esthetic value. Onsite investigation is needed to determine the best sites and the probable limitations. The large stones, shrink-swell potential, wetness, depth to rock, and slope are limitations that are difficult to overcome.

The soils in this unit are in capability subclass VIIs.

11C—Greenton silty clay loam, 5 to 9 percent slopes. This deep, moderately sloping, somewhat poorly drained soil is on convex side slopes. Areas of this unit are rectangular in shape and range from 5 to 200 acres.

Typically, the surface layer is very dark grayish brown, very friable silty clay loam about 9 inches thick. The upper part of the subsoil is very dark grayish brown, friable silty clay loam. The middle part is dark brown, mottled, firm silty clay loam over dark brown, mottled, very firm silty clay. The lower part to a depth of 60 inches is reddish brown, firm silty clay. In some places, bedrock is at a depth of 40 to 60 inches, and in some places part of the surface layer has been removed by erosion.

Included with this soil in mapping are areas of well drained Polo soils and moderately deep Oska and Snead soils. Also included are small areas of poorly drained Sampsel soils. The Oska soils are on the convex shoulders of side slopes. The Polo soils are on ridgetops and upper side slopes. The Sampsel soils are on concave slopes, along some drainageways, and in seepy spots. The Snead soils are lower on side slopes than the Greenton soil. The included soils make up about 10 to 15 percent of the mapped areas.

In this Greenton soil, permeability is slow, and surface runoff is medium. Available water capacity is moderate. Reaction is medium acid or slightly acid in the surface layer and in the upper part of the subsoil and neutral or mildly alkaline in the lower part of the subsoil. The organic matter content is moderate, and natural fertility is high. The surface layer is very friable and easily tilled throughout a fairly wide range in moisture content; however, it tends to crust or puddle after hard rains. A seasonal high water table is at a depth of 1 foot to 3 feet in winter and spring. The shrink-swell potential is high.

In most areas this soil is in cropland or pasture. This soil is suited to corn, soybeans, grain sorghum, small grain, and grasses and legumes for hay and pasture. The erosion hazard is severe if this soil is used for cultivated crops. Installing terraces and waterways and the use of a conservation tillage system, or no-tillage, which leaves large amounts of residue on the soil help control erosion, maintain organic matter content, improve tilth, increase water infiltration, and reduce fertility losses.

The use of this soil for pastureland or hayland is also effective in controlling erosion and improving soil fertility. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, rotational grazing of pasture, timely deferment of grazing, and restricted use during wet periods keep the soil and the pasture in good condition.

Some areas of this soil are being developed for building sites. If buildings are constructed on this soil, foundations and footings should be designed and reinforced to prevent structural damage caused by the shrinking and swelling of the soil. Tile drainage can be used around the footings of buildings to help prevent damage caused by excessive wetness. The slow permeability and wetness are limitations for septic tank absorption fields. Sewage lagoons function properly if an area can be leveled for a lagoon site; or sewage can be piped to adjacent, less sloping areas.

Grading local roads and streets to shed water and providing adequate side ditches and culverts help to prevent the damage resulting from frost action and shrinking and swelling of the soil. Providing suitable base material helps to prevent the damage resulting from low strength and shrinking and swelling.

This soil is in capability subclass IIIe.

13B—Sampsel silty clay loam, 2 to 5 percent slopes. This deep, gently sloping, poorly drained soil is on concave side slopes and low ridge points. Areas of this unit are bowl shaped and range from 20 to 320 acres.

Typically, the surface layer is black, very friable silty clay loam about 7 inches thick. The subsurface layer is also black, very friable silty clay loam about 7 inches thick. The subsoil extends to a depth of about 60 inches. The upper part is very dark gray and dark gray, mottled, friable and firm silty clay loam; the middle part is mottled dark grayish brown, dark gray, and dark brown, firm silty clay; the lower part is mottled yellowish brown and grayish brown, firm silty clay. The surface layer is silty clay in eroded areas because the upper part of the subsoil has been mixed with the surface soil by plowing. In some places, small areas are moderately sloping.

Included with this soil in mapping are small areas of somewhat poorly drained Macksburg and Greenton soils and moderately well drained Deepwater soils. The Macksburg soil is in areas next to the ridgetops. The Deepwater and Greenton soils are on the more sloping ridge points and side slopes. The included soils make up 2 to 5 percent of the unit.

In this Sampsel soil, permeability is slow, and surface runoff from cultivated areas is medium. Available water capacity is moderate. Reaction ranges from mildly alkaline to medium acid in the subsoil and varies widely in the surface layer as a result of local liming practices. Natural fertility is high, and organic matter content is moderate. The surface layer is very friable and easily tilled throughout a fairly wide range in moisture content; however, it tends to crust or puddle after hard rains. A seasonal high water table is within a depth of 1.5 feet during winter and spring. The shrink-swell potential is high.

Most areas are in cropland or pasture. This soil is suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. If the soil is used for cultivated crops, there is a hazard of erosion. The use of a conservation tillage system, or no-tillage, which leaves large amounts of residue on the surface and, in some places, installing terraces and waterways help control erosion, maintain organic matter content, improve tilth, increase water infiltration, and reduce fertility losses.

The use of the soil for pastureland or hayland is also effective in controlling erosion and improving soil fertility. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, rotational grazing of pasture, timely deferment of grazing, and restricted use during wet periods help keep the pasture and the soil in good condition.

This Sampsel soil is suitable for building sites and onsite waste disposal, but wetness and high shrink-swell potential are limitations to the use for dwellings and sanitary facilities. If buildings are constructed on this soil, foundations and footings should be designed and reinforced to prevent structural damage caused by the shrinking and swelling of the soil. Tile drains can be used around the footings to help prevent damage caused by excessive wetness. This soil is suitable for sewage lagoons; however, slope and depth to bedrock are limitations. These limitations can be overcome by leveling and by hauling in extra soil material, if needed. This soil generally is unsuitable for septic tank absorption fields because of wetness and slow permeability.

Grading local roads and streets to shed water and providing adequate side ditches and culverts help to prevent the damage resulting from wetness, frost action, and shrinking and swelling of the soil. Providing suitable base material helps to prevent the damage caused by shrinking and swelling and low strength (fig. 9).

This soil is in capability subclass IIe.

13C—Sampsel silty clay loam, 5 to 9 percent slopes. This deep, moderately sloping, poorly drained soil is on concave side slopes. Areas of this unit are irregular in shape and range from 5 to 115 acres.

Typically, the surface layer is black, friable silty clay loam about 9 inches thick. The subsoil is about 41 inches thick. It is black, mottled, friable silty clay loam in the upper part; gray, mottled, very firm silty clay in the middle part; and mottled, gray, light olive gray, and olive brown, very firm silty clay in the lower part. The substratum to a depth of 63 inches is mottled, gray and olive gray, very firm silty clay. In some eroded areas, the surface layer is mixed with subsoil material.

Included with this soil in mapping are a few small areas of moderately well drained Snead and somewhat poorly drained Greenton soils. The Greenton soils are on higher positions along the upper part of side slopes. The moderately deep Snead soils typically are below Sampsel soils on the side slopes, but are higher on the slopes at the upper edge of the map unit. The included soils make up about 5 to 10 percent of the unit.

In this Sampsel soil, permeability is slow, and surface runoff from cultivated areas is medium. Available water capacity is moderate. Reaction ranges from mildly alkaline to medium acid in the subsoil and varies widely in the surface layer as a result of local liming practices. Natural fertility is high, and organic matter content is moderate. The surface layer is friable and is easily tilled throughout a fairly wide range in moisture content. It does, however, tend to crust or puddle after hard rains. A seasonal high water table is within a depth of 1.5 feet in winter and spring. Some areas have seepy spots that stay wet for long periods. The shrink-swell potential is high.

Most areas are in cropland or pasture. This soil is suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. If the soil is used for cultivated crops, there is a hazard of erosion. Installing terraces and waterways and the use of minimum tillage or no-tillage, which leaves large amounts of residue on the soil, help control erosion. These practices maintain organic matter content, improve tilth, increase water infiltration, and reduce fertility losses. In seepy areas, tillage operations will be delayed and yields reduced by wetness.

The use of the soil for pastureland or hayland is also effective in controlling erosion and improving soil fertility. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, rotational grazing of pasture, timely deferment of grazing, and restricted use during wet periods help keep the pasture and the soil in good condition.

This soil is suitable for building site development and onsite waste disposal; however, wetness, slope, and high shrink-swell potential limit the soil if it is used for dwellings and sanitary facilities. If buildings are constructed on the soil, foundations and footings should be designed and reinforced to prevent structural damage caused by the shrinking and swelling of the soil. Installing tile drains around the footings of buildings helps prevent damage caused by excessive wetness of the soil.

This soil is suitable for sewage lagoons; however, slope and depth to rock are limitations. These limitations can be overcome by leveling and hauling in extra soil material, if needed. Suitable sites for lagoons generally can be located on some of the less sloping areas or on the foot slopes of this soil. This soil generally is unsuitable for septic tank absorption fields because of wetness and slow permeability.

Grading local roads and streets to shed water and providing adequate side ditches and culverts help to prevent the damage resulting from wetness, frost action, and shrinking and swelling of the soil. Providing suitable base material helps to prevent the damage resulting from the low strength and the shrinking and swelling of the soil.

This soil is in capability subclass IIIe.

Figure 9.—This blacktop road on Sampsel silty clay loam, 2 to 5 percent slopes, is breaking up because drainage is inadequate and suitable base material was not used.

14B—Barco loam, 2 to 5 percent slopes. This moderately deep, gently sloping, well drained soil is on convex ridgetops, mounds, the ends of ridges, and upper side slopes. Areas of this unit are irregular in shape and range from 5 to 40 acres.

Typically, the surface layer is very dark grayish brown, very friable loam about 7 inches thick. The subsoil is about 23 inches thick. The upper part of the subsoil is dark brown, friable loam; the next part is dark yellowish brown, friable clay loam; and the lower part is yellowish brown, friable clay loam. It is underlain at a depth of 30 inches by soft sandstone that has thin layers of brownish yellow clay loam. In some areas sandstone is scattered on the surface.

Included with this soil in mapping are some small areas of deep, moderately well drained Deepwater soils and moderately deep, moderately well drained Mandeville soils. The Deepwater soils are in broad areas. The Mandeville soils are on ridge points and on the more sloping areas in prairie where forest has encroached. The included soils make up about 15 percent of the unit.

In this Barco soil, permeability is moderate, and surface runoff is medium. Available water capacity is moderate. Reaction is strongly acid or very strongly acid in the subsoil and varies widely in the surface layer as a result of local liming practices. Natural fertility is medium, and organic matter content is moderate. The surface layer is very friable and easily tilled throughout a fairly wide range in moisture content. In most places root development is restricted below a depth of 20 to 40 inches by soft sandstone. The shrink-swell potential is moderate.

This soil is suited to small grain and is well suited to hay and pasture. Most areas are in fescue pasture. Corn, soybeans, and grain sorghum can be grown on this soil, but yields will be reduced in most years by drought. If the soil is used for cultivated crops, there is a hazard of erosion. The use of terraces and waterways helps control erosion if cuts are not deep enough to expose the underlying bedrock. The use of a conservation tillage system, or no-tillage, which leaves large amounts of crop residue on the soil, helps control erosion, maintain organic matter content, improve tilth, increase water infiltration, and reduce fertility losses.

The use of the soil for pasture or hay is also effective in controlling erosion; however, overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, rotational grazing of pasture, timely deferment of grazing, and restricted use during wet periods help keep the pasture and the soil in good condition.

This soil is suitable for building sites and onsite waste disposal, but the depth to bedrock and moderate shrink-swell potential are limitations for dwellings and sanitary facilities. If buildings are constructed on this soil, foundations and footings should be designed and reinforced to prevent structural damage caused by the shrinking and swelling of the soil. The underlying sandstone substratum is relatively soft and is rippable in most places. Because of the moderate depth to bedrock, all sanitary facilities should be designed to overcome this soil limitation. A properly constructed mound system will function as a septic tank absorption field. If a lagoon is used for waste disposal, extra soil material can be hauled in, if needed.

This soil does not have sufficient strength to support vehicular traffic, but the use of a suitable base material can correct this limitation. It also helps prevent damage caused by the shrinking and swelling of the soil.

This soil is in capability subclass IIe.

17B—Polo silt loam, 2 to 5 percent slopes. This deep, gently sloping, well drained soil is on convex ridgetops and upper side slopes. Areas of this unit are irregular in shape and range from 5 to 160 acres.

Typically, the surface layer is very dark grayish brown, very friable silt loam about 9 inches thick. The subsurface layer is dark brown, very friable silt loam about 5 inches thick. The subsoil is about 46 inches thick. It is dark brown and brown, friable silty clay loam in the upper part and brown and reddish brown, firm silty clay loam in the lower part. In some areas, the surface layer is silty clay loam because the upper part of the subsoil has been mixed with the surface layer by plowing.

Included with this soil in mapping are some small areas of somewhat poorly drained Macksburg soils and moderately well drained Sharpsburg soils, which are in less sloping areas where the ridgetop is broader, and small areas of moderately well drained Deepwater soils. Deepwater soils are in similar areas. The included soils make up about 10 percent of the unit.

In this Polo soil, permeability is moderate, and surface runoff is medium. Available water capacity is high. Reaction is strongly acid or medium acid in the subsoil and varies widely in the surface layer as a result of the local liming practices. Natural fertility is high, and organic matter content is moderate. The surface layer is friable and easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is moderate.

In most areas this soil is used for crops and pasture. It is suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. In the areas used for cultivated crops, erosion is a hazard. Using a conservation tillage system, or using no-tillage, which leaves large amounts of residue on the soil, and, in some places, installing terraces and waterways help control erosion, maintain organic matter content, improve tilth, increase water infiltration, and maintain the fertility of the soil.

This soil is well suited to grasses and legumes for pasture and hay. Maintaining an adequate plant cover and ground mulch helps prevent excessive soil losses and improves the moisture supplying capacity of the soil by reducing runoff. Overstocking and overgrazing pasture reduce the protective plant cover and cause deterioration of the plant community. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help keep the pasture and the soil in good condition.

This soil is suitable for building sites and onsite waste disposal; however, the moderate permeability, slope, seepage, and shrink-swell potential of the soil are moderate limitations to these uses. If buildings are constructed on this soil, foundations and footings should be designed and reinforced to prevent structural damage caused by the shrinking and swelling of the soil. The septic tank absorption fields will function properly if the size of the field is enlarged so that the moderate permeability is overcome. Excessive seepage from sewage lagoons can be prevented by special treatment to seal the bottom. The sites for sewage lagoons will need leveling.

This soil does not have sufficient strength to support vehicular traffic, but this limitation can be overcome by using suitable base material. Grading the roads to shed water and providing adequate side ditches and culverts will help prevent damage caused by frost action and the shrinking and swelling of the soil.

This soil is in capability subclass IIe.

17C—Polo silt loam, 5 to 9 percent slopes. This deep, moderately sloping, well drained soil is on convex side slopes and some of the steeper ridgetops where erosion has occurred. Areas of this unit are irregular in shape and range from 5 to 160 acres.

Typically, the surface layer is black and dark grayish brown, friable silt loam about 8 inches thick. The subsoil is about 57 inches thick. It is very dark grayish brown, friable silty clay loam in the upper part; dark brown and strong brown, friable silty clay loam in the middle part; and brown and dark brown, firm silty clay loam in the lower part. In some areas the present surface layer is silty clay loam where the upper part of the subsoil has been mixed with the original surface layer by plowing. In some small areas, erosion has completely removed all the original surface soil and the present surface layer is dark brown, firm silty clay loam.

Included with this soil in mapping are some small areas of moderately well drained Deepwater and Snead soils and somewhat poorly drained Sampsel soils. Deepwater soils are in similar areas to this soil. The Sampsel soils are in heads of small drainageways where water accumulates. The Snead soils are in areas where the limestone and shale outcrops are at or near the surface. The included soils make up about 12 percent of the unit.

In this Polo soil, permeability is moderate, and surface runoff is medium. Available water capacity is high. Reaction ranges from strongly acid to slightly acid in the subsoil and varies widely in the surface layer as a result of local liming practices. Natural fertility is high, and the organic matter content is moderate, except in areas where the surface layer has been removed by erosion. The shrink-swell potential is moderate.

The surface layer is friable and easily tilled throughout a fairly wide range in moisture content. In areas where the plow layer contains excessive amounts of subsoil material, it does have a tendency to crust or puddle after hard rains.

Most areas are in cropland or pasture. This soil is suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. If the soil is used for cultivated crops, there is a hazard of further erosion. Installing terraces and waterways and the use of a conservation tillage system, or no-tillage, which leaves large amounts of crop residue on the soil, help control erosion, maintain organic matter content, improve tilth, increase water infiltration, and maintain the fertility of the soil.

This soil is well suited to grasses and legumes for pasture and hay. Management that maintains an adequate plant cover and ground mulch helps prevent excessive soil losses and improve the moisture supplying capacity by reducing runoff. Overstocking and overgrazing pasture reduce the protective plant cover and cause deterioration of the plant community. A planned grazing system that includes proper stocking rates, uniform grazing distribution, and timely deferment of grazing help keep the pasture and the soil in good condition.

This soil is suitable for building sites and onsite waste disposal. The moderate permeability, moderate shrink-swell potential, and moderate slope are limitations to these uses. If buildings are constructed on this soil, foundations and footings should be designed and reinforced to prevent structural damage caused by the shrinking and swelling of the soil. Onsite waste disposal can be handled by properly designed septic tank absorption fields. The absorption fields should be enlarged to overcome moderate permeability. Sewage lagoons can be designed to operate properly if the areas for lagoons are leveled, or they can be located on the less sloping areas. Excessive seepage can be prevented by special treatment to seal the bottom of sewage lagoons.

This soil does not have sufficient strength to support vehicular traffic, but this limitation can be overcome by using a suitable base material. Grading the roads to shed water and providing adequate side ditches and culverts will help prevent damage caused by frost action in the soil and by the shrinking and swelling of the soil with changes in moisture content.

This soil is in capability subclass IIIe.

18B—Summit silty clay loam, 2 to 5 percent slopes. This deep, gently sloping, moderately well drained soil is on foot slopes, side slopes, and some narrow ridgetops. Areas of this unit are irregular in shape and range from 10 to 70 acres.

Typically, the surface layer is black, firm silty clay loam about 6 inches thick. The subsoil extends to 64 inches or more. The upper part of the subsoil is very dark gray, very firm silty clay loam; the next part is multicolored, firm and very firm silty clay; and the lower part is multicolored, firm silty clay loam.

Included with this soil in mapping are areas of moderately well drained Eram soils and Kenoma soils. The Eram soils are moderately deep and are on the steeper parts. The Kenoma soils are on ridgetops and side slopes above the Summit soils. The included soils make up about 15 percent of the unit.

In this Summit soil, permeability is slow, and surface runoff is medium. The available water capacity is moderate to high. Organic matter content is moderate, and natural fertility is high. The shrink-swell potential is high. A seasonal high water table is at a depth of 2 to 3 feet in winter and spring. This soil is difficult to manage during wet seasons and gets hard and cracks during dry seasons.

Most areas of this soil are in cropland or pasture. This soil is suited to corn, soybeans, sorghums, small grains, grasses, and legumes. If the soil is used for cultivated crops, there is a hazard of erosion. Installing terraces and waterways and the use of a conservation tillage system, or no-tillage, which leaves large amounts of crop residue on the soil, help control erosion, maintain organic matter content, and improve tilth.

This soil is well suited to grasses and legumes for hay and pasture. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, rotational grazing of pasture, timely deferment of grazing, and restricted use during wet periods help keep the soil and the pasture in good condition.

This soil is suited to building sites and onsite waste disposal. Wetness and high shrink-swell potential are limitations for dwellings. If buildings are constructed on this soil, foundations and footings should be designed and reinforced to prevent structural damage caused by the shrinking and swelling of the soil. Tile drains installed around foundations of buildings help prevent damage caused by excessive wetness. Septic tank absorption fields generally are unsuitable for use on this soil because of slow permeability. Slope is a limitation for sewage lagoons; however, areas generally can be leveled for a suitable site.

Grading local roads and streets to shed water and providing adequate side ditches and culverts help to prevent the damage resulting from shrinking and swelling of the soil. Providing suitable base material helps to prevent the damage resulting from low strength and shrinking and swelling.

This soil is in capability subclass IIe.

18C—Summit silty clay loam, 5 to 9 percent slopes. This deep, moderately sloping, moderately well drained soil is on side slopes and some narrow ridge points. Areas of this unit are somewhat irregular in shape and range from 5 to 90 acres.

Typically, the surface layer is black and very dark gray, friable and firm silty clay loam about 7 inches thick. The subsoil is about 53 inches thick. The upper part of the subsoil is very dark gray and very dark grayish brown, firm silty clay; the next part is dark grayish brown, mottled, very firm silty clay; and the lower part is dark brown, mottled, firm silty clay.

Included with this soil in mapping are some areas of moderately well drained Eram and Kenoma soils. The Eram soils are moderately deep soils on steeper areas. The Kenoma soils are on ridgetops and upper side slopes. The included soils make up about 15 percent of the unit.

In this Summit soil, permeability is slow, and surface runoff is medium. Available water capacity is moderate to high. Organic matter content is moderate, and natural fertility is high. The shrink-swell potential is high. A seasonal high water table is at a depth of 2 or 3 feet during winter and spring. This soil is difficult to till in wet seasons and gets hard and cracks in dry seasons.

Most areas are in cultivated crops and pasture. This soil is suited to corn, soybeans, grain sorghum, small grain, grasses, and legumes. On cultivated cropland, erosion is a hazard. The use of terraces and waterways with a conservation tillage system, or no-tillage, which leaves large amounts of crop residue on the soil, help control erosion, maintain organic matter content, improve tilth, increase water infiltration, and reduce fertility losses.

This soil is well suited to grasses and legumes for hay and pasture. Varieties that do well under wet conditions can be planted. Overgrazing or grazing when the soil is too wet will cause surface compaction, excessive runoff, and poor tilth. Proper stocking rates, rotational grazing of pasture, timely deferment of grazing, and restricted use during wet periods help keep the soil and the pasture in good condition.

This soil is suited to building site development and onsite waste disposal. Wetness and high shrink-swell potential are limitations for dwellings. If buildings are constructed on this soil, foundations and footings should be designed and reinforced to prevent structural damage caused by the shrinking and swelling of the soil. Tile drains installed around foundations of buildings help prevent damage caused by excessive wetness. This soil generally is unsuited to septic tank absorption fields because of wetness and slow permeability. Slope is a limitation for lagoons; however, areas generally can be leveled for lagoon sites or lagoons can be located on suitable, adjacent areas.

Grading local roads and streets to shed water and providing adequate side ditches and culverts help to prevent the damage resulting from shrinking and swelling of the soil. Providing suitable base material helps to prevent the damage resulting from low strength and shrinking and swelling.

This soil is in capability subclass IIIe.

19B—Weller silt loam, 2 to 5 percent slopes. This deep, gently sloping, moderately well drained soil is on ridgetops and rounded ridge points. Areas of this soil are irregular in shape and range from 5 to 60 acres.

Typically, the surface layer is dark grayish brown, very friable silt loam about 7 inches thick. The subsurface layer is brown, very friable silt loam about 4 inches thick. The subsoil, to a depth of 62 inches or more, is dark yellowish brown, friable silty clay loam in the upper part; dark yellowish brown, mottled, firm silty clay in the middle part; and multicolored, friable silty clay loam in the lower part.

Included with this soil in mapping are small areas of moderately well drained Deepwater soils and somewhat poorly drained Macksburg soils. The Deepwater soils, which are on the narrow, more sloping ridge points, have a very dark grayish brown surface layer more than 10 inches thick. The Macksburg soils are on the broader ridgetops. The included soils make up 2 to 5 percent of this map unit.

In this Weller soil, permeability is slow, and surface runoff is medium. Available water capacity is high. Reaction ranges from medium acid to very strongly acid in the subsoil and varies widely in the surface layer as a result of local liming practices. Natural fertility is medium, and the organic matter content is moderately low to moderate. The surface layer is very friable and easily tilled throughout a fairly wide range in moisture content. A seasonal high water table is at a depth of 2 to 4 feet in winter and spring. The shrink-swell potential is high.

Most areas are used for cultivated crops, hay, and pasture. This soil is suited to corn, soybeans, small grain,

grain sorghum, and grasses and legumes for hay and pasture. On cultivated cropland, erosion is a hazard. The use of a conservation tillage system, or no-tillage, which leaves large amounts of crop residue on the soil, and in some places, the use of terraces with waterways help control erosion, maintain organic matter content, improve tilth, increase water infiltration, and reduce fertility losses.

The use of the soil for pastureland or hayland is also effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes compaction of the surface, excessive runoff, and poor tilth. Proper stocking rates, rotational grazing of pasture, timely deferment of grazing, and restricted use during wet periods help keep the pasture and the soil in good condition.

This soil is suited to building site development if buildings are designed and constructed to prevent structural damage caused by the shrinking and swelling of the soil. Installing tile drains around footings and foundations of buildings helps prevent damage caused by excessive wetness. The septic tank absorption fields generally are unsuitable on this soil because of the slow permeability and wetness. This soil is suited to sewage lagoons; however, slope is a limitation. Areas generally can be leveled for a suitable site.

Grading local roads and streets to shed water and providing adequate side ditches and culverts help to prevent the damage resulting from frost action and shrinking and swelling of the soil. Providing suitable base material helps to prevent the damage resulting from low strength and shrinking and swelling.

This soil is in capability subclass IIIe.

19C2—Weller silt loam, 5 to 9 percent slopes, eroded. This deep, moderately sloping, moderately well drained soil is on convex side slopes. Areas of this unit are irregular in shape and range from 5 to 50 acres or more.

Typically, the surface layer is brown, friable silt loam about 6 inches thick. The subsoil is about 54 inches thick. The upper part is brown, friable and firm silty clay loam; the next part is dark brown, very firm silty clay; and the lower part is yellowish brown, mottled, very firm silty clay. In some places, the silt loam surface layer is 12 to 15 inches thick. Also in some areas, where rills and gullies have been cut, all the original surface soil has eroded away and the plow layer is silty clay loam or firm silty clay.

Included with this soil in mapping are some small areas of Deepwater, Mandeville, and Sampsel soils. The Deepwater soils have a thicker, darker surface layer and are on the narrow ridge points and side slopes above this Weller soil. The moderately deep Mandeville soils are on lower side slopes. The poorly drained Sampsel soils are along the upper part of side slopes and heads of drainageways. The included soils make up about 12 percent of the unit.

In this Weller soil, permeability is slow, and available water capacity is high. Surface runoff from cultivated areas is medium. Reaction ranges from medium acid to very strongly acid in the subsoil and varies widely in the surface layer as a result of local liming practices. Natural fertility is medium, and organic matter content is moderately low. The surface layer is friable and is easily tilled in uneroded areas. It is firm and hard to till in eroded areas and is difficult to till in severely eroded spots. It tends to form crusts or puddles after hard rains, especially where the plow layer contains subsoil material. Root development is restricted in some areas because of the compact, fine textured subsoil. A seasonal high water table is at a depth of 2 to 4 feet during winter and spring. The shrink-swell potential is high.

Most areas of this Weller soil are in grass for hay and pasture. This soil is suited to cultivated crops; however, yields will be reduced because of the erosion that has occurred and because of insufficient soil moisture during July and August of most years. The use of a conservation tillage system, or no-tillage, which leaves large amounts of crop residue on the soil, and in some places, the use of terraces with waterways help control erosion, maintain organic matter content, improve tilth, increase water infiltration, and reduce fertility losses.

This soil is suited to grasses and legumes for hay and pasture. The main problems of hay and pasture management are related to low natural fertility and past erosion damage. Maintaining adequate plant cover and ground mulch helps prevent excessive soil losses and improves moisture supplying capacity by reducing runoff. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and rotational grazing of pasture help keep the soil and the pasture in good condition.

This soil is suited to trees. Seedling mortality and windthrow damage are severe hazards. Planting special stock of a larger size than usual may be necessary to achieve better survival of seedlings. Lighter, less intensive, but more frequent thinnings reduce stand density and help prevent windthrow damage.

This soil is suitable for building sites and onsite waste disposal. When buildings are constructed on this soil, foundations and footings should be designed and adequately reinforced to prevent structural damage caused by the shrinking and swelling of the soil. Tile drains installed around footings help prevent damage caused by excessive wetness. Septic tank absorption fields generally are unsuited because of wetness and slow permeability. Slope is a limitation for lagoons. Lagoons can be used, but leveling will be necessary.

Grading local roads and streets to shed water and providing adequate side ditches and culverts help to prevent the damage resulting from frost action and shrinking and swelling of the soil. Providing suitable base material helps to prevent the damage resulting from low strength and shrinking and swelling.

This soil is in capability subclass IIIe.

22C—Oska silty clay loam, 5 to 9 percent slopes. This moderately deep, moderately sloping, well drained soil is on convex side slopes. Areas of this unit are in bands immediately above outcropping ledges of limestone. They are irregular in shape and range from 5 to 60 acres.

Typically, the surface layer is dark brown, friable silty clay loam about 10 inches thick. The subsoil is about 26 inches thick. The upper part is dark reddish brown, friable silty clay loam. The middle part is dark reddish brown, firm silty clay loam. The lower part of the subsoil is reddish brown, firm silty clay. It is underlain by hard, fractured limestone at a depth of about 36 inches. In some places, the depth to hard bedrock is more than 40 inches. Also in some places, the surface layer is silt loam.

Included with this soil in mapping are small areas of a deep, moderately well drained soil that has a subsoil of mixed red, strong brown, and dark gray clay. This soil is on the upslope side of the map unit. Also included are small areas of deep, well drained Polo soils, moderately well drained Snead soils, and somewhat poorly drained Greenton soils. The Polo soils are on the end of ridges and the upper part of side slopes. The Greenton soils are on more concave side slopes. The Snead soils are on the lower part of side slopes. Included soils make up about 15 percent of the map unit.

In this Oska soil, permeability is slow, and surface runoff is medium. Available water capacity is moderate. Reaction is medium acid or slightly acid in the upper part of the subsoil and medium acid to neutral in the lower part. Natural fertility is medium, and organic matter content is moderate. The surface layer is friable and easily tilled, but root development is restricted below a depth of 20 to 40 inches by limestone bedrock. The shrink-swell potential is high.

Most areas are in fescue pasture; a small percentage of the acreage is wooded. Grasses and legumes for hay and pasture can be grown on this soil. Major problems of pasture management are the hazard of erosion and the moderate available water supply. Insufficient soil moisture during summer is commonly a limitation for crops and pastures. Maintaining an adequate plant cover and ground mulch helps prevent excessive soil losses and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing pasture reduce the protective vegetative cover and cause deterioration of the plant community. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help keep the pasture and the soil in good condition.

Corn, soybeans, and grain sorghum will grow on this soil, but yields will be low because the supply of available water is only moderate. Wheat and other small grains grow well on this soil. On cultivated cropland, the hazard of erosion is severe. The use of a conservation tillage system, or no-tillage, which leaves large amounts of crop residue on the soil, helps control erosion, maintain organic matter content, increase water infiltration, and reduce fertility losses. If terraces and grassed waterways are used, onsite investigation and careful design should be used to leave soil material above the bedrock.

This Oska soil is suitable for building sites and sewage lagoons, but depth to bedrock (fig. 10) and high shrink-swell potential are limitations. If dwellings without basements are constructed on this soil, foundations and footings should be designed and reinforced to prevent structural damage caused by the high shrinking and swelling of the soil and to compensate for the moderate depth to bedrock. Sewage lagoons will function if enough suitable soil material can be hauled in to construct berms; otherwise, sewage facilities should be located on adjacent, more suitable soils.

The Oska soil does not have sufficient strength to support vehicular traffic, but this limitation can be overcome by using suitable base material. Grading local roads to shed water will help prevent damage caused by shrinking and swelling of the soil.

This soil is in capability subclass IIIe.

28D—Coweta loam, 5 to 14 percent slopes. This shallow, moderately sloping and strongly sloping, well drained soil is on rounded mounds and on side slopes. Areas of this unit are oval or irregular in shape and range from 5 to 50 acres or more.

Typically, the surface layer is very dark grayish brown, very friable loam about 4 inches thick. The subsoil is about 15 inches thick. It is dark brown, very friable loam in the upper part and dark brown and yellowish brown, very friable gravelly loam in the lower part. Below that, to a depth of 46 inches, is soft sandstone interbedded with shale. In some areas the soil contains more gravel.

Included with this soil in mapping are small areas of moderately deep Barco and deep Deepwater soils. The Barco and Deepwater soils are near the outer edge of Coweta soils. The included soils make up about 15 percent of this map unit.

In this Coweta soil, permeability is moderate, and surface runoff is medium. Available water capacity is very low. Reaction ranges from strongly acid to slightly acid. Natural fertility and organic matter content are low. The surface layer is very friable and easily tilled throughout a fairly wide range in moisture content, but when plowed, it erodes easily. Root development is restricted below a depth of 10 to 20 inches by soft sandstone bedrock.

Most of the acreage is used for pasture, and a small acreage is used for hay. This soil generally is not suited to corn, soybeans, grain sorghum, and small grain.

This soil is best suited to grasses and legumes for hay and pasture, but yields will be low in most years because of insufficient soil moisture. The use of the soil for pastureland is effective in controlling erosion. Proper stocking rates, rotational grazing of pasture, and timely deferment of grazing help keep the pasture and the soil in good condition.

The soil is poorly suited to trees. Species that will grow are of only poor quality.

This soil generally is suitable for dwellings without basements but is limited by shallowness to rock, slope, and stoniness. If this soil is used for building site development, dwellings without basements should be designed to fit the natural lay of the landscape and allow for the shallowness to sandstone bedrock. This bedrock can be ripped in most places. This soil is unsuitable for onsite waste disposal systems because of shallowness to bedrock; however, sewage can generally be piped to adjacent areas with more suitable soils.

Local roads and streets should be designed and constructed on this soil if cuts are not deep.

This soil is in capability subclass VIe.

29D—Norris silty clay loam, 5 to 14 percent slopes. This shallow, moderately sloping and strongly sloping, well drained soil is on convex, narrow ridgetops and side slopes. Areas of this unit are irregular in shape and range from 5 to 150 acres.

Typically, the surface layer is dark grayish brown, friable silty clay loam about 3 inches thick. Below the surface layer is a transitional layer of mixed, dark grayish brown and dark brown, friable silty clay loam about 6 inches thick. The substratum to a depth of 15 inches is mixed, grayish brown and light olive brown, firm, shaly silty clay loam. Below that, to a depth of 26 inches or more, is multicolored, soft, weathered shale. In some

Figure 10.—Grading operations scattered limestone rock on this area of Oska silty clay loam, 5 to 9 percent slopes.

places, shale is at a depth of more than 20 inches and the subsoil has more clay. In a few areas slopes are greater than 14 percent.

Included with this soil in mapping, and making up about 10 percent of the unit, are small areas of well drained Mandeville soils and moderately well drained Snead soils. The Mandeville and Snead soils are on positions above the Norris soils.

In this Norris soil, permeability is moderate, surface runoff is medium to rapid, and available water capacity is low. Reaction is strongly acid or very strongly acid. In some areas, the natural fertility is moderately low, and in some, the organic matter content is very low. The surface layer is very friable and easily tilled, but shale bedrock restricts root development below a depth of 20 inches.

In most areas this soil remains in hardwood forests. It generally is poorly suited to trees and grasses and legumes for hay and pasture. Seedling mortality, windthrow damage, and erosion are moderate hazards for trees. Planting special stock of larger size than usual will increase survival. Lighter, less intensive, but more frequent thinnings reduce stand density and help prevent windthrow damage. Trees grown on this soil have a slow growth rate and usually start to rot or develop hollow places before they reach harvestable size. If trees are grown, aspect should determine the site selected. Logging roads and skid trails should be on the contour to prevent erosion.

This soil is suited to grasses for pasture. The soil should be tilled only when reseeding or establishing seeding for pasture. Major problems of pasture management are the hazard of erosion and the low available water capacity. The soil is somewhat droughty because of its low available water capacity and water losses by runoff. Management that maintains an adequate plant cover and ground mulch helps prevent excessive soil losses and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing pasture reduce the protective ground cover and cause deterioration of the plant community. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help keep the pasture and the soil in good condition.

This soil is poorly suited to use as habitat for wildlife, but it provides cover, ground, and tree dens if food is grown on surrounding soils.

This soil is suitable for building sites and onsite waste disposal, but limitations are severe for sanitary facilities because of the shallowness to rock, which is also a limitation for dwellings. Dwellings without basements should be designed to fit the natural slope of the landscape, or they should be located on more suitable, less sloping soils. The design should allow for the shallow depth to bedrock. Sanitary facilities generally can be located on more suitable, adjacent soils.

Local roads should be designed to compensate for the shallowness to rock, slope, and frost action.

This soil is in capability subclass VIe.

32—Freeburg silt loam. This deep, nearly level, somewhat poorly drained soil is on low terraces and second bottoms. It is subject to occasional flooding. Areas of this unit are irregular in shape and range from 5 to 50 acres or more.

Typically, the surface layer is dark brown, very friable silt loam about 9 inches thick. The subsurface layer, which is about 8 inches thick, is brown, very friable silt loam. The subsoil, extending to a depth of 60 inches or more, is yellowish brown, mottled, friable silty clay loam in the upper part. The lower part is dark brown, mottled, friable silty clay loam. In some places, on terrace breaks, the upper part of the subsoil has been mixed with the original surface layer by plowing. In a few areas that have a dark surface layer, the upper part of the subsoil is darker and is not mottled.

Included with this soil in mapping are small areas of poorly drained, nearly level Bremer and Moniteau soils in areas facing the center of the map unit. The inclusions make up about 10 percent of the mapped areas.

Permeability is moderately slow, and runoff is slow. Available water capacity is high. Reaction generally is very strongly acid in the subsoil. Natural fertility is low, and organic matter content is moderately low, but this unit responds well to fertilization. The surface layer is very friable and easily tilled, but it remains wet for long periods because of poor surface drainage. A seasonal high water table is at a depth of 1.5 to 3.0 feet during winter and spring. The shrink-swell potential is moderate.

Most areas are used for cultivated crops and pasture. This soil is well suited to grain sorghum, soybeans, small grain, and grasses and legumes for hay and pasture. If this soil is used for cultivated crops, wetness is a limitation during planting and harvesting. The use of a conservation tillage system, or no-tillage, winter cover crops, and contouring on the terrace breaks help control erosion and condition the soil for crops. Returning crop residue to the soil or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

Grasses and legumes for hay and pasture grow well on the soil if wetness-tolerant species are used. Restricted use during wet periods helps keep the pasture and the soil in good condition and reduces surface compaction.

This soil is suited to trees, and there are no hazards or limitations in planting and harvesting trees.

This soil generally is unsuitable for building site development and onsite waste disposal because of wetness and occasional flooding.

This soil is in capability subclass IIw.

33—Zook silty clay loam. This deep, nearly level, poorly drained soil is on wide bottom lands and narrower stream valleys of smaller streams. It is subject to occasional flooding. Areas of this unit are irregular in shape and range from 5 to 500 acres.

Typically, the surface layer is black, friable silty clay loam about 5 inches thick. The subsurface layer is black, very dark gray, and very dark grayish brown, firm silty clay loam about 27 inches thick. The subsoil is very dark gray, firm silty clay loam about 23 inches thick. The substratum to a depth of about 72 inches is very dark gray, mottled, firm silty clay loam. In some places, about 12 inches of brown silt loam overwash covers the soil.

Included with this soil in mapping are some small areas of moderately well drained Verdigris soils along stream channels. The included soils make up about 5 to 10 percent of the unit.

Permeability is slow, and runoff is slow to very slow. Available water capacity is high. Reaction ranges from medium acid to mildly alkaline throughout the soil. Both natural fertility and organic matter content are high. The surface layer is friable and easily tilled unless wet. Field operations during periods of high moisture content will cause the soil to form large, firmly bonded aggregates that are difficult to break down. Root development is restricted below a depth of 1 foot to 3 feet because of a high water table. The shrink-swell potential is high.

Most areas are in cultivated crops. This soil is suited to corn, soybeans, grain sorghum, small grain, and grasses for hay and pasture. On cultivated cropland, crops can be damaged in some years by wetness and occasional flooding. Surface drains and land smoothing help improve surface drainage. Timeliness of tillage operations and harvesting and selection of crops help prevent crop damage in most years.

This soil is well suited to grasses for hay and pasture if wetness-tolerant species are used. Restricted use during wet periods helps keep the pasture and the soil in good condition and avoid surface compaction.

This Zook soil is well suited to wetland wildlife. It is suited to plantings of wetland food and cover plants and to shallow water impoundments for wetland wildlife. Openland wildlife can be encouraged by maintaining a maximum interdispersion of fields in which grains and seed crops are available for food and border cover for protection.

This soil generally is unsuitable for building sites and onsite waste disposal because of occasional flooding.

This soil is in capability subclass IIw.

34—Blackoar silt loam. This deep, nearly level, poorly drained soil is on bottom lands. It is subject to occasional flooding. Areas of this unit are irregular in shape and range from 5 to 200 acres or more.

Typically, the surface layer is very dark grayish brown, very friable silt loam about 9 inches thick. The subsurface layer, about 7 inches thick, is very dark gray, very friable silt loam. The subsoil, which extends to a depth of 60 inches or more, is dark gray, mottled, very friable and friable silt loam. In some places, the soil is silty clay loam in some part or throughout. In places, the subsoil is very dark gray.

Included with this soil in mapping are small areas of the moderately well drained Verdigris soils and the more clayey Zook soils. The Verdigris soils are on natural levees along streams and former channels of streams. The Zook soils are in areas where slack water deposited fine textured material.

In this Blackoar soil, permeability is moderate, and runoff is slow. Available water capacity is high. Reaction is neutral or medium acid. Natural fertility is high, and organic matter content is moderate. The surface layer is friable and easily tilled, but slow runoff and a seasonal high water table within a depth of 1 foot during winter and spring limit tillage operations.

Most areas are used for cultivated crops, hay, and pasture. This soil is well suited to corn, soybeans, sorghums, small grains, and grasses and legumes for hay and pasture. On cultivated cropland, crops can be damaged in some years by wetness and occasional flooding. Planting and harvesting and selection of crops can be planned to avoid most damage caused by occasional flooding. Surface drains and land grading help improve surface drainage. The use of a conservation tillage system, or no-tillage, with winter cover crops and returning crop residue to the soil help to maintain tilth and increase water infiltration.

This soil is well suited to grasses and legumes for hay and pasture. Varieties should be selected that will tolerate occasional flooding and a high water table. Grazing and haying when the soil is wet cause surface compaction and poor tilth. Proper stocking rates, rotational grazing of pasture, timely deferment of grazing, and restricted use during wet periods help keep the pasture and the soil in good condition.

This soil is well suited to trees that will tolerate wet conditions, and some areas still remain in native hardwoods. Plant competition, seedling mortality, the windthrow hazard, and use of equipment on this soil are problems. Management practices will need to be done during dry times of the year. Mechanical or chemical means should be used for thorough site preparation. Ridging the soil and planting on the ridges will increase seedling survival. Lighter, less intensive, but frequent thinnings to reduce stand density will help prevent windthrow damage.

This soil is suited to both openland and wetland wildlife. It is suited to plantings of wetland cover plants. Shallow water impoundments can be constructed to improve wetland habitat. Openland wildlife can be encouraged by maintaining fields in which grains and seed crops are available for food and border cover for protection.

This soil generally is unsuitable for building sites and onsite waste disposal because of occasional flooding.

This soil is in capability subclass IIw.

36—Bremer silty clay loam. This deep, nearly level, poorly drained soil is on second bottoms and low terraces. It is subject to rare flooding. Areas of this unit are irregular or rectangular in shape and range from 5 to 100 acres or more.

Typically, the surface layer is very dark gray, very friable silty clay loam about 8 inches thick. The subsurface layer is black, very friable and friable silty clay loam about 8 inches thick. The subsoil is about 31 inches thick. The upper part is very dark gray, friable and firm silty clay loam; the lower part is gray, mottled, firm silty clay loam. The substratum to a depth of 60 inches is gray, mottled, friable silty clay loam. In a few places there are some terrace breaks.

Included with this soil in mapping, and making up about 8 percent of the map unit, are small areas of somewhat poorly drained Freeburg soils on or near the terrace breaks.

In this Bremer soil, permeability is moderately slow, and runoff is slow. Available water capacity is high. Reaction is medium acid to neutral in the subsoil. Organic matter content and natural fertility are high. The surface layer is very friable and easily tilled, but the soil tends to remain wet. If it is tilled when wet, it will form crusts or puddles. This soil erodes on terrace breaks and on toe slopes if erosion control practices are not used. A seasonal high water table is at a depth of 1 foot to 2 feet during winter and spring. The shrink-swell potential is high.

Most areas are in cultivated crops or pasture. This soil is suited to corn, soybeans, grain sorghum, small grain, and grasses and legumes for hay and pasture. If this soil is used for cultivated crops, drainage is needed on the broad, nearly level areas, and erosion control is needed on the terrace breaks and the toe slopes. Surface drains and land grading help improve surface drainage on the nearly level areas. Planting and harvesting and selection of crops can be planned to avoid crop damage caused by wetness in most years. Use of waterways, a conservation tillage system or no-tillage, and winter cover crops is needed. Returning crop residue to the soil or regularly adding organic material helps improve fertility, reduce crusting, and increase water infiltration.

This soil is suited to pasture or hay if water-tolerant grasses and legumes are grown. Timely deferment of grazing and restricted use during wet periods help keep the pasture and the soil in good condition.

This soil generally is unsuitable for building sites and onsite waste disposal because of rare flooding.

This soil is in capability subclass IIw.

37—Moniteau silt loam. This deep, nearly level, poorly drained soil is on low terraces and second bottoms. It is subject to occasional flooding. Areas of this map unit are rectangular to irregular in shape and range from 5 to 25 acres.

Typically, the surface layer is dark grayish brown, very friable silt loam about 8 inches thick. The subsurface layer is grayish brown and light gray, very friable silt loam about 6 inches thick. The subsoil is about 55 inches thick. The upper part is dark grayish brown, mottled, friable silty clay loam; the next part is mottled, dark grayish brown and dark yellowish brown, firm silty clay loam. The lower part is dark grayish brown, mottled, firm silty clay loam. In some places, the surface layer is very dark grayish brown.

Included with this soil in mapping are small tracts of moderately well drained Verdigris soils and some small areas of somewhat poorly drained Freeburg soils. The Verdigris soils are below the terrace breaks. The Freeburg soils are near the terrace breaks. Also included are some eroded areas that have slopes ranging from 3 to 7 percent. The included soils make up about 10 percent of the mapped areas.

In this Moniteau soil, permeability is slow, and surface runoff is very slow. Available water capacity is high. Reaction ranges from medium acid to very strongly acid in the subsoil and varies widely in the surface layer as a result of local liming practices. Natural fertility is moderate, and organic matter content is moderately low. The surface layer is very friable and easily tilled, but runoff is so slow that tillage is delayed by wetness and by flooding in some places in most years. A seasonal high water table is at a depth of 1 foot to 2 feet in spring. The shrink-swell potential is moderate.

Most areas are in cultivated crops or pasture. This soil is suited to soybeans, grain sorghum, small grain, and grasses and legumes for hay and pasture. If this soil is used for cultivated crops, in some years crop damage can be expected as a result of wetness and occasional flooding. Planting and harvesting and selection of crops can be planned to avoid damage from occasional flooding. Surface drains and land smoothing help improve surface drainage. Insufficient soil moisture is often a limitation for summer crops. The use of a conservation tillage system, or no-tillage, with winter cover crops and returning crop residue to the soil help improve fertility, reduce crusting, increase water infiltration, and reduce erosion on the sloping escarpments.

This Moniteau soil is suited to hay and pasture if wetness-tolerant grasses and legumes are grown. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and poor tilth. Proper stocking rates, rotational grazing of pasture, timely deferment of grazing, and restricted use during wet periods help keep the pasture and the soil in good condition.

This soil is suited to trees. Only species that are wetness tolerant should be selected. Cuttings and seedlings will grow on this soil if competing vegetation is controlled or removed. The mortality rate is moderate when planting seedlings because the soil is saturated during wet periods. Management practices should be done during dry periods. Ridging the soil and planting on the ridges will increase seedling survival. Lighter, less intensive, but more frequent thinnings to reduce stand density will help prevent windthrow damage. Plant competition can be overcome by the use of mechanical or chemical means for a thorough site preparation.

This Moniteau soil generally is unsuitable for building sites and onsite waste disposal because of occasional flooding.

This soil is in capability subclass IIIw.

40—Haig silt loam. This deep, nearly level, poorly drained soil is on broad, convex ridgetops. Areas of this map unit are long and rectangular shaped and range from 80 to 300 acres.

Typically, the surface layer is black, very friable silt loam about 10 inches thick. The subsoil extends to a depth of 60 inches or more. The upper part of the subsoil is very dark gray, friable silty clay loam; the next part is very dark gray and dark grayish brown, firm and very firm silty clay. The lower part is grayish brown, mottled, firm silty clay loam. In some areas the surface layer is dark grayish brown.

Included with this soil in mapping are small tracts of somewhat poorly drained Macksburg and sloping Sampsel soils. Also included are some areas of moderately well drained Kenoma soils. The Macksburg soils are on the rounded ridgetops, or mounds, and Sampsel soils are near the heads of drains. The Kenoma soils are on the more sloping areas. Included soils make up about 10 percent of the mapped areas.

In this Haig soil, permeability is slow, and runoff is very slow. Available water capacity is high. Reaction ranges from slightly acid to strongly acid in the subsoil and from neutral to slightly acid in the surface layer. Natural fertility is high, and organic matter content is moderate. The surface layer is friable and easily tilled, but this soil is slow to dry, and tillage operations are restricted in some years. A seasonal high water table is at a depth of 1 foot to 2 feet in winter and spring. The shrink-swell potential is high.

Most areas of this soil are in cultivated crops and pasture, and some are irrigated. This soil is suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. Corn and soybeans respond well to supplemental irrigation. In some years tillage operations are delayed because of wetness. Land grading will improve surface drainage in a few small places, but most areas do not need surface drainage. If the soil is used for cultivated crops, erosion is a slight hazard because of long, gradual slopes. The use of a conservation tillage system, or no-tillage, which leaves large amounts of crop residue on the soil, helps control erosion, maintain organic matter content, improve tilth, increase water infiltration, and reduce fertility losses.

Grasses and legumes for hay and pasture grow well on this soil. The varieties that will tolerate wet conditions should be planted. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, rotational grazing of pasture, timely deferment of grazing, and restricted use during wet periods help keep the pasture and the soil in good condition.

This soil is suitable for building site development and onsite waste disposal. Wetness and high shrink-swell potential are limitations for dwellings. If buildings are constructed on this soil, tile drains should be installed around the footings to prevent damage caused by excessive wetness. Foundations and footings should be designed and reinforced to prevent structural damage caused by the shrinking and swelling of the soil. Septic tank absorption fields will not function on this soil because of a high water table and the slow permeability of the soil. Sewage lagoons will function and should be used for onsite waste disposal.

Building local roads and streets on raised, well-compacted subgrade material and providing adequate side ditches and culverts help to prevent the damage caused by wetness, frost action, and shrinking and swelling of the soil. Providing suitable base material helps to prevent the damage caused by shrinking and swelling and low strength.

This soil is in capability subclass IIw.

47C—Mandeville silt loam, 5 to 9 percent slopes. This moderately deep, moderately sloping, well drained soil is on convex side slopes and narrow ridgetops. Areas of this unit are irregular in shape and 5 to 105 acres.

Typically, the surface layer is dark brown, very friable silt loam about 5 inches thick. The subsurface layer is brown, very friable silt loam about 3 inches thick. The subsoil is about 22 inches thick. The upper part is yellowish brown, very friable silt loam; the next part is yellowish brown, friable silty clay loam. The lower part is mottled yellowish brown, brown, light brownish gray, and olive gray, friable shaly silty clay loam. Below that, to a depth of 37 inches, is light olive brown, soft micaceous shale. In some places, the subsoil is thicker, and shale is more than 40 inches from the surface. Also in some places, the subsoil has more clay.

Included with this soil in mapping are small areas of moderately well drained Deepwater soils and some shallow Norris soils. The Deepwater soils have a dark surface layer and are on ridge points and upper side slopes. The Norris soils are lower on side slopes and on steeper areas. The included soils make up about 10 percent of the mapped areas.

In this Mandeville soil, permeability is moderate, and surface runoff is medium. Available water capacity is moderate. The surface layer is very friable and easily tilled throughout a fairly wide range in moisture content. Organic matter content is moderately low, and natural fertility is medium. Reaction is very strongly acid in the subsoil. In limed areas, the surface layer is medium acid or slightly acid, depending on the amount of lime applied. Root development is restricted below a depth of 20 to 40 inches by shale bedrock.

Most areas are in grass for hay and pasture. This soil is well suited to pasture and hay. Major problems of pasture management are the hazard of erosion and the moderate available water capacity. The soil has moderate available water capacity, but low rainfall and insufficient soil moisture are common during summer. Management that maintains an adequate plant cover and ground mulch helps prevent excessive soil losses and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing the pasture reduce the protective plant cover and cause deterioration of the plant community. A grazing system that includes proper stocking rates, uniform grazing distribution, and timely deferment of grazing helps keep the pasture and the soil in good condition.

If this soil is used for corn, a shortage of soil moisture occurs in most years during summer. The soil is suited to soybeans, grain sorghum, small grain, and grasses and legumes for hay and pasture. On the soil used for cultivated crops, there is a hazard of erosion. The use of a conservation tillage system, or no-tillage, with winter cover crops and grassed waterways helps prevent excessive soil loss. If terraces are built on this soil, cuts should not be deep because of the moderate depth to shale. Returning crop residue to the soil or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

This soil is suited to trees, and some of the areas still remain in native hardwoods. There are no hazards or limitations that affect planting or harvesting trees. Logging roads and skids can be on the contour, where possible, to prevent gullying. Tree seeds, cuttings, and seedlings grow well.

This soil is suited to building site development. If dwellings without basements are constructed on this soil, sites can be selected where the moderate depth to shale bedrock does not interfere with construction of foundations and footings. Dwellings can be designed to fit the natural slope of the landscape. Sanitary facilities generally can be located on more suitable soils in the area.

Grading local roads and streets to shed water helps to prevent the damage caused by frost action. Providing suitable base material helps to prevent the damage caused by low strength. Locating roads on the contour, where possible, will minimize the use of cut and fill material.

This soil is in capability subclass IIIe.

49D—Eram silty clay loam, 5 to 14 percent slopes. This moderately deep, moderately sloping and strongly sloping, moderately well drained soil is on narrow ridgetops and side slopes. Areas of this unit are irregular in shape and range from 5 to 100 acres.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 10 inches thick. The subsoil is about 25 inches thick. It is dark brown, firm and very firm silty clay loam in the upper part. The next part is dark yellowish brown, very firm clay. The lower part is mottled, grayish brown, dark yellowish brown, and dark gray, very firm silty clay. It is underlain at a depth of about 35 inches by yellowish brown, weathered shale that has slickensides in the upper part. In some places, shale is at a depth of more than 40 inches.

Included with this soil in mapping are some areas of shallow Coweta soils, well drained Oska soils, and Summit and Snead soils. These soils generally are on similar positions, but Coweta soils are on side slopes where sandy shale crops out. The Oska soils are in areas where limestone bedrock is 20 to 40 inches below the surface. Summit soils are on side slopes where shale bedrock is at a depth of more than 40 inches and the surface layer is thicker. Snead soils have free carbonates at a depth of 12 to 20 inches and are on similar positions. The included soils make up about 15 percent of the mapped areas.

In this Eram soil, permeability is slow, and runoff is rapid. Available water capacity is low, organic matter content is moderate, and natural fertility is medium. The surface layer is friable, but the soil tends to crack and be cloddy when dry and sticky and hard to till when moist. Below a depth of 20 to 40 inches, root development is restricted by shale bedrock. A seasonal high water table is at a depth of 2 to 3 feet during winter and spring. The shrink-swell potential is high.

Most areas are in pasture. The use of the soil for pastureland or hayland is effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, rotational grazing of pasture, timely deferment of grazing, and restricted use during wet periods help keep pasture and the soil in good condition.

This soil generally is not suitable for cultivation because of the steep slopes and severe erosion hazard.

This soil is suited to building site development and onsite waste disposal. The limitations to building construction are steepness of slope, wetness, high shrink-swell potential, and the depth to shale bedrock. Dwellings without basements should be designed, constructed with foundation drains, and adequately reinforced to help overcome excessive wetness and shrinking and swelling of the soil. The slow permeability, wetness, and depth to rock are limitations for onsite waste disposal systems. Sewage lagoons generally can be located in adjacent areas on more suitable soils.

Grading local roads and streets to shed water and providing adequate side ditches and culverts help to prevent the damage caused by shrinking and swelling of the soil. Providing suitable base material helps to prevent the damage caused by shrinking and swelling and low strength.

This soil is in capability subclass VIe.

51B—Kenoma silt loam, 1 to 4 percent slopes. This deep, gently sloping, moderately well drained soil is on broad upland ridgetops. Areas of this unit are long and wide and range from 5 to 200 acres or more.

Typically, the surface layer, which is about 8 inches thick, is very dark grayish brown, very friable silt loam. The subsoil extends to a depth of 60 inches or more. The upper part of the subsoil is very dark grayish brown, firm silty clay. The next part is dark grayish brown, mottled, very firm silty clay. The lower part is yellowish brown, mottled, very firm silty clay. In some small areas, the surface layer is dark grayish brown.

Included with this soil in mapping are some areas of the poorly drained Haig soils on the nearly level ridgetops and the less clayey Deepwater soils on the more sloping areas. The included soils make up about 10 percent of the mapped areas.

In this Kenoma soil, permeability is very slow, and surface runoff is slow. Available water capacity is moderate. Reaction ranges from strongly acid to mildly alkaline in the subsoil and varies widely in the surface layer, depending on local liming practices. Organic matter content is moderate, and natural fertility is high. The shrink-swell potential is high. The surface layer is very friable and is easily tilled, but the soil tends to crack in dry periods. It is slow to dry, and tillage operations are limited in some years.

Most areas are used for cultivated crops, hay, and pasture. The soil is suited to corn, soybeans, grain sorghum (fig. 11), small grains, grasses, and legumes. On cultivated cropland, yields will be reduced in most years because of insufficient soil moisture during summer. The use of a conservation tillage system, or no-tillage, which leaves large amounts of crop residue on the soil, and the use of terraces with waterways in places help control erosion. These practices maintain organic matter content, improve tilth, increase infiltration of water, and reduce fertility losses and drying and cracking of the soil.

This soil is well suited to grasses and legumes for hay and pasture. The varieties that do well under wet conditions in spring and dry conditions in summer can be planted. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, rotational grazing of pasture, timely deferment of grazing, and restricted use during wet periods help keep the pasture and the soil in good condition.

Figure 11.—A field of grain sorghum on Kenoma silt loam, 1 to 4 percent slopes.

This soil is suitable for building sites and onsite waste disposal. The shrink-swell potential is a severe limitation for dwellings. If buildings are constructed on this soil, foundations and footings can be designed and reinforced to prevent structural damage caused by shrinking and swelling of the soil. Tile drains should be provided around footings and foundations to help prevent the damage caused by excessive wetness, which may result from poor surface drainage around foundations or gutter failure. The very slow permeability is a severe limitation to septic tank absorption fields; however, sewage lagoons function well on this soil.

Local roads need a suitable base material added to prevent damage caused by low strength and shrinking and swelling of the soil.

This soil is in capability subclass IIe.

51C—Kenoma silt loam, 4 to 7 percent slopes. This deep, moderately sloping, moderately well drained soil is on broad upland side slopes. Areas are irregular in shape and range from 5 to 100 acres.

Typically, the surface layer is very dark grayish brown, very friable silt loam about 8 inches thick. The subsoil extends to 60 inches or more. The upper part is very dark grayish brown, firm silty clay; the middle part is mottled, dark gray and dark grayish brown, mottled, very firm silty clay; and the lower part is mottled, light olive and gray, very firm clay. In a few small areas, the surface layer is dark grayish brown, and in some, the surface layer is silty clay loam or silty clay where erosion has removed a part or all the surface layer.

Included with this soil in mapping are some areas of the less clayey Deepwater soils, which are on ridge points and lower side slopes. The included soils make up about 10 to 15 percent of the mapped areas.

In this Kenoma soil, permeability is very slow, and surface runoff is medium. Available water capacity is moderate. Organic matter content is moderate, and natural fertility is high. The shrink-swell potential is high. The surface layer is very friable and easily tilled, but the soil is slow to dry so that tillage operations are limited in spring, and the soil tends to crack during dry periods.

Most areas are in crops and pasture. This soil is suited to corn, soybeans, grain sorghum, small grain, and grasses and legumes. If this soil is used for cultivated crops, there is a hazard of erosion. Terraces and waterways used with a conservation tillage system, or no-tillage, which leaves large amounts of crop residue on the soil, prevent soil erosion, reduce drying and cracking of the soil, maintain organic matter content, improve tilth, increase water infiltration, and reduce fertility losses.

Grasses and legumes for hay and pasture grow well on this soil. Varieties that do well under wet conditions in spring and dry conditions in summer can be planted. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, rotational grazing of pasture, timely deferment of grazing, and restricted use during wet periods help keep the soil and the pasture in good condition.

This Kenoma soil is suitable for building site development and onsite waste disposal. The shrink-swell potential is a limitation for dwellings. If buildings are constructed on this soil, foundations and footings should be designed and reinforced to prevent structural damage caused by the shrinking and swelling of the soils. Tile drains should be provided around footings and foundations to help prevent damage caused by the excessive wetness, which may result from poor surface drainage around foundations or from gutter failure. The very slow permeability is a limitation to septic tank absorption fields; however, sewage lagoons can be used for onsite waste disposal. Slope is a moderate limitation, but areas generally can be leveled for a site.

Suitable base material for local roads can be added to prevent damage caused by the shrinking and swelling of the soil and low strength.

This soil is in capability subclass IIIe.

52C—Nowata Variant silt loam, 5 to 9 percent slopes. This deep, moderately sloping, well drained soil is on convex side slopes. Areas of this unit are irregular in shape and range from 5 to 80 acres.

Typically, the surface layer is very dark brown, very friable silt loam about 7 inches thick. The subsoil is about 20 inches thick. The upper part is very dark grayish brown, friable very cherty silty clay loam; the middle part is dark reddish brown, firm very cherty silty clay loam; and the lower part is mixed yellowish brown, dark red, and reddish brown, very firm clay. The substratum is multicolored, very firm clay. Hard limestone bedrock is at a depth of 49 inches. In some areas, bedrock is at a depth of less than 40 inches, and in other areas, the soil contains less chert.

Included with this soil in mapping are areas of noncherty Oska soils and somewhat poorly drained Greenton and moderately well drained Snead soils. The Oska soils are lower on side slopes. The Greenton and Snead soils are in concave areas lower on side slopes. These soils make up about 15 percent of the map unit.

In this Nowata Variant, permeability is moderately slow, and runoff is medium. Available water capacity is low. Reaction is slightly acid in the upper part of the soil and medium acid in the lower part. Organic matter content is moderate, and natural fertility is medium. The surface layer is very friable, but chert at or near the surface makes this soil hard to till. The shrink-swell potential is moderate.

Most of the acreage is in grasses for hay and pasture. This soil is poorly suited to corn, soybeans, grain sorghum, and small grain. On cultivated cropland, insufficient soil moisture is often a limitation during summer. The use of crop residue or regular additions of other material helps improve fertility, reduce erosion, and increase water infiltration.

This soil is suited to grasses and legumes for hay and pasture. Insufficient soil moisture is common during summer months. The use of the soil for pastureland is effective in controlling erosion. However, overgrazing or grazing when the soil is wet will cause surface compaction, excessive runoff, and erosion. Proper stocking rates, rotational grazing of pasture, and timely deferment of grazing help keep the pasture and the soil in good condition.

This soil generally is suitable for dwellings if the design allows for the moderate shrink-swell potential and, on sites for dwellings with basements, depth to rock. Buildings can be designed to fit the natural slope of the landscape. This soil is not suitable for onsite waste disposal systems because of its slow permeability and depth to bedrock. Sanitary facilities generally can be located on adjacent more suitable soils.

Local roads and streets should be constructed with suitable base material to prevent damage caused by shrinking and swelling of the soil. Locating roads on the contour, where possible, will minimize the use of cut and fill material.

This soil is in capability subclass IVe.

62B—Macksburg-Urban land complex, 2 to 5 percent slopes. This complex consists of gently sloping Macksburg soils and areas of Urban land. It is one area of approximately 670 acres in the Richards Gebaur Air Base.

This complex is 55 to 65 percent Macksburg soils and 30 to 40 percent Urban land. The Macksburg soils and Urban land are so intricately mixed, or so small in size, that it was not practical to separate them at the scale used in mapping.

Typically, the Macksburg soils have a surface layer, about 12 inches thick, that is very dark brown and black, very friable silt loam. The subsurface layer, which is about 7 inches thick, is very dark gray, very friable silty clay loam. The subsoil is about 39 inches thick. The upper part of the subsoil is dark grayish brown, mottled, friable silty clay loam. The lower part is grayish brown, mottled, friable silty clay loam. The substratum to a depth of 72 inches is grayish brown, mottled, very friable silty clay loam.

Urban land consists mainly of streets, airplane runways, taxiways, parking aprons, airplane hangers, and buildings that so obscure or alter the soil that identification is not feasible.

Included with this complex in mapping are some areas where the surface layer has been removed and only the dark grayish brown silty clay loam subsoil remains; only the substratum remains in other places. Also included are places that have fill material on the surface of the original Macksburg soils. Some small areas of Sampsel, Greenton, and Polo soils are on lower side slopes. The Sampsel soils are poorly drained. The Greenton soils are on side slopes. The Polo soils are redder throughout and are on narrow ridgetops and side slopes. The included soils make up about 15 percent of the mapped areas.

The Macksburg soils have moderately slow permeability and slow surface runoff. Available water capacity is high. Reaction ranges from slightly acid to medium acid. The organic matter content is moderate, and natural fertility is high. A seasonal high water table is at a depth of 2 to 4 feet during winter and spring.

Most areas of the Macksburg soils are planted to grass for erosion control or are in lawns. Because of location, these soils are not suited to cultivation. Grasses and legumes for hay can be grown on the Macksburg soils, and most species of lawn grasses grow well. Maintaining an adequate plant cover and ground mulch helps prevent excessive soil losses and improves moisture supplying capacity by reducing runoff.

The soils in this unit generally are suited to building site development. If buildings are constructed on these soils, foundations and footings should be designed and reinforced to prevent structural damage caused by the shrinking and swelling of the soil. Tile drains can be installed around the buildings to help prevent damage caused by excessive wetness. Generally, commercial sewers are used.

Grading local roads and streets to shed water and providing adequate side ditches and culverts help to prevent the damage resulting from frost action and shrinking and swelling of the Macksburg soils. Providing suitable base material helps to prevent the damage resulting from low strength and shrinking and swelling.

This map unit was not assigned an interpretative grouping.

93—Verdigris silt loam. This deep, nearly level, moderately well drained soil is on bottom lands near streams or in old meander belts. It is subject to occasional flooding. Areas of this unit are long and narrow in shape and generally are the same width as the meander belt for that stream. They range from 5 to 200 acres or more.

Typically, the surface layer is very dark grayish brown, very friable silt loam about 13 inches thick. The friable silty clay loam subsurface layer, about 24 inches thick, is very dark brown in the upper part and very dark grayish brown, friable silty clay loam in the lower part. Below that is a dark brown, friable silty clay loam transitional layer about 13 inches thick. The substratum to a depth of 61 inches or more is dark brown, friable clay loam. In some places, on wider valleys, the soil is lighter colored. There are some areas around old channels that have slopes ranging to 5 percent.

Included with this soil in mapping are small areas of poorly drained Blackoar soils in shallow depressions and of somewhat poorly drained Freeburg soils on small terraces. The included soils make up about 10 percent of the mapped areas.

In this Verdigris soil, permeability is moderate, and surface runoff is slow. Available water capacity is high. Reaction is neutral or slightly acid. Natural fertility is high, and organic matter content is moderate. The surface layer is very friable and is easily tilled throughout a fairly wide range in moisture content.

Most areas of this soil are used for cultivated crops. This soil is well suited to corn, grain sorghum, small grain, and grasses for hay and pasture. If the soil is used for cultivated crops, planting and harvesting can be planned to avoid flooding. The use of a conservation tillage system, or no-tillage, with winter cover crops and crop residue help maintain tilth and increase water infiltration.

This soil is well suited to grasses and legumes for hay and pasture. The varieties should be selected that will tolerate floods of short duration. Grazing and haying when the soil is wet will cause surface compaction and poor tilth. Proper stocking rates, rotational grazing of pasture, timely deferment of grazing, and restricted use during wet periods will help keep the pasture and the soil in good condition.

This soil is well suited to trees. The areas along streams and old meander belts are in native hardwoods. Tree seeds, cuttings, and seedlings grow well if competing vegetation is controlled or removed. Site preparation may include mechanical or chemical means. There are no hazards or limitations to be concerned about when planting or harvesting trees.

This soil generally is unsuitable for building sites and onsite waste disposal because of flooding over most of the area. The soil is a good source of topsoil and cover material for sanitary landfills. It tends to slough and compress when used as material for dikes and levees.

This soil is in capability subclass IIw.

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 providing the nation's short- and long-range needs for food and fiber. The acreage of high-quality farmland is limited, and the U.S. Department of Agriculture recognizes that government at local, state, and federal levels, as well as individuals, must encourage and facilitate the wise use of our nation's prime farmland.

Prime farmland soils, as defined by the U.S. Department of Agriculture, are soils that are best suited to producing food, feed, forage, fiber, and oilseed crops. Such soils have properties that are favorable for the economic production of sustained high yields of crops. The soils need only to be treated and managed using acceptable farming methods. The moisture supply, of course, must be adequate, and the growing season has to be sufficiently long. Prime farmland soils produce the highest yields with minimal inputs of energy and economic resources, and farming these soils results in the least damage to the environment.

Prime farmland soils may presently be in use as cropland, pasture, or woodland, or they may be in other uses. They either are used for producing food or fiber or are available for these uses. Urban or built-up land and water areas cannot be considered prime farmland.

Prime farmland soils usually get an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The acidity or alkalinity level of the soils is acceptable. The soils have few or no rocks and are permeable to water and air. They are not excessively erodible or saturated with water for long periods and are not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent.

About 243,750 acres, or nearly 55 percent of Cass County, meets the soil requirements for prime farmland. Areas are scattered throughout the county, but the largest acreages are in soil associations 3 and 4 on the general soil map. Crops grown on this land, mainly corn and soybeans, account for about two-thirds of the total agricultural income of the county each year (*18*).

A recent trend in land use in some parts of the county has been the conversion of prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, or difficult to cultivate and are less productive.

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

Some soils have a high water table and need to be drained in order to qualify as prime farmland. Onsite evaluation is necessary to determine the effectiveness of corrective measures.

For more detailed information on the criteria for prime farmland soils, consult the local office of the Soil Conservation Service.

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

Lee Ellis, district conservationist, Soil Conservation Service, assisted in the preparation of 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.

Approximately 361,100 acres in the survey area was used for crops and pasture in 1967 (*7*). Of this total, 146,800 acres was used for permanent pasture; 106,000 acres for row crops; 23,000 acres for close-grown crops, mainly wheat; and 129,553 acres for rotation hay and pasture. The rest was idle cropland and openland formerly cropped.

The potential of the soils in Cass County for increased production of food is good. About 27,371 acres of potentially good cropland is used as woodland, and about 127,298 acres is used as pasture. In addition to the reserve productive capacity represented by this land, food production could also be increased considerably by extending the latest crop production technology to all cropland in the county. This soil survey can greatly facilitate the application of such technology.

Because of livestock market fluctuations and the increased demand for grain in foreign countries, the acreage used for row crops has increased, and the acreage in permanent pasture has shown a corresponding decrease. There also has been an increase in urban development in most of the county. In 1970, about 4 percent of the county (*7*) was urban and built-up land. This figure has been increasing at a rate of about 500 acres per year. The use of this soil survey to help make land use decisions that will influence the future role of farming in the county is discussed in the section "Detailed Soil Map Units."

Soil erosion is the major problem on nearly all cropland and overgrazed pastureland in Cass County. All soils having slopes in excess of 2 percent are susceptible to erosion damage. Soils such as Haig soils that have slopes of 2 percent or less will erode severely during intense spring rains if tillage is excessive and all crop residue is removed (fig. 12). Sloping soils on terraced fields also erode severely between the terraces if tillage is excessive and all crop residue is removed or covered. Rotations that include small grain or meadow

Figure 12.—Erosion on Haig silt loam, where tillage is excessive and little crop residue is on the surface. Slope is 0 to 2 percent.

and the use of a conservation tillage system or no-tillage help reduce sheet erosion between terraces.

Fall plowing is common in the survey area but is a poor practice on most upland soils. Most cropland consists of sloping soils that are subject to damaging erosion if they are plowed in the fall.

Erosion control practices, such as terracing, no-tillage, or conservation tillage, and crop rotations will control erosion and sustain production over a long period on sloping soils, such as Deepwater, Greenton, Higginsville, and Kenoma. On livestock farms, which require pasture and hay, the legume and grass forage crops reduce erosion on sloping land, provide nitrogen, and improve tilth for the following crops in the rotation.

Terraces and diversions reduce the length of slope and reduce runoff and erosion. They are most practical on deep, well drained soils that have regular slopes. The slopes are uniform on most soils so that waterways and terraces can be built. Deepwater, Sharpsburg, and Polo soils are suitable for terraces, but terracing is not practical on Coweta, Norris, and Nowata soils. Terrace channels and waterways help to drain the wet soils, such as Sampsel soils, and make them easier to farm. A clayey subsoil, which would be exposed in terrace channels, or bedrock at a depth of less than 40 inches reduces suitability for terraces on other soils. Terraces can be built on some areas of Barco, Eram, Oska, and Snead soils if cuts are not deep enough to expose bedrock. Cropping systems that provide substantial vegetative cover are needed to control erosion on these soils. Most areas of these soils should be kept in permanent vegetation; but if the soils are cropped, minimizing tillage and leaving crop residue on the surface help to increase infiltration and reduce runoff and erosion.

Tillage practices can be adapted to most soils in the survey area but are more difficult to use on the eroded soils and on the soils that have a clayey surface layer, such as Sampsel and Summit soils. The use of no-tillage for corn and soybeans, which is common on an increasing acreage, reduces erosion on sloping soils and can be adapted to most soils in the survey area.

Soil blowing is a hazard in the winter and early spring on Haig, Macksburg, Deepwater, Polo, Kenoma, and Sharpsburg soils when they are left bare by fall plowing and disking. Soil blowing can damage these soils in a few hours if winds are strong and the soils are dry and bare of vegetation or surface mulch. Maintaining vegetative cover, surface mulch, or a rough surface through proper tillage minimizes soil blowing on these soils.

Soil drainage is the major management need on about 36,060 acres of cropland in the survey area. Without drainage measures, some soils are naturally so wet that some damage to crops commonly grown in the area can be expected in most years. These are the somewhat poorly drained Freeburg and poorly drained Bremer, Blackoar, Moniteau, and Zook soils, which make up about 3,600 acres of the survey area (*7*). Haig soils generally do not require additional surface drainage. Adequate surface drainage generally can be obtained by proper direction of rows and the use of installed drainage systems.

Surface ditches, land grading, and protection from flooding on the Blackoar, Moniteau, and Zook soils will greatly reduce crop damage during most years.

Sampsel, Summit, and Weller soils have good natural drainage most of the year, but they tend to dry out slowly in the spring and after rains. Small areas of wet hillside seeps are included in mapped areas of the Sampsel and Weller soils. Tile drains for the seepy areas improve these soils for farming and act as outlets for terraces.

Haig, Kenoma, and Macksburg soils are on broad ridgetop divides where slow runoff causes wet conditions after rains. Greenton and Higginsville soils are on concave positions below those soils. All these soils are slow to dry out in the spring; therefore, tillage operations are delayed in most years.

Rainfall is moderate and is adequate for crops and pasture in many years, but summer droughts of sufficient severity and duration are common and reduce crop yields. Crops and pasture grown on shallow and moderately deep soils, for example, Barco, Coweta, Eram, Norris, Nowata, Oska, and Snead soils, are severely damaged by summer drought in most years. Crops and pasture grown on Kenoma, Moniteau, and Weller soils are less susceptible to drought. Yields are lowered by drought on these soils, but not as much as on the shallow and moderately deep soils. The remaining deep soils will produce crops and pasture in most years, and yields are not reduced by droughts of short duration.

Irrigation. Several irrigation systems are currently in use in Cass County, and about 5,000 to 7,000 acres is irrigated each year. Presently, only center pivot and "big-gun" systems are used with water supplied from adjacent shallow lakes. Such systems increase yields by one-third to one-half by supplying supplemental water during critical periods of crop growth. Irrigation also makes double-cropping an attractive alternative in cropping systems. Soybeans can be planted directly into wheat stubble. The irrigation system then supplies enough water to insure germination and crop growth. The large amount of residue on the surface of the soil is helpful in protecting the soil from erosion.

In considering relative costs and benefits of an irrigation system, soil and water conservation practices must be included. Immediately after irrigation, the saturated topsoil is extremely vulnerable to erosion if intense rainfall occurs. Such accelerated erosion can drastically reduce natural fertility, and it also causes rapid sedimentation of any bodies of water downstream. Since most systems are supplied by reservoirs in the irrigated watershed, such sedimentation reduces the irrigation capacity. No wells at present have been found to produce enough water for irrigation purposes; therefore, protection of the topsoil from erosion is doubly crucial. Another management concern is careful maintenance of terraces. If ruts are allowed to develop where the wheels of the system pass over the saturated terrace berm, the effectiveness of the terraces is reduced.

Pasture and hay crops suited to the soils and climate of the survey area include several legumes, cool-season grasses, and warm-season native grasses. Alfalfa and red clover are the legumes commonly grown for hay. They are also used in mixtures with bromegrass, fescue, orchardgrass, or timothy for hay and pasture.

Warm-season native grasses adapted to the survey area are big bluestem, little bluestem, indiangrass, and switchgrass. These grasses produce well during the hot summer months. They need different management techniques for establishing seedlings and for grazing than cool-season grasses.

Alfalfa is best suited to deep, moderately well drained, or well drained soils, such as Deepwater, Polo, Sharpsburg, and Verdigris soils. The other legumes and all grasses do well on most of the upland soils in the survey area. For Blackoar, Bremer, Haig, Weller, and Zook soils, moisture-tolerant plants should be selected.

The major management concern on most of the pastureland is overgrazing and gully erosion. Grazing should be controlled so that the plants survive and give maximum production. Also keeping grasses at a desirable height will reduce runoff and gully erosion.

Yields Per Acre

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

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

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider 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 woodland and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit (*16*). Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

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.

There are no class V or class VIII soils in Cass County.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, or s,* 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. The capability classification of each map unit is given in the section "Detailed Soil Map Units."

Woodland Management and Productivity

James L. Robinson, forester, Soil Conservation Service, assisted in the preparation of this section.

Cass County is in the Cherokee Prairie Land Resource Area of Missouri. The prairie areas typically were not heavily forested; most of the timber was on bottom lands and in narrow strips along small watercourses. A Forest Service survey published in 1972 indicates that 34,500 acres of Cass County was woodland. This figure indicates a 31 percent decrease in timber acreage between 1959 and 1972.

The Snead-Polo-Oska association on the general soil map is primarily made up of soils formed under prairie vegetation. Woodland will generally be found on the Snead-Rock outcrop complex and on some of the minor soils in this association. The upper side slopes contain species typical of the oak-hickory forest. Black oak, northern red oak, white oak, blackjack oak, post oak, and hickory are common. Some pin oak and shingle oak also occur along border areas and on upper side slope positions. American elm, hackberry, ash, black walnut, and some Kentucky coffee trees are more abundant on the lower side slopes.

The Zook-Blackoar-Verdigris association occupies the river bottoms and flood plains. The bottom land hardwoods are varied. The principal forest type is silver maple-American elm in most woodland of this association. Cottonwood, ash, boxelder, pin oak, sycamore, hickory, and black walnut are common. Large numbers of cottonwood and black willow generally occupy areas reverting back to timber from recently disturbed areas. The better drained soils, such as Verdigris, are excellent black walnut sites. Most areas left in timber have inadequate drainage for cropping or are frequently flooded. These soils are productive timber sites; however, there is a tremendous need for woodland improvement in these stands. Fire, improper harvesting, and lack of good management have reduced much of the woodland value and increased the amount of undesirable species in the stand.

The Macksburg-Sampsel-Greenton, Kenoma-Haig-Deepwater, and Summit-Eram-Kenoma associations are made up of prairie soils that have very minor areas in timber. Woodland occupies areas along small drainageways or steeper slopes where woodland has been permitted to encroach. Pin oak, shingle oak, locust, post oak, blackjack oak, black oak, and hickory are common. The wooded encroachment in the drainage pattern consists of species commonly growing on the bottom lands, such as sycamore, pin oak, cottonwood, maple, and elm.

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 (woodland suitability) symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for 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.

Windbreaks and Environmental Plantings

James L. Robinson, forester, Soil Conservation Service, assisted in the preparation of this section.

A need for well designed farmstead and feedlot windbreaks is very evident in the county, especially in soil associations 3, 4, and 5. Windbreaks can reduce significantly the energy required to heat a home. Windbreaks reduce the windchill effect of cold winter winds, making it more comfortable for humans and animals. Animals protected by a windbreak have shown significant gains over winter as compared to animals not protected.

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

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

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To 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

Edward A. Gaskins, biologist, Soil Conservation Service, assisted in the preparation of this section.

The 1980 Statewide Comprehensive Outdoor Recreation Plan (SCORP) shows a total of 4,220 acres of recreation developments in Cass County (*13*). Ownership of these areas is 2 percent state, 42 percent municipal, 8 percent school, 32 percent private, and 16 percent other. The facilities listed include lakes, river sports, swimming areas, hunting and fishing areas, a fairground, historical sites, an archery range, game courts, ballfields, picnic areas, play areas, horse arenas, and wildlife viewing areas. Increases in foot trails, bike paths, playfields, and fishing and hunting areas are needed to meet a projected 76 percent increase in the county population by 1990 (*8*).

The Harrisonville City Park (144 acres) is the largest public recreation area in the county. The state-owned Dorsett Hill Prairie (79 acres) offers opportunities for nature study. Some streams and city reservoirs offer public fishing.

The 1974 NACD Nationwide Outdoor Recreation Inventory lists 11 private and semiprivate commercial recreation enterprises in operation (*4*). They vary from swimming areas, golf courses, and a historical site to lake development properties, a gun club, a picnic area, and commercial fishing lakes. Water sports areas and public hunting areas are the main recreation needs listed by the inventory committee.

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 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 gentle 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.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

Edward A. Gaskins, biologist, Soil Conservation Service, assisted in the preparation of this section.

Cass is one of thirteen counties that make up the West Prairie Zoogeographic Region in Missouri (*10*). Prior to cultivation, the county was a mosaic of tall grass prairie and oak-hickory forest. Today, only scattered parts of the original prairie remain. The woodland base is primarily associated with the streams and watercourses of the county. The original ecosystem has been changed by cultivation and clearing for agricultural purposes, commercial timber harvesting, overgrazing, and increasing urban development. Urban pressure from the Kansas City metropolitan area continues to affect land use changes and wildlife habitat in the survey area. One growth study predicts about 76 percent increase in the county's population between 1970 and 1990 (*8*). All these factors seriously affect the wildlife resources in Cass County.

Songbird populations are rated as "good to excellent" (*8*) for each of the soil associations. Wildlife game species primarily consist of those favoring an openland type habitat. The Macksburg-Sampsel-Greenton, Kenoma-Haig-Deepwater, Summit-Eram-Kenoma, Snead-Polo-Oska, and Zook-Blackoar-Verdigris associations all show a predominance of cropland and grassland—the openland wildlife habitat in Cass County. Small blocks of timber, waterways, hedgerows, fencerows, and other odd areas containing wooded or brushy cover provide the edge habitat, or "hard cover," which is essential for the majority of openland wildlife. These key habitat areas are fast disappearing in the intensively agricultural and urbanized parts of the county. The loss of cover extending into food producing areas is the most serious threat to openland species.

Cass County has a fair resident dove population, which is expanded by good migratory flights during the fall hunting season. Hunting pressure on the dove is very heavy because of the Kansas City influence. Quail populations are poor, and rabbit numbers are fair. A few prairie chickens are reported each year.

The furbearer population is rated as "good" in Cass County. Trapping has been increasing for the past few years because of rising prices paid for furs. The harvest records for the 1976-79 seasons show that raccoon, opossum, coyote, muskrat, striped skunk, mink, beaver, and gray fox were the eight most commonly trapped species. The hunting season has been closed on red fox and bobcat for the last few years, and each has increased in numbers.

There are no predominantly woodland associations in the county; however, of the five soil associations, the Zook-Blackoar-Verdigris and Snead-Polo-Oska associations contain the most woodland habitat. The other three associations add 5 to 9 percent to the total woodland wildlife habitat base. The good deer population is rapidly approaching its carrying capacity. The greatest numbers of deer are found in the wooded bottom lands. A successful stocking of wild turkey was made in 1977. Good populations of fox squirrel can be found in wooded areas.

Wetland habitat is by far the least important of the three major types in the county. Only the Zook-Blackoar-Verdigris association has any wetland benefits. Most of the wet soils of these prime bottom land soils have been drained and are now intensively farmed. Much of the remaining woodland still exists only because of a wetness condition. Irrigation reservoirs are beginning to attract many geese and ducks. Many farmers are constructing shooting blinds to take advantage of increasing numbers of snow, blue, and Canada geese and several species of duck. Goose nesting tubs on farm ponds and lakes are beginning to show signs of use. Pleasant Hill now has its own resident goose flock. Good populations of wood duck can be found on the old and new channels of the South Grand River and on Big Creek. At least two organized duck hunting clubs operate within the county.

There are no permanent flowing streams in Cass County (*8*). Stream fishing is somewhat limited in the county. The better fishing waters are the South Grand River and Big, Poney, and Alexander Creeks. The principal stream species are channel and bullhead catfish, carp, drum, crappie, largemouth bass, bluegill, and green sunfish.

Impoundment fishing opportunities are more numerous in the survey area. City reservoirs at Harrisonville, Pleasant Hill, Freeman City, Peculiar, and Garden City offer public access. Lake Annette and the Kansas City-Southern Railroad lake provide opportunity for the public to fish. Largemouth bass, bluegill, crappie, and channel and bullhead catfish are typical fish found in the larger lakes.

Approximately 2,000 farm ponds and small lakes in the survey area have been stocked with fish. Most have been stocked with largemouth bass, channel catfish, and bluegill.

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, oats, millet, soybeans, and milo.

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 bluegrass, switchgrass, orchardgrass, indiangrass, clover, alfalfa, trefoil, and crownvetch.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, pokeweed, foxtail, croton, and partridgepea.

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, the available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, sweetgum, apple, hawthorn, dogwood, hickory, blackberry, wild plum, sumac, persimmon, and sassafras. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are autumn-olive, crabapple, Amur honeysuckle, and hazelnut.

Coniferous plants furnish winter cover, 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, fir, cedar, and juniper.

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, wild millet, wildrice, cutgrass, cattail, rushes, sedges, and buttonbush.

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, meadowlark, field sparrow, cottontail, red fox, woodchuck, and mourning dove.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and 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, muskrat, mink, and beaver.

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, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

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

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, and shrink-swell potential can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, 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 or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 12 shows the degree and the 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, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

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

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

Table 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, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

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

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

The ratings in table 12 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

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

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

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

Construction Materials

Table 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, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; 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 or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind 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 wind erosion, 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.

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. "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 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, SP-SM.

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 earth-moving 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.

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.

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 or by runoff from adjacent slopes. 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, no more than once 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.

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.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

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 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 (*17*). 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 Argiudoll (*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, montmorillonitic, thermic Vertic 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 (*15*). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (*17*). 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."

Barco Series

The Barco series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in acid sandstone residuum. They are on narrow upland ridgetops and side slopes. The slope ranges from 2 to 5 percent.

Barco soils commonly are adjacent to Coweta and Deepwater soils. Coweta soils are shallow soils and generally are lower on the landscape than Barco soils, but may occur above those soils on mounds. Deepwater soils are deep, have less sand throughout, and generally are below Barco soils.

Typical pedon of Barco loam, 2 to 5 percent slopes, about 400 feet east and 950 feet north of the southwest corner of sec. 35, T. 44 N., R. 29 W.

A1—0 to 3 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; many fine roots; few pebbles of soft sandstone (less than 10 percent); neutral; abrupt smooth boundary.

A2—3 to 7 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; moderate thin platy structure parting to weak fine granular; very friable; many fine roots; few pebbles of soft sandstone (less than 10 percent); few worm casts; slightly acid; abrupt smooth boundary.

Bt1—7 to 13 inches; dark brown (10YR 3/3) loam, brown (10YR 4/3) dry; weak fine subangular blocky structure; friable; many fine roots; few pebbles of soft sandstone (less than 10 percent); few worm casts; few faint clay films; very strongly acid; clear smooth boundary.

Bt2—13 to 18 inches; dark yellowish brown (10YR 4/4) clay loam; weak fine subangular blocky structure; friable; many fine roots; few faint clay films; few small fragments of soft sandstone (less than 10 percent); very strongly acid; clear smooth boundary.

Bt3—18 to 24 inches; dark yellowish brown (10YR 4/4) clay loam; many medium prominent yellowish red (5YR 4/6) mottles; weak fine subangular blocky structure; friable; few fine roots; few dark grayish brown (10YR 4/2) worm casts; few distinct clay films; few black stains on faces of some peds; very strongly acid; clear smooth boundary.

Bt4—24 to 30 inches; yellowish brown (10YR 5/4) clay loam; many medium faint light yellowish brown (10YR 6/4) and many fine prominent yellowish red (5YR 4/6) mottles; moderate fine subangular blocky structure; friable; few fine roots; few distinct clay films; very strongly acid; abrupt smooth boundary.

Cr—30 to 41 inches; soft, weathered sandstone rock that has thin layers of brownish yellow (10YR 6/6) clay loam; firm; few fine roots; strongly acid.

R—41 inches; hard sandstone bedrock.

The solum thickness and depth to soft sandstone bedrock range from 20 to 40 inches.

The A horizon typically is loam, but the range includes silt loam. The hue is 7.5YR or 10YR, value is 2 or 3, and chroma is 2 or 3. This horizon is neutral to strongly acid. The B horizon has hue of 7.5YR or 10YR, value of 3 to 5, and chroma of 3 through 8. It is loam, sandy clay loam, or clay loam. The B horizon is strongly acid or very strongly acid.

Blackoar Series

The Blackoar series consists of deep, poorly drained, moderately permeable soils on flood plains. These soils formed in recently deposited silty alluvium. The slope ranges from 0 to 2 percent.

Blackoar soils are similar to Zook soils and commonly are adjacent to Verdigris and Zook soils. Verdigris soils are moderately well drained, have a thicker mollic epipedon, and are on natural levees along streams. Zook soils are fine textured throughout, have a thicker mollic epipedon, and are in lower positions.

Typical pedon of Blackoar silt loam, 2,500 feet south and 1,250 feet west of the northeast corner of sec. 8, T. 45 N., R. 29 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; yellowish red (5YR 5/8) stains along boundary between horizons; weak fine granular structure; very friable; few very fine roots; medium acid; abrupt smooth boundary.

A—9 to 16 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; few very fine roots; few very fine black concretions of iron and manganese oxides; medium acid; abrupt smooth boundary.

BAg—16 to 22 inches; dark gray (10YR 4/1) silt loam; common fine faint very dark gray (10YR 3/1) and gray (10YR 6/1) mottles; weak fine granular structure; very friable; few fine roots; few fine black concretions of iron and manganese oxides; medium acid; clear smooth boundary.

Bg1—22 to 29 inches; dark gray (10YR 4/1) silt loam; few distinct medium gray (10YR 6/1) and few fine prominent reddish brown (2.5YR 4/4) mottles; weak fine subangular blocky structure; friable; few very fine roots; few fine black concretions of iron and manganese oxides; medium acid; clear smooth boundary.

Bg2—29 to 60 inches; dark gray (10YR 4/1) silt loam; common coarse faint gray (10YR 6/1) and common medium prominent dark brown (7.5YR 4/4) mottles; weak fine subangular blocky structure; friable; very few very fine roots; few fine black concretions of iron and manganese oxides; neutral.

The solum thickness ranges from 36 to 60 inches. The solum ranges from neutral to medium acid. It is silty loam throughout, but thin layers of silty clay loam are in the B horizon of some pedons.

The A or Ap horizon has hue of 10YR, value of 3, and chroma of 1 or 2. The matrix colors of the Bg horizon range in hue from 10YR through 5Y, value of 4 through 6, and chroma of 2 or less.

Bremer Series

The Bremer series consists of deep, poorly drained, moderately slowly permeable soils on low stream terraces and high bottoms. These soils formed in silty alluvium. The slope ranges from 0 to 2 percent.

Bremer soils are similar to Haig and Zook soils and commonly are adjacent to Blackoar, Weller, and Zook soils. Blackoar soils are coarser textured and are on flood plains. Haig soils contain more clay in the Bt horizon. In contrast to Bremer soils, Weller soils do not have a mollic epipedon, and they contain more clay in the subsoil and are on uplands. Zook soils do not have an argillic horizon.

Typical pedon of Bremer silty clay loam, 1,860 feet west and 2,920 feet south of the northeast corner of sec. 1, T. 44 N., R. 33 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; very friable; many fine roots; medium acid; abrupt smooth boundary.

A1—8 to 11 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; very friable; many fine roots; few worm casts; medium acid; abrupt smooth boundary.

A2—11 to 16 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; many fine roots; few worm casts; slightly acid; clear smooth boundary.

Bt1—16 to 24 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; many fine roots; few faint clay films; few fine black concretions of iron and manganese oxides; slightly acid; clear smooth boundary.

Bt2—24 to 32 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; firm; many fine roots; few faint clay films; many fine black concretions of iron and manganese oxides; slightly acid; clear smooth boundary.

Btg—32 to 47 inches; gray (10YR 5/1) silty clay loam; many medium distinct dark yellowish brown (10YR 4/4) mottles; weak coarse blocky structure; firm; many fine roots; few distinct clay films; many fine black concretions of iron and manganese oxides; neutral; abrupt smooth boundary.

Cg—47 to 60 inches; gray (10YR 5/1) silty clay loam; common coarse faint dark gray (10YR 4/1), grayish brown (10YR 5/2), and distinct dark yellowish brown (10YR 4/4) mottles; massive; friable; common fine roots; many fine black concretions of iron and manganese oxides; neutral.

The solum thickness ranges from 40 to 60 inches. The A horizon contains 24 to 34 percent clay and ranges from medium acid to neutral. It is neutral in hue or has hue of 10YR. It has value of 2 or 3 and chroma of 0 or 1. The Bt horizon is silty clay loam and averages 36 to 40 percent clay in the upper 20 inches of the argillic horizon. It has hue of 10YR through 5Y, value of 3 through 5, and chroma of 1 or less. The C horizon has hue of 10YR through 5Y, value of 4 or 5, and chroma of 1 or less.

Coweta Series

The Coweta series consists of shallow, well drained, moderately permeable soils on uplands. These soils formed in residuum derived from sandstone and shale. The slope ranges from 5 to 14 percent.

Coweta soils commonly are adjacent to Barco and Deepwater soils. Barco soils are moderately deep, have less sand in the solum, and are in similar positions on the landscape. Deepwater soils are deep, have an argillic horizon, and are below Coweta soils on the landscape.

Typical pedon of Coweta loam, 5 to 14 percent slopes, 2,210 feet east and 100 feet north of the southwest corner of sec. 6, T. 43 N., R. 33 W.

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

BA—4 to 8 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; weak fine granular structure; very friable; many fine roots; 7 percent fine sandstone pebbles; strongly acid; abrupt smooth boundary.

Bw1—8 to 15 inches; dark brown (7.5YR 4/4) gravelly loam; weak fine subangular blocky structure; very friable; few fine roots; 30 percent sandstone pebbles; strongly acid; abrupt smooth boundary.

Bw2—15 to 19 inches; yellowish brown (10YR 5/6) gravelly loam; weak fine subangular blocky structure; very friable; few fine roots; 30 percent sandstone pebbles; strongly acid; abrupt smooth boundary.

Cr—19 to 46 inches; soft, broken sandstone and sandy shale.

The solum thickness and depth to soft bedrock range from 10 to 20 inches. The soil is slightly acid to strongly acid throughout.

The A horizon has hue of 7.5YR or 10YR, value of 3, and chroma of 2 or 3. It typically is loam, but the range includes fine sandy loam that is 0 to 20 percent coarse fragments. The B horizon has hue of 10YR through 5YR, value of 4 or 5, and chroma of 2 to 8. It is fine sandy loam, loam, or clay loam; content of coarse fragments ranges from 15 to 30 percent. The C horizon is soft, acid sandstone interbedded with shale. In some pedons, hard sandstone occurs between depths of 24 and 60 inches.

Deepwater Series

The Deepwater series consists of deep, moderately well drained, moderately permeable soils on uplands. These soils formed in shale residuum. The slope ranges from 2 to 9 percent.

Deepwater soils are adjacent to Barco, Kenoma, and Summit soils. Barco soils are moderately deep, have more sand throughout, and are higher on the landscape than Deepwater soils. Kenoma soils contain more clay in the subsoil than Deepwater soils and are higher on the landscape. Summit soils contain more clay and are lower on the landscape.

Typical pedon of Deepwater silt loam, 5 to 9 percent slopes, 925 feet south and 500 feet west of the center of sec. 35, T. 44 N., R. 29 W.

A1—0 to 7 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak fine granular structure; very friable; many fine roots; few fine black concretions of iron and manganese oxides; medium acid; clear smooth boundary.

A2—7 to 11 inches; very dark gray (10YR 3/1) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; many fine roots; common worm casts; few fine black concretions of iron and manganese oxides; medium acid; clear smooth boundary.

BA—11 to 16 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; friable; many fine roots; common worm casts; few fine black concretions of iron and manganese oxides; medium acid; clear smooth boundary.

Bt1—16 to 25 inches; brown (10YR 4/3) silty clay loam; few fine prominent red (2.5YR 4/8) mottles; weak fine subangular blocky structure; friable; common fine roots; few distinct clay films; few fine black concretions of iron and manganese oxides; strongly acid; abrupt smooth boundary.

Bt2—25 to 33 inches; dark yellowish brown (10YR 4/4) silty clay loam; few fine prominent red (2.5YR 4/8) and few fine prominent dark grayish brown (10YR 4/2) mottles; weak fine subangular blocky structure; friable; few fine roots; common distinct clay films; few fine black concretions of iron and manganese oxides; medium acid; clear smooth boundary.

Bt3—33 to 48 inches; dark brown (7.5YR 4/4) silty clay loam; many medium prominent dark grayish brown (10YR 4/2) mottles; moderate medium prismatic structure parting to weak fine subangular blocky; firm; few fine roots; many distinct clay films; common fine black and red concretions of iron and manganese oxides; slightly acid; clear smooth boundary.

Bt4—48 to 62 inches; dark grayish brown (10YR 4/2) silty clay; many fine prominent reddish brown (5YR 4/4) and dark brown (7.5YR 4/4) mottles; moderate medium prismatic structure parting to weak fine angular blocky; firm; few very fine roots; many distinct clay films; few fine black concretions of iron and manganese oxides; slightly acid.

The solum thickness typically is 48 to 72 inches. The mollic epipedon ranges from 11 to 24 inches in thickness.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 through 3. It ranges from strongly acid to neutral. The B horizon has hue of 7.5YR or 10YR, value of 4 to 7, and chroma of 2 to 6, and it is mottled in the lower part. The upper 20 inches of the argillic horizon averages 28 to 35 percent clay. The Bt horizon is strongly acid in the upper part and ranges from medium acid to slightly acid in the lower part.

Eram Series

The Eram series consists of moderately deep, moderately well drained, slowly permeable soils on uplands. These soils formed in shale residuum. The slope ranges from 5 to 14 percent.

Eram soils are similar to Snead soils and commonly are adjacent to Kenoma and Summit soils. Snead soils have carbonates at a depth of 12 to 20 inches and, unlike Eram soils, do not have an argillic horizon. Kenoma and Summit soils are deep and generally are on less sloping areas.

Typical pedon of Eram silty clay loam, 5 to 14 percent slopes, 450 feet west and 550 feet north of the southeast corner of sec. 4, T. 43 N., R. 29 W.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak very fine granular structure; friable; many fine roots; neutral; abrupt smooth boundary.

A—6 to 10 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; few fine roots; medium acid; clear smooth boundary.

Bt1—10 to 15 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; moderate very fine subangular blocky structure; firm; few fine roots; few faint clay films; few fine brown concretions of iron and manganese oxides; 5 percent chert fragments (10 to 25 millimeters in diameter); medium acid; clear smooth boundary.

Bt2—15 to 19 inches; dark brown (10YR 3/3) silty clay loam, grayish brown (10YR 5/2) dry; common fine faint dark yellowish brown (10YR 3/4) mottles; moderate very fine subangular blocky structure; very firm; few fine roots; few faint clay films; few fine brown concretions of iron and manganese oxides; 10 percent shale and chert fragments (5 to 20 millimeters in diameter); medium acid; clear smooth boundary.

Bt3—19 to 26 inches; yellowish brown (10YR 5/4) clay; many fine distinct dark reddish brown (2.5YR 3/4) mottles; moderate fine angular blocky structure; very firm; few fine roots; many pressure faces and slickensides with dark gray and dark grayish brown material along faces of peds; medium acid; gradual irregular boundary.

Bt4—26 to 35 inches; mottled grayish brown (10YR 5/2), dark yellowish brown (10YR 4/6), and dark gray (10YR 4/1) silty clay; moderate fine angular blocky structure; very firm; few fine roots; common distinct clay films in root channels and on faces of some peds; slickensides on faces of some peds; few fine concretions of iron and manganese oxides; slightly acid; gradual smooth boundary.

Cr1—35 to 46 inches; yellowish brown (10YR 5/6), mixed weathered shale; angular blocky structure; slickensides and pressure faces.

Cr2—46 to 63 inches; yellowish brown (10YR 5/4) shale; can be dug with backhoe.

The thickness of the solum and depth to bedrock range from 20 to 40 inches.

The A horizon has hue of 7.5YR through 5Y, value of 2 or 3, and chroma of 2 or 3. It typically is silty clay loam, but the range includes silt loam and clay loam. The A horizon is medium acid or slightly acid unless limed. The B horizon has hue of 5YR through 10YR, value of 2 through 5, and chroma of 2 through 4. It is clay loam, silty clay loam, silty clay, or clay. The B horizon ranges from strongly acid through neutral.

Freeburg Series

The Freeburg series consists of deep, somewhat poorly drained, moderately slowly permeable soils on low stream terraces. These soils formed in silty alluvium. The slope ranges from 0 to 2 percent.

Freeburg soils commonly are adjacent to Blackoar, Bremer, and Kennebec soils. Blackoar soils are on bottom lands. They have a mollic epipedon, are poorly drained, and have a coarser textured B horizon. Bremer soils are fine textured, have a mollic epipedon, and are slightly lower on the landscape. Kennebec soils have a mollic epipedon, do not have an argillic horizon, and are on bottom lands below Freeburg soils.

Typical pedon of Freeburg silt loam, 4,300 feet north and 1,200 feet west of the southeast corner of sec. 6, T. 44 N., R. 31 W.

Ap—0 to 4 inches; dark brown (10YR 4/3) silt loam; weak fine granular structure; very friable; few fine roots; very few very fine black concretions of iron and manganese oxides; slightly acid; abrupt smooth boundary.

A—4 to 9 inches; dark brown (10YR 4/3) silt loam; weak fine granular structure; very friable; few fine roots; very few very fine black concretions of iron and manganese oxides; slightly acid; abrupt, smooth boundary.

E—9 to 17 inches; brown (10YR 5/3) silt loam; weak fine granular structure; very friable; common fine roots; many fine root pores; slightly acid; abrupt smooth boundary.

Bt1—17 to 21 inches; yellowish brown (10YR 5/4) silty clay loam; common fine distinct light gray (10YR 7/2) mottles; weak medium subangular blocky structure; friable; common fine roots; few faint clay films; light gray silt coatings on faces of some peds; strongly acid; abrupt smooth boundary.

Bt2—21 to 41 inches; yellowish brown (10YR 5/4) silty clay loam; many coarse distinct light brownish gray (10YR 6/2) and dark yellowish brown (10YR 4/6) mottles; weak medium subangular blocky structure; friable; few fine roots; few distinct clay films; very strongly acid; clear smooth boundary.

BC—41 to 60 inches; dark brown (7.5YR 4/4) silty clay loam; many coarse prominent grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; friable; strongly acid.

The solum thickness ranges from 33 to 60 inches or more.

The A horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. It typically is silt loam, but the range includes loam. It is slightly acid or neutral. The B horizon has hue of 10YR, value of 4 through 6, and chroma of 1 through 6. It has mottles of high value and chroma of 2 or less. The B horizon ranges from medium acid to strongly acid in the upper part and is strongly acid or very strongly acid in the lower part.

Greenton Series

The Greenton series consists of deep, somewhat poorly drained, slowly permeable soils on uplands. These soils formed in loess and residuum derived from interbedded silty and clayey shale and clay beds. The slope ranges from 5 to 9 percent.

Greenton soils are similar to Macksburg soils and commonly are adjacent to Macksburg, Oska, and Sampsel soils. Macksburg soils have less clay in the BC and C horizons and are on adjacent, higher lying ridgetops. Oska soils are moderately deep, have redder colors in the subsoil, and are on lower positions. Sampsel soils have bright colored mottles in the lower part of the mollic epipedon and are on similar but seepy areas.

Typical pedon of Greenton silty clay loam, 5 to 9 percent slopes, 1,950 feet west and 800 feet south of the northeast corner of sec. 17, T. 46 N., R. 30 W.

Ap—0 to 5 inches; very dark grayish brown (10YR 3/2) silty clay loam; weak fine granular structure; very friable; many fine roots; medium acid; abrupt smooth boundary.
A—5 to 9 inches; very dark grayish brown (10YR 3/2) silty clay loam; weak fine granular structure; very friable; many fine roots; medium acid; clear smooth boundary.
Bt1—9 to 16 inches; very dark grayish brown (10YR 3/2) silty clay loam; moderate fine subangular blocky structure; friable; many fine roots; few faint clay films; few black concretions of iron and manganese oxides; medium acid; gradual smooth boundary.
Bt2—16 to 22 inches; dark brown (10YR 3/3) silty clay loam; many fine prominent dark reddish brown (5YR 3/4) mottles; moderate fine subangular blocky structure; firm; few fine roots; common distinct clay films; few fine black concretions of iron and manganese oxides; medium acid; gradual smooth boundary.
2Bt3—22 to 37 inches; dark brown (7.5YR 4/4) silty clay; common medium prominent dark gray (10YR 4/1) mottles; moderate medium angular blocky structure; very firm; few fine roots; common prominent clay films; many medium black concretions of iron and manganese oxides; few fine pebbles; neutral; gradual smooth boundary.
2Bt4—37 to 53 inches; dark brown (7.5YR 4/4) silty clay; common medium prominent dark grayish brown (2.5Y 4/2) mottles; moderate medium angular blocky structure; very firm; few fine roots; common medium black concretions of iron and manganese oxides; common prominent clay films; neutral; gradual smooth boundary.
2Bt5—53 to 60 inches; dark brown (7.5YR 4/4) silty clay; common medium prominent dark grayish brown (2.5YR 4/2) mottles; weak medium angular blocky structure; firm; common prominent clay films; common fine concretions of iron and manganese oxides; common chert fragments; neutral.

The solum thickness ranges from 40 to 60 inches. Reaction ranges from neutral to medium acid.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The Bt horizon has hue of 10YR or 7.5YR, value of 3 to 6, and chroma of 2 to 5. It is silty clay loam or silty clay.

Haig Series

The Haig series consists of deep, poorly drained, slowly permeable soils on uplands. These soils formed in thick loess. The slope ranges from 0 to 2 percent.

Haig soils are similar to Bremer soils and commonly are adjacent to Deepwater, Macksburg, and Sampsel soils. Bremer soils have less clay in the Bt horizon. Deepwater soils are moderately well drained, have less clay in the Bt horizon, and are on more sloping, narrower ridgetops. Macksburg soils have less clay in the Bt horizon, are somewhat poorly drained, and are on lower positions. Sampsel soils are sloping and on lower positions.

Typical pedon of Haig silt loam, 100 feet west and 1,640 feet north of the southeast corner of sec. 17, T. 44 N., R. 30 W.

Ap—0 to 10 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; common roots; slightly acid; abrupt smooth boundary.
Bt1—10 to 14 inches; very dark gray (10YR 3/1) silty clay loam, very dark gray (10YR 3/1) dry; few fine distinct gray (10YR 5/1) mottles; weak fine subangular blocky structure; friable; common roots; few faint clay films; few fine concretions of iron and manganese oxides; medium acid; clear smooth boundary.
Bt2—14 to 20 inches; very dark gray (10YR 3/1) silty clay, very dark gray (10YR 3/1) dry; few fine prominent dark brown (7.5YR 4/4) and few fine distinct grayish brown (10YR 5/2) mottles; weak fine subangular blocky structure; firm; common roots; common distinct clay films; few fine black concretions of iron and manganese oxides; medium acid; clear smooth boundary.
Btg1—20 to 37 inches; olive gray (5Y 4/2) silty clay; common fine prominent dark brown (7.5YR 4/4) and distinct dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; very firm; common roots; common distinct clay films; few fine black concretions of iron and manganese oxides; medium acid; gradual smooth boundary.
Btg2—37 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam; few fine distinct yellowish brown (10YR 5/4) mottles; weak fine subangular blocky structure; firm; few fine roots; common distinct clay films in root pores and on faces of some peds; few fine black concretions of iron and manganese oxides; slightly acid.

The solum thickness ranges from 48 to 60 inches or more. Reaction is medium acid or strongly acid in the most acid part.

The A horizon ranges from 10 to 18 inches in thickness and has hue of 10YR, value of 2 or 3, and chroma of 1. It typically is silt loam, but the range includes silty clay loam. The clay content of the upper 20 inches of the argillic horizon ranges from 42 to 48 percent. The upper part of the Bt horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 1. The lower part of the Bt horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 or 2.

Higginsville Series

The Higginsville series consists of deep, somewhat poorly drained, moderately permeable soils on uplands. These soils formed in thick loess. The slope ranges from 5 to 9 percent.

Higginsville soils are similar to Macksburg soils and commonly are adjacent to Macksburg and Sampsel soils. Macksburg soils contain more clay in the B horizon. Sampsel soils contain more clay throughout the profile. They have bright colored mottles in the lower part of the mollic epipedon and are on lower positions adjacent to drainageways.

Typical pedon of Higginsville silt loam, 5 to 9 percent slopes, 200 feet east and 200 feet south of the northwest corner of sec. 13, T. 46 N., R. 33 W.

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

A—6 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; black (10YR 2/1) ped exteriors; weak fine granular structure; very friable; many very fine roots; medium acid; clear smooth boundary.

BA—9 to 14 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; dark brown (10YR 3/3) ped exteriors; weak fine subangular blocky structure; friable; many very fine roots; few clear white silt grains on faces of peds; strongly acid; clear smooth boundary.

Bt1—14 to 18 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; very dark gray (10YR 3/1) ped exteriors; weak fine subangular blocky structure; friable; many very fine roots; few faint clay films; few fine strong brown concretions of iron and manganese oxides; few worm casts; strongly acid; clear smooth boundary.

Bt2—18 to 24 inches; dark brown (10YR 4/3) silty clay loam; few fine faint dark grayish brown (10YR 4/2) and few fine prominent yellowish red (5YR 4/6) mottles; weak fine subangular blocky structure; friable; many very fine roots; few faint clay films; few black concretions of iron and manganese oxides; few worm casts; strongly acid; clear smooth boundary.

Bt3—24 to 32 inches; mottled grayish brown (10YR 5/2), dark grayish brown (10YR 4/2), yellowish brown (10YR 5/8), and red (2.5YR 4/6) silty clay loam; weak fine subangular blocky structure; friable; many very fine roots; few distinct clay films; common fine black concretions of iron and manganese oxides; strongly acid; clear smooth boundary.

Bt4—32 to 50 inches; mottled gray (10YR 5/1) and yellowish brown (10YR 5/6) silty clay loam; weak fine prismatic structure parting to weak fine subangular blocky; friable; few fine roots and root pores; few distinct clay films; common fine black concretions of iron and manganese oxides; medium acid; abrupt smooth boundary.

C—50 to 65 inches; mottled dark grayish brown (10YR 4/2), brown (10YR 5/3), and reddish brown (5YR 4/3) silty clay loam; weak coarse blocky structure; friable; few fine roots; slightly acid.

The solum thickness ranges from 38 to 54 inches. Depth to bedrock is greater than 60 inches. Thickness of the mollic epipedon averages about 20 inches but ranges from 10 to 24 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It ranges from medium acid to neutral.

The upper part of the B horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 or 3; but in some pedons, coatings on faces of peds have chroma of 1. The lower part of the B horizon is mottled with a wide range of colors. Reaction ranges from strongly acid to neutral.

The C horizon is mottled with a wide range of colors.

Kenoma Series

The Kenoma series consists of deep, moderately well drained, very slowly permeable soils on convex erosional uplands. These soils formed in old alluvium or residuum that is overlain by loess in places. The slope ranges from 1 to 7 percent.

Kenoma soils are similar to Summit soils and are adjacent to Deepwater and Summit soils. Deepwater soils contain less clay throughout the profile. They have a thinner mollic epipedon than Kenoma soils and are on lower positions. Summit soils have a thick BA horizon and a silty clay loam surface layer.

Typical pedon of Kenoma silt loam, 1 to 4 percent slopes, 200 feet north and 200 feet west of the southeast corner of sec. 27, T. 43 N., R. 33 W.

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

Bt1—8 to 24 inches; very dark grayish brown (10YR 3/2) silty clay, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; firm; many roots; few faint clay films; gray silt coatings on faces of peds; medium acid; gradual smooth boundary.

Bt2—24 to 39 inches; dark grayish brown (10YR 4/2) silty clay, grayish brown (10YR 5/2) dry; many fine prominent reddish brown (5YR 4/4) and medium prominent brown (10YR 5/6) mottles; moderate fine subangular blocky structure; very firm; many fine roots; pressure faces; very dark gray silty material on vertical faces of peds; medium acid; gradual smooth boundary.

Bt3—39 to 54 inches; yellowish brown (10YR 5/4) silty clay; common fine prominent red (2.5YR 4/6) mottles; moderate fine subangular blocky structure; very firm; few fine roots; pressure faces; slightly acid; gradual smooth boundary.

BC—54 to 60 inches; yellowish brown (10YR 5/4) silty clay; common very fine yellowish red (5YR 4/6) mottles; weak coarse angular blocky structure; very firm; few fine roots; slickensides in lower part; neutral.

The solum thickness typically is about 60 inches but ranges from 30 to 60 inches.

The A horizon ranges from strongly acid to slightly acid. It has hue of 10YR, value of 2 or 3, and chroma of 2 or 3. The mollic epipedon extends into the upper B horizon. The B horizon has hue of 10YR or 7.5YR, value of 3 through 6, and chroma of 2 through 6. It is silty clay in the upper part and silty clay or clay in the lower part. The B horizon has common to many mottles of brown, yellowish brown, or reddish brown. The B and C horizons range from strongly acid to neutral.

Macksburg Series

The Macksburg series consists of deep, somewhat poorly drained, moderately slowly permeable soils on uplands. These soils formed in silty loess. The slope ranges from 2 to 5 percent.

Macksburg soils are similar to Higginsville soils and commonly are adjacent to Haig, Polo, and Sampsel soils. Haig soils have a fine-textured B horizon, are poorly drained, and are on slightly higher, broad ridgetops. Higginsville soils have less clay in the B horizon. The Polo soils are well drained, have redder colors in the B and C horizons, and are on lower positions. Sampsel soils contain more clay than Macksburg soils, have bright mottles in the lower part of the mollic epipedon, and are on lower seepy areas.

Typical pedon of Macksburg silt loam, 2 to 5 percent slopes, 1,000 feet north and 100 feet west of the southeast corner of sec. 21, T. 46 N., R. 33 W.

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

A—8 to 12 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; many roots; neutral; clear smooth boundary.

AB—12 to 19 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; weak fine subangular blocky structure; friable; many fine roots; slightly acid; clear smooth boundary.

Bt1—19 to 35 inches; dark grayish brown (10YR 4/2) silty clay loam; weak fine subangular blocky structure; firm; many fine roots; few fine faint very dark gray (10YR 3/1) and few fine prominent dark brown (7.5YR 4/4) mottles; few faint black (10YR 2/1) clay films; few fine dark concretions of iron and manganese oxides; medium acid; gradual smooth boundary.

Bt2—35 to 44 inches; grayish brown (2.5Y 5/2) silty clay loam; few coarse distinct yellowish brown (10YR 5/4) and few fine prominent brownish yellow (10YR 6/6) mottles; weak fine subangular blocky structure; firm; few distinct clay films; common fine dark (10YR 2/1) concretions of iron and manganese oxides; slightly acid; gradual smooth boundary.

BC—44 to 58 inches; grayish brown (2.5Y 5/2) silty clay loam; many prominent yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; firm; few fine roots; common dark concretions of iron and manganese oxides; slightly acid; gradual smooth boundary.

C—58 to 72 inches; grayish brown (10YR 5/2) silty clay loam; many fine prominent yellowish brown (10YR 5/6) mottles; weak coarse blocky structure; friable; few fine roots; common dark concretions of iron and manganese oxides; neutral; gradual smooth boundary.

The solum thickness typically is about 60 inches and ranges from 48 to 84 inches. Reaction is slightly acid or strongly acid in the A horizon unless the soil is limed, and it is medium acid or slightly acid in the B horizon. The mollic epipedon ranges from 16 to about 28 inches in thickness.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It typically is silt loam, but the range includes silty clay loam. The B horizon has hue of 10YR, value of 4 or 5, and chroma of 2 to 4. Mottles of higher value and chroma are common throughout the B horizon. The BC and C horizons are mottled and have hue of 10YR through 5Y, value of 4 to 6, and chroma of 2 to 4.

Mandeville Series

The Mandeville series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in silty residuum of shale. The slope ranges from 5 to 9 percent.

Mandeville soils are adjacent to Norris and Weller soils. Norris soils are shallow, do not have an argillic horizon, and are on steeper positions. Weller soils are deeper than Mandeville soils. They have a fine-textured B horizon and are on higher positions than Mandeville soils.

Typical pedon of Mandeville silt loam, 5 to 9 percent slopes, 60 feet south and 100 feet east of the northwest corner of sec. 36, T. 46 N., R. 30 W.

A—0 to 5 inches; dark brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; weak fine granular structure; very friable; many medium and fine roots; 10 percent fine shale fragments; medium acid; abrupt smooth boundary.

E—5 to 8 inches; brown (10YR 5/3) silt loam; weak fine granular structure; very friable; many medium and fine roots; few fine black concretions of iron and manganese oxides; 10 percent fine shale fragments; strongly acid; abrupt smooth boundary.

BE—8 to 12 inches; yellowish brown (10YR 5/4) silt loam; weak fine subangular blocky structure; very friable; many medium and fine roots; few fine black concretions of iron and manganese oxides; 10 percent fine shale fragments; very strongly acid; clear smooth boundary.

Bt1—12 to 17 inches; yellowish brown (10YR 5/4) silty clay loam; weak fine subangular blocky structure; friable; many medium and fine roots; few faint clay films on faces of peds and in root pores; few fine black concretions of iron and manganese oxides; 10 percent fine shale fragments; very strongly acid; clear smooth boundary.

Bt2—17 to 23 inches; yellowish brown (10YR 5/4) silty clay loam; few fine distinct brown (7.5YR 4/4) and prominent light brownish gray (2.5Y 6/2) mottles; weak fine subangular blocky structure; friable; many fine roots; few faint clay films on faces of peds; few fine black concretions of iron and manganese oxides; very strongly acid; abrupt smooth boundary.

Bt3—23 to 30 inches; mottled yellowish brown (10YR 5/4), brown (7.5YR 4/4), light brownish gray (2.5Y 6/2), and olive gray (5Y 5/2) shaly silty clay loam; massive; friable; common fine roots; few faint clay films on shale fragments and in root channels; 20 percent soft shale fragments; very strongly acid; abrupt smooth boundary.

Cr—30 to 37 inches; light olive brown (2.5Y 5/4), soft shale with thin beds of silty clay loam; slightly acid.

The solum thickness and depth to soft bedrock range from 20 to 40 inches.

The A horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. The E horizon has hue of 10YR, value of 5 or 6, and chroma of 3 or 4. The A and E horizons range from slightly acid to strongly acid. The B horizon has hue of 10YR or 7.5YR, value of 4 through 6, and chroma of 3 through 6. The clay content averages between 20 and 30 percent, and the content of fine sand and coarser averages less than 10 percent. Reaction ranges from very strongly acid through medium acid, and typically some part of this horizon is at least strongly acid.

The Cr horizon is weathered, soft, rippable, acid, micaceous shale. Some pedons have a silt loam C horizon that contains many shale fragments.

Moniteau Series

The Moniteau series consists of deep, poorly drained, slowly permeable soils on low stream terraces. These soils formed in silty alluvium. The slope ranges from 0 to 1 percent.

Moniteau soils commonly are adjacent to Blackoar and Kennebec soils. Blackoar and Kennebec soils both have less clay, have a mollic epipedon, and are on bottom lands.

Typical pedon of Moniteau silt loam, 1,750 feet east and 920 feet north of the center of sec. 16, T. 46 N., R. 31 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam, grayish brown (10YR 5/2) dry; weak thin platy structure; very friable; few roots; few fine dark concretions of iron and manganese oxides; slightly acid; abrupt smooth boundary.

E—8 to 14 inches; mixed grayish brown (10YR 5/2) and light gray (10YR 7/2) silt loam; weak thin platy structure; very friable; few fine roots; few fine dark concretions of iron and manganese oxides; slightly acid; clear smooth boundary.

Btg1—14 to 24 inches; dark grayish brown (10YR 4/2) silty clay loam; few fine faint brown (10YR 5/3) mottles; weak fine subangular blocky structure; friable; few roots; few faint clay films; light gray (10YR 7/1) silt coats; few fine dark concretions of iron and manganese oxides; very strongly acid; clear smooth boundary.

Btg2—24 to 46 inches; mottled dark grayish brown (10YR 4/2) and dark yellowish brown (10YR 4/4) silty clay loam; moderate fine subangular blocky structure; firm; few fine roots; few faint clay films on faces of peds; light gray (10YR 7/1) silt coats; few fine concretions of iron and manganese oxides; strongly acid; gradual smooth boundary.

Btg3—46 to 69 inches; dark grayish brown (10YR 4/2) silty clay loam; few fine faint gray (10YR 5/1) and brown (10YR 4/3) mottles; weak fine subangular blocky structure; firm; few root pores; few faint clay films on faces of peds; strongly acid.

The solum ranges from 36 to 70 or more inches in thickness.

The A or Ap horizon has hue of 10YR, value of 4 or 5, and chroma of 1 or 2. The E horizon has hue of 10YR, value of 5 through 7, and chroma of 1 or 2. It is slightly acid or medium acid. The B horizon has hue of 10YR through 5Y, value of 4 through 6, and chroma of 1 or 2. Mottles of higher chroma are present. The upper 20 inches of the argillic horizon averages between 30 and 35 percent clay, and the B horizon ranges from 5 to 15 percent sand throughout. Reaction ranges from medium acid to very strongly acid.

Norris Series

The Norris series consists of shallow, well drained, moderately permeable soils on uplands. These soils formed in residuum of acid micaceous shale. The slope ranges from 5 to 14 percent.

Norris soils commonly are adjacent to Mandeville and Snead soils. Mandeville soils are moderately deep, have an argillic horizon, and are on higher positions. Snead soils are moderately deep and have a thick mollic epipedon. They have a higher clay content and are higher on the landscape than Norris soils.

Typical pedon of Norris silty clay loam, 5 to 14 percent slopes, 1,800 feet east and 1,300 feet north of the southwest corner of sec. 8, T. 43 N., R. 32 W.

A—0 to 3 inches; dark grayish brown (10YR 4/2) silty clay loam; weak fine granular structure; friable; many fine roots; about 10 percent fine shale fragments; few fine chert fragments; strongly acid; clear smooth boundary.

AC—3 to 9 inches; mixed dark grayish brown (2.5Y 4/2) and dark brown (7.5YR 4/4) silty clay loam; moderate fine subangular blocky structure; friable; many fine roots; about 10 percent fine shale fragments; common worm casts; strongly acid; clear smooth boundary.

C—9 to 15 inches; mixed grayish brown (2.5Y 5/2) and light olive brown (2.5Y 5/6) shaly silty clay loam; weak medium blocky structure; firm; many fine roots; more than 35 percent shale fragments; many worm casts; strongly acid; clear smooth boundary.

Cr—15 to 26 inches; mixed gray (N 6/0), dark gray (N 4/0), and brownish yellow (10YR 6/8) weathered shale; can be dug with spade; few fine roots between shale layers; medium acid.

Thickness of the solum and depth to the soft shale bedrock range from 8 to 20 inches. The solum is strongly acid or very strongly acid throughout. The volume of rock fragments ranges from 10 to 35 percent throughout the profile.

The A horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 1 through 3. It typically is silty clay loam, but the range includes loam or silt loam and their shaly analogs. The AC horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 through 4. It is loam, silt loam, silty clay loam, and their shaly analogs.

Nowata Variant

The Nowata Variant consists of deep, well drained, moderately slowly permeable soils on uplands. These soils formed in cherty and clayey residuum underlain by limestone. The slope ranges from 5 to 9 percent.

Nowata Variant soils commonly are adjacent to Greenton and Polo soils. Greenton soils do not have chert fragments and are on ridgetops above and on side slopes below Nowata Variant soils. Polo soils have a redder B horizon and are on ridgetops above Nowata Variant soils.

Typical pedon of Nowata Variant silt loam, 5 to 9 percent slopes, on the section line, 1,000 feet north of the southwest corner of sec. 3, T. 45 N., R. 33 W.

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

A2—3 to 7 inches; very dark brown (10YR 2/2) silt loam, very dark grayish brown (10YR 3/2) dry; moderate very fine subangular blocky structure; friable; many coarse roots; 10 percent chert fragments that are 5 to 7 centimeters in diameter; neutral; clear smooth boundary.

BA—7 to 14 inches; very dark grayish brown (10YR 3/2) very cherty silty clay loam, dark grayish brown (10YR 4/2) dry; moderate very fine subangular blocky structure; friable; many coarse roots; 60 percent chert fragments that are 2 to 7 centimeters in diameter; slightly acid; clear irregular boundary.

Bt—14 to 23 inches; dark reddish brown (5YR 3/4) very cherty silty clay loam; moderate very fine subangular blocky structure; firm; many medium roots; 80 percent chert fragments that are 2 to 15 centimeters in diameter; few fine black concretions of iron and manganese oxides; few distinct clay films on faces of peds; medium acid; abrupt irregular boundary.

BC—23 to 27 inches; mixed yellowish brown (10YR 5/4), dark red (2.5YR 3/6), and reddish brown (5YR 4/4) clay; moderate fine angular blocky structure; very firm; common medium roots; some pressure faces and slickensides; common fine black concretions of iron and manganese oxides; medium acid; abrupt wavy boundary.

C1—27 to 34 inches; dark yellowish brown (10YR 4/4) clay; common fine prominent dark red (2.5YR 3/6) and reddish brown (5YR 4/4) mottles; moderate medium angular blocky structure; very firm; few fine roots; some pressure faces and slickensides; common fine black concretions of iron and manganese oxides; slightly acid; abrupt wavy boundary.

C2—34 to 49 inches; mixed strong brown (7.5YR 5/8), dark yellowish brown (10YR 4/6), and reddish brown (5YR 4/4) clay; weak fine angular blocky structure; very firm; pressure faces and slickensides; 45 percent soft, weathered limestone and some hard limestone fragments 26 centimeters in diameter; neutral; abrupt wavy boundary.

R—49 inches; hard limestone bedrock.

The solum thickness and depth to bedrock range from 40 to 60 inches. Reaction is neutral to medium acid throughout.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3, and chroma of 2 or 3. The content of gravel or chert fragments ranges from 0 to 10 percent. The B horizon has hue of 5YR through 10YR, value of 2 through 4, and chroma of 2 through 4. The B horizon has chert fragments up to 15 centimeters in size that range from 35 to 85 percent by volume. The content of chert fragments larger than 8 centimeters ranges from 0 to 50 percent.

Oska Series

The Oska series consists of moderately deep, well drained, slowly permeable soils on uplands. These soils formed in residuum derived from interbedded limestone and calcareous shale. The slope ranges from 5 to 9 percent.

Oska soils are similar to Polo soils and are commonly adjacent to Greenton, Polo, and Snead soils. Greenton soils are deep, do not have the reddish brown colors, and are on lower positions. Polo soils are deep and are on higher positions. Snead soils have very dark gray and olive colors throughout and generally are lower on the landscape than Oska soils.

Typical pedon of Oska silty clay loam, 5 to 9 percent slopes, 1,050 feet south and 950 feet west of the center of sec. 17, T. 46 N., R. 33 W.

A—0 to 10 inches; dark brown (7.5YR 3/2) silty clay loam, brown (10YR 4/3) dry; weak thin platy structure parting to weak fine granular; friable; many coarse roots; medium acid; gradual smooth boundary.

BA—10 to 18 inches; dark reddish brown (5YR 3/2) silty clay loam, brown (10YR 4/3) dry; weak fine subangular blocky structure; friable; many coarse roots; medium acid; gradual smooth boundary.

Bt1—18 to 24 inches; dark reddish brown (5YR 3/4) silty clay loam; moderate fine subangular blocky structure; firm; many coarse roots; dark reddish brown (5YR 3/2) ped exteriors; common distinct clay films; medium acid; gradual smooth boundary.

Bt2—24 to 36 inches; reddish brown (5YR 4/4) silty clay; moderate fine subangular blocky structure; firm; common distinct clay films; many coarse roots; limestone rock (10 percent 3 to 9 inches in diameter) fragments; dark reddish brown (5YR 3/2) ped exteriors; common black concretions of iron and manganese oxides; slightly acid; abrupt irregular boundary.

R—36 inches; hard fractured limestone rock.

The solum thickness typically is about 36 inches, but solum thickness and depth to bedrock range from 20 to 40 inches. The mollic epipedon is 9 to 20 inches thick and extends into the upper part of the B horizon. Reaction is medium acid or slightly acid in the A horizon and medium acid to neutral in the lower horizons.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3, and chroma of 2. It typically is silty clay loam, but the range includes silt loam. The B horizon has hue of 7.5YR or 5YR, value of 3 through 5, and chroma of 2 through 6. It is silty clay loam or clay and silty clay.

Polo Series

The Polo series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in loess and residuum derived from limestone and shale. The slope ranges from 2 to 9 percent.

Polo soils are similar to Oska and Sharpsburg soils, and they commonly are adjacent to Greenton, Oska, and Sharpsburg soils. Greenton soils have gray mottles in the upper part of the B horizon, are not reddish brown in the lower part of the B horizon, and are lower on the landscape. Oska soils have a lithic contact within 40 inches of the surface. Sharpsburg soils are not reddish brown in the lower part of the Bt horizon.

Typical pedon of Polo silt loam, 2 to 5 percent slopes, 975 feet north and 450 feet west of the center of sec. 17, T. 46 N., R. 33 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak thin platy structure parting to weak fine granular; very friable; common fine roots; slightly acid; abrupt smooth boundary.

A—9 to 14 inches; dark brown (7.5YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak fine granular; very friable; few fine roots; slightly acid; clear smooth boundary.

BA—14 to 22 inches; dark brown (7.5YR 3/2) silty clay loam; weak fine subangular blocky structure; friable; few fine roots; slightly acid; clear smooth boundary.

Bt1—22 to 29 inches; brown (7.5YR 4/4) silty clay loam; weak fine subangular blocky structure; friable; few fine roots; common distinct clay films; slightly acid; clear smooth boundary.

Bt2—29 to 35 inches; brown (7.5YR 4/4) silty clay loam; moderate medium subangular blocky structure; firm; few fine roots; many distinct clay films; strongly acid; gradual smooth boundary.

2Bt3—35 to 60 inches; reddish brown (5YR 4/4) silty clay loam; moderate medium prismatic structure parting to moderate medium subangular blocky; firm; few root pores; many distinct clay films; medium acid.

The solum thickness typically is more than 60 inches and ranges from 48 to 96 inches. The mollic epipedon extends into the B horizon and ranges from 20 to 30 inches in thickness.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3, and chroma of 2 or 3. It is silt loam or silty clay loam and is slightly acid or medium acid. The B horizon has hue of 7.5YR, value of 3 or 4, and chroma of 3 or 4. It is silty clay loam or silty clay and ranges from slightly acid to strongly acid. The 2Bt horizon has hue of 7.5YR or 5YR and value of 4 or 5. It is silty clay or silty clay loam and ranges from slightly acid to strongly acid.

Sampsel Series

The Sampsel series consists of deep, poorly drained, slowly permeable soils on uplands. These soils formed in shale residuum. The slope ranges from 2 to 9 percent.

Sampsel soils commonly are adjacent to Greenton, Macksburg, and Snead soils. Greenton soils do not have bright mottles in the lower part of the mollic epipedon and are on similar but less seepy areas. Macksburg soils do not have mottles in the lower part of the mollic epipedon and generally are higher on the landscape. Snead soils are moderately deep, do not have bright mottles in the lower part of the mollic epipedon, and are either above or below Sampsel soils on the landscape.

Typical pedon of Sampsel silty clay loam, 2 to 5 percent slopes, 1,260 feet west and 1,880 feet south of the northeast corner of sec. 1, T. 46 N., R. 33 W.

Ap—0 to 7 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; few fine roots; neutral; abrupt smooth boundary.

A—7 to 14 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; very friable; few fine roots; few fine black concretions of iron and manganese oxides; medium acid; gradual smooth boundary.

BA—14 to 19 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; many fine faint very dark gray (N 3/0) and distinct dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; friable; few fine roots; few fine black concretions of iron and manganese oxides; medium acid; gradual smooth boundary.

Btg1—19 to 25 inches; dark gray (10YR 4/1) silty clay loam; many fine distinct dark brown (10YR 4/3) and prominent dark brown (7.5YR 4/4) mottles; moderate fine subangular blocky structure; firm; few fine roots; few faint clay films; few fine black concretions of iron and manganese oxides; medium acid; gradual smooth boundary.

Btg2—25 to 42 inches; mottled dark grayish brown (2.5Y 4/2), dark gray (N 4/0), and dark brown (10YR 4/3) silty clay; weak fine subangular blocky structure; firm; few fine roots; few distinct clay films; few fine black concretions of iron and manganese oxides; slightly acid; gradual smooth boundary.

Btg3—42 to 60 inches; mottled grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/4-5/6) silty clay; weak fine blocky structure; firm; few distinct clay films; common fine black concretions of iron and manganese oxides; slightly acid.

The thickness of the solum ranges from 36 to 70 inches. Thickness of the mollic epipedon ranges from 10 to 20 inches.

The A and BA horizons have hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The A horizon typically is silty clay loam, but the range includes silt loam. The Bt horizon has hue of 10YR through 5Y, value of 4 and 5, and chroma of 1 or 2, except for higher chroma mottles. It is silty clay loam or silty clay averaging between 36 and 48 percent clay. The Bt horizon ranges from mildly alkaline to medium acid.

Sharpsburg Series

The Sharpsburg series consists of deep, moderately well drained, moderately permeable soils on uplands. These soils formed in loess. The slope ranges from 2 to 5 percent.

Sharpsburg soils are similar to Polo soils and commonly are adjacent to Macksburg and Polo soils. Macksburg soils are grayer throughout the profile and are on the wider ridgetops. Polo soils are redder in the lower part of the B horizon.

Typical pedon of Sharpsburg silty clay loam, 2 to 5 percent slopes, 1,320 feet north and 350 feet east of the center of sec. 3, T. 46 N., R. 30 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; many very fine roots; medium acid; abrupt smooth boundary.

A—9 to 12 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak fine granular; very friable; many fine roots; few very fine black concretions of iron and manganese oxides; medium acid; abrupt smooth boundary.

AB—12 to 16 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; many very fine roots; few worm casts; few very fine black concretions of iron and manganese oxides; medium acid; abrupt smooth boundary.

Bt1—16 to 21 inches; brown (10YR 4/3) silty clay loam, mixed grayish brown (10YR 5/2) and brown (10YR 5/3) dry; weak fine subangular blocky structure; firm; common very fine roots; few faint clay films; few fine black concretions of iron and manganese oxides; medium acid; clear smooth boundary.

Bt2—21 to 28 inches; dark yellowish brown (10YR 4/4) silty clay loam; weak fine subangular blocky structure; firm; common fine roots; few distinct clay films; few fine black concretions of iron and manganese oxides; strongly acid; clear smooth boundary.

Bt3—28 to 39 inches; dark yellowish brown (10YR 4/4) silty clay loam; common fine prominent grayish brown (10YR 5/2) mottles; moderate medium blocky structure; firm; common fine roots; common distinct clay films; few fine black concretions of iron and manganese oxides; strongly acid; clear smooth boundary.

Bt4—39 to 60 inches; dark yellowish brown (10YR 4/4) silty clay loam; common coarse prominent grayish brown (10YR 5/2) mottles; weak coarse blocky structure; firm; few fine roots; few distinct clay films; few fine black concretions of iron and manganese oxides; strongly acid.

The solum ranges from 42 to 72 inches in thickness.

The A horizon has hue of 10YR, value of 3, and chroma of 2 or 3. The B horizon has hue of 10YR, value of 4, and chroma of 3 or 4. Reaction is medium acid or strongly acid. The Bt horizon contains 36 to 42 percent clay. The C horizon is mottled and has hue of 10YR through 2.5Y, value of 4 to 6, and chroma of 2 to 4.

Snead Series

The Snead series consists of moderately deep, moderately well drained, slowly permeable soils on uplands. These soils formed in residuum derived from calcareous clayey shale thinly interbedded with limestone. The slope ranges from 5 to 30 percent.

Snead soils commonly are adjacent to Greenton, Oska, and Polo soils. Greenton soils are deep, have an argillic horizon, and generally are on similar but less sloping positions. Oska soils are redder, have an argillic horizon, and are above Snead soils on the landscape. Polo soils are deep and are redder than Snead soils. They have an argillic horizon and generally are above Snead soils on the landscape.

Typical pedon of Snead flaggy silty clay loam in an area of Snead-Rock outcrop complex, 14 to 30 percent slopes, 900 feet south and 300 feet west of the northeast corner of sec. 18, T. 46 N., R. 33 W.

A1—0 to 6 inches; very dark gray (10YR 3/1) flaggy silty clay loam, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; friable; common medium and fine roots; 10 to 15 percent limestone fragments; neutral; clear irregular boundary.

A2—6 to 11 inches; very dark grayish brown (10YR 3/2) flaggy silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; few fine roots; 10 to 15 percent limestone fragments; neutral; clear wavy boundary.

Bw1—11 to 14 inches; dark grayish brown (10YR 4/2) flaggy silty clay loam; moderate fine subangular blocky structure; firm; 10 percent limestone fragments; neutral; abrupt wavy boundary.

Bw2—14 to 19 inches; olive (5Y 4/3) silty clay; few medium faint pale olive (5Y 6/3) mottles; moderate fine subangular blocky structure; firm; few fine roots; few fine shale fragments; few fine black concretions of iron and manganese oxides; mildly alkaline; abrupt wavy boundary.

BC—19 to 25 inches; olive (5Y 5/3) silty clay; few fine prominent yellowish brown (10YR 5/6) mottles; weak very fine subangular blocky structure; firm; few fine shale chips; strong effervescence; mildly alkaline; abrupt smooth boundary.

Cr1—25 to 32 inches; light yellowish brown (2.5Y 6/4) soft fractured shale; few fine prominent gray (10YR 5/1) mottles; violent effervescence; moderately alkaline; abrupt smooth boundary.

Cr2—32 to 50 inches; light yellowish brown (2.5Y 6/4) shale; can be dug with spade; violent effervescence; moderately alkaline.

The thickness of the solum ranges from 15 to 40 inches, and depth to soft shale ranges from 20 to 40 inches. Reaction is neutral or slightly acid in the upper horizons and neutral to moderately alkaline in the lower horizons.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1 or 2. It typically is silty clay loam, but the range includes silt loam. The B horizon has hue of 10YR through 5Y, value of 4 or 5, and chroma of 2 through 6. The B horizon is silty clay or silty clay loam.

Summit Series

The Summit series consists of deep, moderately well drained, slowly permeable soils on uplands. These soils formed in residuum derived from calcareous clay or shale. The slope ranges from 2 to 9 percent.

Summit soils are similar to Kenoma soils and commonly are adjacent to Deepwater, Eram, and Kenoma soils. Deepwater soils have less clay throughout the solum and are on higher positions. Eram soils are moderately deep and generally are in more sloping areas. Kenoma soils have a silt loam surface layer. They have a thinner mollic epipedon than Summit soils and do not have a BA horizon.

Typical pedon of Summit silty clay loam, 2 to 5 percent slopes, 200 feet east and 2,600 feet south of the northwest corner of sec. 1, T. 44 N., R. 31 W.

Ap—0 to 3 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; firm; many fine roots; few fine black concretions of iron and manganese oxides; slightly acid; abrupt smooth boundary.

A—3 to 6 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; firm; many fine roots; few fine black concretions of iron and manganese oxides; neutral; clear smooth boundary.

BA—6 to 15 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; very firm; many fine roots; moderate fine black concretions of iron and manganese oxides; neutral; clear smooth boundary.

Bt1—15 to 20 inches; mottled very dark grayish brown (10YR 3/2) and dark yellowish brown (10YR 4/4) silty clay; moderate medium and fine subangular blocky structure; very firm; many fine roots; moderate fine black concretions of iron and manganese oxides; slickensides; neutral; clear smooth boundary.

Bt2—20 to 27 inches; mottled dark grayish brown (10YR 4/2), gray (10YR 5/1), and yellowish brown (10YR 5/6) silty clay; moderate medium subangular blocky structure; very firm; many fine roots; common fine black concretions of iron and manganese oxides; slickensides; very dark gray material on vertical faces of peds; neutral; gradual smooth boundary.

Bt3—27 to 36 inches; mottled grayish brown (10YR 5/2), brown (10YR 6/3), and yellowish brown (10YR 5/6) silty clay; weak medium subangular blocky structure; very firm; common fine roots; few distinct clay films; common fine black concretions of iron and manganese oxides; neutral; clear smooth boundary.

Bt4—36 to 42 inches; mottled pale brown (10YR 6/3) and yellowish brown (10YR 5/6) silty clay; weak medium subangular blocky structure; firm; common fine roots; few distinct clay films; common fine black concretions of iron and manganese oxides; neutral; clear smooth boundary.

Bt5—42 to 64 inches; mottled gray (10YR 5/1), brown (7.5YR 4/4), and yellowish brown (10YR 5/6) silty clay loam; weak coarse blocky structure; firm; few fine roots; some pressure faces and slickensides; neutral.

The solum thickness ranges from 50 to more than 60 inches.

The A horizon typically is neutral but ranges from neutral to medium acid. The A horizon has value of 2 or 3 and chroma of 1 or 2. The BA horizon has the same range in color and reaction as the A horizon, and it is silty clay loam, silty clay, or clay. The upper part of the Bt horizon has hue of 10YR or 2.5Y, value of 2 through 4, and chroma of 1 through 4 and is silty clay or clay. The lower part of the Bt horizon is mottled with a wide range in colors. The reaction ranges from slightly acid through moderately alkaline.

Verdigris Series

The Verdigris series consists of deep, moderately well drained, moderately permeable soils on flood plains. These soils formed in silty alluvium. The slope ranges from 0 to 3 percent.

Verdigris soils commonly are adjacent to Blackoar and Zook soils. Blackoar soils are poorly drained, have a dark gray matrix below the A horizon, and are farther from the stream channel. Zook soils are poorly drained, have a higher clay content, and are on slightly lower positions farther from the stream.

Typical pedon of Verdigris silt loam, 2,440 feet west and 960 feet north of the center of sec. 15, T. 46 N., R. 31 W.

Ap—0 to 13 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; many fine roots; neutral; abrupt smooth boundary.

A1—13 to 19 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; friable; many fine roots; neutral; clear smooth boundary.

A2—19 to 37 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; many fine roots; few worm casts; neutral; gradual smooth boundary.

AC—37 to 49 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; very weak fine subangular blocky structure; friable; few fine roots; slightly acid; clear smooth boundary.

C—49 to 61 inches; dark brown (10YR 3/3) clay loam, brown (10YR 5/3) dry; massive; friable; few fine roots; few gravels (2 to 10 millimeters in size); slightly acid.

The solum and mollic epipedon are more than 36 inches thick. The A and C horizons typically average between 24 and 30 percent clay, but below a depth of 40 inches, the amount is variable. Reaction typically is slightly acid or neutral but ranges to medium acid in the upper part of the A horizon.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The C horizon has hue of 10YR or 2.5Y, value of 3, and chroma of 1 through 3.

Weller Series

The Weller series consists of deep, moderately well drained, slowly permeable soils on upland ridgetops. These soils formed in loess. The slope ranges from 2 to 9 percent.

Weller soils are similar to Freeburg soils and commonly are adjacent to Macksburg, Mandeville, and Sharpsburg soils. Freeburg soils contain less clay. Macksburg soils have a mollic epipedon, contain less clay than Weller soils, and are on wide ridgetops. Mandeville soils are moderately deep and are on lower positions. Sharpsburg soils have a mollic epipedon and are on similar positions.

Typical pedon of Weller silt loam, 2 to 5 percent slopes, 720 feet east and 400 feet south of the northwest corner of sec. 33, T. 46 N., R. 29 W.

A—0 to 7 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; weak fine granular structure; very friable; common fine roots; few fine black concretions of iron and manganese oxides; strongly acid; clear smooth boundary.

E—7 to 11 inches; brown (10YR 5/3) silt loam, very pale brown (10YR 7/3) dry; weak fine granular structure; very friable; common fine roots; few fine black concretions of iron and manganese oxides; very strongly acid; clear smooth boundary.

BE—11 to 14 inches; dark yellowish brown (10YR 4/4) silty clay loam; common distinct light gray (10YR 7/1) silt coatings on faces of peds; weak fine subangular blocky structure; friable; few fine roots; few fine black concretions of iron and manganese oxides; strongly acid; clear smooth boundary.

Bt1—14 to 24 inches; dark yellowish brown (10YR 4/4) silty clay; few fine distinct light brownish gray (10YR 5/2) mottles; weak fine subangular blocky structure; firm; few fine roots; few faint clay films; few fine black concretions of iron and manganese oxides; strongly acid; clear smooth boundary.

Bt2—24 to 43 inches; mottled dark yellowish brown (10YR 4/4), light brownish gray (10YR 6/2), and brown (7.5YR 4/4) silty clay loam; weak medium subangular blocky structure; friable; very few fine roots; few distinct clay films; few fine black concretions of iron and manganese oxides; medium acid; clear smooth boundary.

Bt3—43 to 62 inches; mottled light brownish gray (10YR 6/2), dark yellowish brown (10YR 4/4), and brown (7.5YR 4/4) silty clay loam; weak coarse blocky structure; friable; few fine roots; few distinct clay films; common fine black concretions of iron and manganese oxides; neutral.

The solum thickness typically is greater than 60 inches. Reaction is strongly acid or very strongly acid in the most acid part. The A or Ap horizon has hue of 10YR, value of 4 or 5, and chroma of 1 through 3. It typically is silt loam, but the range includes silty clay loam. The E horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. The B horizon has hue of 10YR, value of 4 or 5, and chroma of 4 to 6. The clay maximum of the Bt horizon is 42 to 48 percent. The clay content gradually decreases with depth throughout the B horizon.

Zook Series

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

Zook soils are similar to Bremer soils and commonly are adjacent to Blackoar and Verdigris soils. Blackoar soils are fine-silty, are not as dark throughout, and are on similar positions. Bremer soils contain less clay in the B horizon and have a thinner mollic epipedon. Verdigris soils are moderately well drained, contain less clay, and are nearer the streams.

Typical pedon of Zook silty clay loam, 1,260 feet north and 100 feet west of the southeast corner of sec. 33, T. 46 N., R. 30 W.

Ap—0 to 5 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; many fine roots; few fine black concretions of iron and manganese oxides; slightly acid; abrupt smooth boundary.

A1—5 to 11 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; firm; many fine roots; few fine black concretions of iron and manganese oxides; slightly acid; abrupt smooth boundary.

A2—11 to 20 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; firm; common fine roots; few fine black concretions of iron and manganese oxides; medium acid; abrupt smooth boundary.

AB—20 to 32 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; moderate fine prismatic structure parting to weak fine subangular blocky; firm; few fine roots; few fine black concretions of iron and manganese oxides; medium acid; gradual smooth boundary.

Bg—32 to 52 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; moderate fine prismatic structure parting to moderate fine subangular blocky; firm; few fine roots; few medium black concretions of iron and manganese oxides; medium acid; gradual smooth boundary.

Cg—52 to 72 inches; very dark gray (10YR 3/1) silty clay loam; few fine distinct dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; firm; very few fine roots; few black concretions of iron and manganese oxides; medium acid.

The solum thickness typically is greater than 40 inches but ranges from 36 to 64 inches. Reaction typically is medium acid or slightly acid but ranges to mildly alkaline. The solum, below a depth of 16 inches, ranges from 36 to 45 percent clay to a depth of 4 feet or more.

The A horizon has hue of 2.5Y or 10YR, value of 2 or 3, and chroma of 0 or 1. Texture is silty clay loam or silty clay ranging from 32 to 44 percent clay. The B and C horizons have hue of 10YR through 5Y, value of 3 to 5, and chroma of 1.

Factors of Soil Formation

Soil is produced by soil-forming processes acting on material deposited or accumulated by geologic agencies. The characteristics of the soil at any given point depend on (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil formation have acted on the soil material (*14*).

Climate and plant and animal life are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that is formed and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil that has distinct horizons. Although it varies in length, time is always required for differentiation of soil horizons. Generally a long time is required 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. Many of the processes of soil formation are unknown.

Parent Material

Parent material is the unconsolidated mass from which a soil formed. It determines the limits of the chemical and mineral composition of the soil. In Cass County three kinds of parent material, alone or in combinations of two or more, have contributed to the formation of soils. These are residual material from bedrock; loess, or wind-deposited, material; and alluvial, or water-deposited, material.

Residual material weathered from limestone, sandstone, and shale to form the parent material of such soils as Barco, Mandeville, Norris, and Snead soils.

Loess parent material, principally made up of silt, was transported into Cass County by wind. The Haig, Higginsville, and Macksburg soils formed in this material.

Alluvial parent material in Cass County is of local origin. It is made up of silt, sand, clay, and gravel and is transported by water from the uplands to the flood plains of streams. Soils such as Blackoar, Verdigris, and Zook soils formed in alluvium deposited by Big Creek and South Grand River and other tributary streams.

Climate

Climate, both long ago and recently, has been an important factor in the formation of soils in Cass County. As a result of the climate of long ago, soil-forming materials were deposited in the county by wind and water. The more recent climate has affected, either directly or indirectly, the development of soils that formed from these and other materials. Geologic erosion, plant and animal life, and in more recent time, accelerated erosion have varied with the climate, and changes have influenced soil development.

Climate largely determines the rate of weathering of soils, and it also influences the type of vegetation that grows on soils. Cass County has a temperate, humid, continental climate. The average precipitation is about 37 inches (*6*), and the frost-free season averages 166 days (*5*). The prevailing winds are from the south or southwest. These winds are generally warm and moist, but in most years, between mid-July and September, they are hot and dry and rainfall is limited. Short periods of excessive rainfall are common in spring, fall, or both. The soils are frozen for short periods in winter, and soil formation processes are slowed. In most places the average annual temperature of the soil at a depth of 20 inches is about 59 degrees F.

The humid climate of Cass County is conducive to the relatively rapid breakdown of minerals for the formation of clay and the translocation of those materials downward in the soil profile. The subsoil of the Haig and Kenoma soils is high in clay content. These soils, therefore, have very slow to slow permeability in the subsoil, which causes excess wetness during seasons of highest rainfall. Conversely, the low available water capacity of their subsoil causes droughtiness during hot summer months when rainfall is low.

Plants and Animals

Plants, burrowing animals, insects, bacteria, and fungi are important in the formation of soils. They affect the organic matter content, plant nutrients, structure, and porosity of soils.

Many of the soils in Cass County formed when the vegetation was mainly tall prairie grasses. These soils, generally known as "prairie soils," have a thick, dark surface layer that is high in organic matter because of abundant bacteria and decay of the fine grass roots. Soils that formed under this plant cover are in the Barco, Bremer, Deepwater, Greenton, Haig, Kenoma, Macksburg, Polo, Sampsel, and Sharpsburg series.

Deciduous forests and their associated plant and animal life formed soils that have a light colored surface layer and low organic matter content. Only about 8 percent of Cass County formed under forest vegetation alone; however, a large acreage of the soils formed under prairie vegetation and then under forest vegetation. Such soils have a surface layer that is lighter than prairie soils and somewhat darker than forest soils. Soils that formed under forest vegetation in Cass County are in the Freeburg, Mandeville, Moniteau, Norris, and Weller series.

Micro-organisms reduce organic matter to humus. The release of plant nutrients and the fixation of atmospheric nitrogen by nodule bacteria are examples of the contributions that micro-organisms make to soil formation and plant growth. Earthworms, insects, and burrowing animals also have a favorable effect on tilth, fertility, and drainage.

Man also has had an influence on soil formation. Soil in many places has been tilled and used for intensive cropping. Grain and forage residue has been removed from the soil and used as feed and forage. Chemical sprays are often used to reduce the growth of some residue-producing plants and to help control insects and pests. These practices tend to leave the soil surface bare of protective cover and permit erosion of the surface layer. A significant acreage of the soils in Cass County has been eroded.

Relief

Relief, or topography, affects soil formation through its influence on drainage, runoff, infiltration, and other related factors, including accelerated erosion. In areas that have about the same plant cover and rainfall, runoff is rapid on steep slopes and is slower or absent in nearly level areas. In areas where most of the water runs off, little water enters the soil and it forms slowly. In these areas, soil horizons are indistinct and the solum is thin. The Snead soil is an example. In areas where little water runs off, or where it runs off slowly, more water enters the soil and soil formation is rapid. In these areas, soil horizons are distinct and the solum is thick. An example is the Haig soil.

Time

The degree of profile development is reflected by the length of time that the parent material has been in place and subject to weathering. Young soils show little profile development or horizon differentiation. Mature soils show the effects of clay movement and leaching, and they have clearly distinct horizons.

Verdigris soils are among the youngest soils in the county. The material in which these soils formed washed from nearby uplands and was deposited by the local streams. In places of extreme erosion and deposition, 30 to 40 inches or more of this material probably was deposited in as little as one year. Horizons within the Verdigris soils are not distinct. The upper 13 inches of these soils is only slightly different from the rest of the profile. The difference is most likely a result of tillage and the incorporation of residue in the upper 13 inches in relatively recent years.

Examples of old or mature soils in the county are the Haig and Kenoma soils. These soils have a well developed subsoil that is high in clay content and strikingly different from the adjacent upper and lower layers. The soils developed in areas of subnormal relief. Runoff was slow, and the soils remained wet during most of the year. Erosion on areas under native grasses was negligible. Water that did not evaporate or run off moved downward through the soils.

The subnormal relief and excess water hastened the process of soil formation, and in time the clay particles moved from the surface layer down into the lower layers. This translocation of clay resulted in the accumulation of dark clay immediately below a severely leached, silty subsurface layer. Relief, and its influence on local climate, was a very significant factor in the formation and development of these soils. The length of time required for the development of mature soils was considerably shortened.

The Barco, Deepwater, and Norris soils have been in place as long as Haig and Kenoma soils and have had equal time to develop. These soils, however, have thin or weak horizon development. Differences in parent material, animal life, and relief have apparently been the dominant factors in development. A much longer time is required for these soils to develop to maturity.

Other soils in the county range in profile development from fairly youthful to fairly old. An example of an older soil is the Haig soils, which have developed a fairly fine textured subsoil. A fairly youthful profile is represented by the Mandeville soils, which have a relatively thin, medium-textured subsoil. In both of these soils, the particular stage of profile development is an expression of the interrelationship of the various factors of soil formation.

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, pt. 19, 464 pp., illus.

(3) Austin, Morris E. 1965. Land resource regions and major land resource areas of the United States. U.S. Dep. Agric. Handb. 296, 82 pp., map.

(4) Bureau of Outdoor Recreation. 1974. NACD nationwide outdoor recreation inventory.

(5) Decker, Wayne L. 1955. Late spring and early killing freezes in Missouri. Mo. Agric. Exp. Stn. Bull. 649, 15 pp., illus.

(6) Missouri Agricultural Experiment Station. [n.d.] Monthly precipitation in Missouri. Climatic atlas of Missouri No. 1. Mo. Agric. Exp. Stn. Bull. 630, 68 pp., illus.

(7) Missouri Conservation Needs Inventory Committee. 1970. Missouri soil and water conservation needs inventory. 196 pp.

(8) Missouri Department of Natural Resources, Division of Parks and Recreation. 1976. Missouri statewide comprehensive outdoor recreation plan (SCORP).

(9) Missouri Division of Geological Survey and Water Resources. 1963. Water quality map and ground water areas of Missouri.

(10) Nagel, Werner O. 1970. Conservation contrasts. Mo. Dep. Conserv., 453 pp., illus.

(11) Raymore Missouri Centennial Committee. 1972. Raymore Missouri Centennial 1872-1972. The Printery, Clinton, Mo., 200 pp.

(12) St. Joseph Missouri National Historical Company. 1883. History of Cass and Bates Counties, Missouri, 1,415 pp.

(13) State Interagency Council for Outdoor Recreation. 1980. Missouri statewide comprehensive outdoor recreation plan (SCORP).

(14) United States Department of Agriculture. 1914. Soil survey of Cass County, Missouri. Bur. Soils, 28 pp., illus.

(15) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus. [Supplements replacing pp. 173-188 issued May 1962.]

(16) United States Department of Agriculture. 1961. Land capability classification. U.S. Dep. Agric. Handb. 210, 21 pp.

(17) 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.

(18) United States Department of Commerce. 1974. Census of agriculture, preliminary report, Cass County, Missouri. Soc. and Econ. Statis. Admin., Bur. Census.

Glossary

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

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

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

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.

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.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

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 fragment.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard compacted layers to a depth below normal plow depth.

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.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

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.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazingland for a prescribed period.

Dense layer (in tables). A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

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

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

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Edge habitat. The zone of transition from one type of plant cover to another.

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 alkali (in tables). Excess exchangeable sodium in the soil. The resulting poor physical properties restrict the growth of plants.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

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

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

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

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.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

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 upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual.* The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

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, a plowed surface horizon, most of which was originally part of a B horizon.

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) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

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 A or B 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, the Arabic numeral 2 precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock 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.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

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.

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

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

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

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

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

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

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

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

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.

Narrow-base terrace. A terrace no more than 4 to 8 feet wide at the base. A narrow-base terrace is similar to a broad-base terrace, except for the width of the ridge and channel.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

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.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

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

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

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

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.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

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

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

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 underlying material. 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.

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.

Slippage (in tables). Soil mass susceptible to movement downslope when loaded, excavated, or wet.

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.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in 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.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

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, EB) below the surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

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.

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.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

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.

Unstable fill (in tables). Risk of caving or sloughing on banks of fill material.

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

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-79 at Harrisonville, Missouri]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days[1]	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	38.4	18.0	28.2	67	-9	12	1.33	.34	2.11	3	5.7
February---	44.5	23.4	34.0	73	-3	19	1.28	.43	1.97	3	4.3
March------	55.2	32.0	43.6	83	7	70	2.76	1.27	4.03	6	3.0
April------	68.1	44.7	56.4	87	23	219	3.84	1.95	5.47	7	.4
May--------	77.1	54.3	65.7	91	34	487	4.40	2.92	5.74	8	.0
June-------	85.0	63.0	74.0	98	47	720	4.72	1.68	7.23	7	.0
July-------	90.5	67.4	79.0	103	53	899	3.66	1.19	5.68	6	.0
August-----	89.3	65.3	77.3	101	51	846	3.51	1.17	5.43	6	.0
September--	82.2	57.7	70.0	99	38	600	4.49	1.64	6.85	5	.0
October----	71.1	46.5	58.8	91	26	301	3.40	.90	5.40	5	.0
November---	55.6	33.7	44.7	78	10	52	2.03	.42	3.29	4	.7
December---	43.5	24.1	33.8	69	-5	9	1.39	.49	2.12	3	3.3
Yearly:											
Average--	66.7	44.2	55.5	---	---	---	---	---	---	---	---
Extreme--	---	---	---	103	-11	---	---	---	---	---	---
Total----	---	---	---	---	---	4,234	36.81	29.36	44.63	63	17.4

[1] A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1951-79 at Harrisonville, Missouri]

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 12	April 23	April 26
2 years in 10 later than--	April 6	April 18	April 22
5 years in 10 later than--	March 26	April 8	April 15
First freezing temperature in fall:			
1 year in 10 earlier than--	October 26	October 20	October 11
2 years in 10 earlier than--	October 31	October 24	October 15
5 years in 10 earlier than--	November 9	November 3	October 24

TABLE 3.--GROWING SEASON

[Recorded in the period 1951-79 at Harrisonville, Missouri]

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	202	185	175
8 years in 10	211	193	180
5 years in 10	228	208	191
2 years in 10	244	222	202
1 year in 10	253	230	208

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

Map symbol	Soil name	Acres	Percent
2C	Higginsville silt loam, 5 to 9 percent slopes	550	0.1
5B	Macksburg silt loam, 2 to 5 percent slopes	36,500	8.0
6B	Sharpsburg silty clay loam, 2 to 5 percent slopes	6,600	1.5
7B	Deepwater silt loam, 2 to 5 percent slopes	14,100	3.2
7C	Deepwater silt loam, 5 to 9 percent slopes	16,800	3.7
8	Pits, quarries	790	0.2
9D	Snead silty clay loam, 5 to 14 percent slopes	15,400	3.4
10D	Snead-Rock outcrop complex, 5 to 14 percent slopes	19,300	4.3
10F	Snead-Rock outcrop complex, 14 to 30 percent slopes	2,650	0.6
11C	Greenton silty clay loam, 5 to 9 percent slopes	26,100	5.8
13B	Sampsel silty clay loam, 2 to 5 percent slopes	22,070	4.9
13C	Sampsel silty clay loam, 5 to 9 percent slopes	7,600	1.7
14B	Barco loam, 2 to 5 percent slopes	3,550	0.8
17B	Polo silt loam, 2 to 5 percent slopes	11,700	2.6
17C	Polo silt loam, 5 to 9 percent slopes	3,100	0.7
18B	Summit silty clay loam, 2 to 5 percent slopes	8,500	1.9
18C	Summit silty clay loam, 5 to 9 percent slopes	13,800	3.1
19B	Weller silt loam, 2 to 5 percent slopes	5,600	1.3
19C2	Weller silt loam, 5 to 9 percent slopes, eroded	15,700	3.5
22C	Oska silty clay loam, 5 to 9 percent slopes	18,100	4.1
28D	Coweta loam, 5 to 14 percent slopes	3,650	0.8
29D	Norris silty clay loam, 5 to 14 percent slopes	1,950	0.4
32	Freeburg silt loam	3,250	0.7
33	Zook silty clay loam	11,600	2.6
34	Blackoar silt loam	17,500	3.9
36	Bremer silty clay loam	7,100	1.6
37	Moniteau silt loam	3,600	0.8
40	Haig silt loam	30,500	6.8
47C	Mandeville silt loam, 5 to 9 percent slopes	4,300	1.0
49D	Eram silty clay loam, 5 to 14 percent slopes	7,500	1.7
51B	Kenoma silt loam, 1 to 4 percent slopes	37,000	8.2
51C	Kenoma silt loam, 4 to 7 percent slopes	42,050	9.3
52C	Nowata Variant silt loam, 5 to 9 percent slopes	1,050	0.2
62B	Macksburg-Urban land complex, 2 to 5 percent slopes	588	0.1
93	Verdigris silt loam	26,600	5.9
	Water less than 40 acres in size	1,700	0.4
	Total land area	448,448	99.8
	Water more than 40 acres in size	1,050	0.2
	Total area	449,498	100.0

TABLE 5.--PRIME FARMLAND

[Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name]

Map symbol	Soil name
5B	Macksburg silt loam, 2 to 5 percent slopes
6B	Sharpsburg silty clay loam, 2 to 5 percent slopes
7B	Deepwater silt loam, 2 to 5 percent slopes
13B	Sampsel silty clay loam, 2 to 5 percent slopes (where drained)
14B	Barco loam, 2 to 5 percent slopes
17B	Polo silt loam, 2 to 5 percent slopes
18B	Summit silty clay loam, 2 to 5 percent slopes
19B	Weller silt loam, 2 to 5 percent slopes
32	Freeburg silt loam
33	Zook silty clay loam (where drained)
34	Blackoar silt loam (where drained)
36	Bremer silty clay loam (where drained)
37	Moniteau silt loam (where drained)
40	Haig silt loam (where drained)
51B	Kenoma silt loam, 1 to 4 percent slopes
93	Verdigris silt loam

TABLE 6.--LAND CAPABILITY SUBCLASS 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	Capability subclass	Corn	Soybeans	Grain sorghum	Winter wheat	Grass-legume hay	Tall fescue
		Bu	Bu	Bu	Bu	Ton	AUM*
2C--------------- Higginsville	IIIe	108	41	94	45	4.8	9.2
5B--------------- Macksburg	IIe	110	44	96	46	4.9	7.6
6B--------------- Sharpsburg	IIe	101	43	88	42	4.7	9.0
7B--------------- Deepwater	IIe	85	45	88	40	4.0	9.0
7C--------------- Deepwater	IIIe	75	40	77	35	4.0	8.0
8. Pits							
9D--------------- Snead	IVe	---	---	---	25	2.7	4.2
10D-------------- Snead-Rock outcrop	VIs	---	---	---	---	1.5	3.0
10F-------------- Snead-Rock outcrop	VIIs	---	---	---	---	1.0	2.0
11C-------------- Greenton	IIIe	77	28	65	31	3.4	6.8
13B-------------- Sampsel	IIe	86	33	74	35	3.3	6.6
13C-------------- Sampsel	IIIe	79	30	66	30	3.0	5.0
14B-------------- Barco	IIe	72	31	61	35	3.3	6.6
17B-------------- Polo	IIe	96	36	83	40	4.3	8.6
17C-------------- Polo	IIIe	90	34	75	36	4.0	8.0
18B-------------- Summit	IIe	60	35	65	40	4.0	7.5
18C-------------- Summit	IIIe	55	30	60	35	3.7	7.0
19B-------------- Weller	IIIe	95	36	70	35	4.0	7.4
19C2------------- Weller	IIIe	85	32	50	24	3.2	5.0
22C-------------- Oska	IIIe	60	32	70	34	3.0	5.0
28D-------------- Coweta	VIe	---	---	---	---	---	3.5

See footnote at end of table.

TABLE 6.--LAND CAPABILITY SUBCLASS AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Capability subclass	Corn	Soybeans	Grain sorghum	Winter wheat	Grass-legume hay	Tall fescue
		Bu	Bu	Bu	Bu	Ton	AUM*
29D------------- Norris	VIe	---	---	---	---	1.3	3.0
32-------------- Freeburg	IIw	92	35	80	38	4.0	8.0
33-------------- Zook	IIw	96	36	83	32	4.0	6.6
34-------------- Blackoar	IIw	100	37	85	42	4.4	9.0
36-------------- Bremer	IIw	106	40	83	40	4.5	8.6
37-------------- Moniteau	IIIw	84	31	72	35	3.7	6.6
40-------------- Haig	IIw	105	40	83	40	4.2	8.6
47C------------- Mandeville	IIIe	60	21	55	30	2.7	5.2
49D------------- Eram	VIe	---	---	---	---	3.0	4.5
51B------------- Kenoma	IIe	75	28	70	35	3.2	5.0
51C------------- Kenoma	IIIe	65	23	62	30	2.9	4.0
52C------------- Nowata Variant	IVe	---	20	35	25	2.5	4.0
62B------------- Macksburg-Urban land	---	---	---	---	---	---	---
93-------------- Verdigris	IIw	100	35	75	42	2.5	6.5

* 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.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Equipment limitation	Seedling mortality	Plant competition	Potential productivity: Common trees	Site index	Trees to plant
2C: Higginsville	---	---	---	---	---	---	---	Pecan, eastern cottonwood, pin oak, silver maple, American sycamore, green ash.
5B: Macksburg	---	---	---	---	---	---	---	Pin oak, eastern cottonwood, European alder.
6B: Sharpsburg	---	---	---	---	---	---	---	Black walnut, green ash, white oak, northern red oak.
7B, 7C: Deepwater	---	---	---	---	---	---	---	Pin oak, pecan.
8*. Pits								
9D: Snead	4c	Slight	Slight	Severe	Slight	Northern red oak White oak White ash Sugar maple	62 55 56 ---	Silver maple, eastern cottonwood, eastern redcedar, white ash, northern red oak.
10D*: Snead	4x	Slight	Moderate	Severe	Slight	Northern red oak White ash White oak Post oak	62 56 55 ---	White ash, northern red oak.
Rock outcrop.								
10F*: Snead	4x	Moderate	Severe	Severe	Slight	Northern red oak White ash White oak Post oak	62 56 --- ---	White ash, northern red oak.
Rock outcrop.								
11C: Greenton	---	---	---	---	---	---	---	White ash, black oak, white oak, black walnut, sugar maple.
13B, 13C: Sampsel	---	---	---	---	---	---	---	Green ash, pin oak, sweetgum, eastern cottonwood, pecan.
14B: Barco	---	---	---	---	---	---	---	White oak, black walnut, eastern white pine.
17B, 17C: Polo	---	---	---	---	---	---	---	Black walnut, pin oak, white oak, green ash, eastern cottonwood, black cherry.
18B, 18C: Summit	---	---	---	---	---	---	---	Green ash, pin oak, eastern white pine.
19B, 19C2: Weller	4c	Slight	Slight	Severe	Slight	White oak Northern red oak Black oak	55 --- ---	Eastern white pine, northern red oak, white oak.
22C: Oska	---	---	---	---	---	---	---	Pin oak, green ash, sugar maple.
28D: Coweta	---	---	---	---	---	---	---	Eastern white pine, white ash.

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Equipment limitation	Seedling mortality	Plant competition	Potential productivity: Common trees	Site index	Trees to plant
29D Norris	5d	Moderate	Slight	Moderate	Slight	White oak Black oak Northern red oak	49 --- ---	Shortleaf pine, white oak, eastern white pine.
32 Freeburg	3o	Slight	Slight	Slight	Slight	White oak	65	White oak, pin oak, green ash, eastern cottonwood, black oak, pecan.
33 Zook	---	---	---	---	---	---	---	Green ash, silver maple, pin oak.
34 Blackoar	3w	Slight	Severe	Moderate	Severe	Pin oak Eastern cottonwood Green ash	80 95 ---	Pin oak, eastern cottonwood, pecan, green ash.
36 Bremer	3w	Slight	Severe	Moderate	Severe	Eastern cottonwood Silver maple	90 80	American sycamore, hackberry, green ash, eastern cottonwood, silver maple.
37 Moniteau	4w	Slight	Severe	Moderate	Severe	White oak Pin oak	55 70	White oak, pin oak, green ash, eastern cottonwood, silver maple, black willow.
40 Haig	---	---	---	---	---	---	---	Pin oak, pecan, green ash, eastern cottonwood.
47C Mandeville	4o	Slight	Slight	Slight	Slight	White oak Black walnut Black oak Shagbark hickory White ash	60 --- --- --- ---	White oak, black oak, green ash.
49D Eram	---	---	---	---	---	---	---	Pin oak, pecan.
51B, 51C Kenoma	---	---	---	---	---	---	---	Black walnut, green ash.
52C Nowata Variant	---	---	---	---	---	---	---	Eastern redcedar, white ash.
62B*: Macksburg.								
Urban land.								
93 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, silver maple.

* 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 there are no recommended species for that height group]

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
2C------------------ Higginsville	Lilac-------------	Amur honeysuckle, autumn-olive, Manchurian crabapple, Siberian peashrub.	Eastern redcedar, Russian-olive, jack pine, hackberry, green ash, Austrian pine.	Honeylocust-------	---
5B------------------ Macksburg	Lilac-------------	Amur honeysuckle, autumn-olive, Manchurian crabapple, Siberian peashrub.	Eastern redcedar, Russian-olive, jack pine, hackberry, green ash, Austrian pine.	Honeylocust-------	---
6B------------------ Sharpsburg	---	Amur maple, Amur honeysuckle, lilac, autumn-olive.	Green ash, hackberry, bur oak, eastern redcedar, Russian-olive.	Austrian pine, eastern white pine, honeylocust.	---
7B, 7C-------------- Deepwater	---	Amur honeysuckle, autumn-olive, Amur maple, lilac.	Hackberry, Russian-olive, eastern redcedar.	Norway spruce, pin oak, honeylocust, green ash, eastern white pine.	---
8*. Pits					
9D------------------ Snead	Lilac, Amur honeysuckle, fragrant sumac.	Autumn-olive------	Eastern redcedar, green ash, hackberry, Austrian pine, Russian-olive, bur oak.	Honeylocust, Siberian elm.	---
10D*, 10F*:					
Snead---------------	Lilac, Amur honeysuckle, fragrant sumac.	Autumn-olive------	Eastern redcedar, green ash, hackberry, Austrian pine, Russian-olive, bur oak.	Honeylocust, Siberian elm.	---
Rock outcrop.					
11C----------------- Greenton	Lilac-------------	Amur honeysuckle, autumn-olive, Manchurian crabapple, Siberian peashrub.	Eastern redcedar, Austrian pine, hackberry, green ash, jack pine, Russian-olive.	Honeylocust-------	---
13B, 13C------------ Sampsel	Lilac-------------	Amur honeysuckle, autumn-olive, Manchurian crabapple, Siberian peashrub.	Eastern redcedar, Austrian pine, hackberry, green ash, jack pine, Russian-olive.	Honeylocust-------	---
14B----------------- Barco	Amur honeysuckle, lilac, fragrant sumac.	Autumn-olive------	Green ash, eastern redcedar, bur oak, Russian-olive, Austrian pine, hackberry.	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
17B, 17C---------- Polo	---	Amur honeysuckle, autumn-olive, Amur maple, lilac.	Hackberry, green ash, bur oak, Russian-olive, eastern redcedar.	Austrian pine, honeylocust, eastern white pine.	---
18B, 18C---------- Summit	Lilac-------------	Autumn-olive, Amur maple, Amur honeysuckle, Manchurian crabapple.	Eastern redcedar, jack pine, hackberry, green ash, Russian-olive, Austrian pine.	Honeylocust-------	---
19B, 19C2--------- Weller	Lilac-------------	Manchurian crabapple, Amur honeysuckle, Siberian peashrub, autumn-olive.	Eastern redcedar, Austrian pine, hackberry, green ash, jack pine, Russian-olive.	Honeylocust-------	---
22C--------------- Oska	Lilac, Amur honey-suckle, fragrant sumac.	Autumn-olive------	Green ash, hackberry, Austrian pine, eastern redcedar, Russian-olive, bur oak.	Honeylocust, Siberian elm.	---
28D. Coweta					
29D. Norris					
32---------------- Freeburg	---	Amur maple, Amur honeysuckle, autumn-olive, lilac.	Eastern redcedar	Hackberry, pin oak, eastern white pine, green ash, honeylocust, Austrian pine.	Eastern cottonwood.
33---------------- Zook	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Honeylocust, golden willow, green ash, northern red oak, silver maple, Austrian pine.	Eastern cottonwood.
34---------------- Blackoar	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Silver maple, Austrian pine, green ash, golden willow, honeylocust, northern red oak.	Eastern cottonwood.
36---------------- Bremer	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Austrian pine, honeylocust, green ash, silver maple, golden willow, northern red oak.	Eastern cottonwood.
37---------------- Moniteau	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Green ash, Austrian pine, silver maple, honeylocust, northern red oak, golden willow.	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
40 Haig	Redosier dogwood	Common chokecherry, American plum.	Eastern redcedar, hackberry.	Austrian pine, honeylocust, green ash, golden willow, silver maple, northern red oak.	Eastern cottonwood.
47C Mandeville	Amur honeysuckle, lilac, fragrant sumac.	Autumn-olive	Eastern redcedar, Austrian pine, hackberry, green ash, bur oak, Russian-olive.	Honeylocust, Siberian elm.	---
49D Eram	Lilac, Amur honeysuckle, fragrant sumac.	Autumn-olive	Eastern redcedar, bur oak, hackberry, green ash, Russian-olive, Austrian pine, honeylocust.	Siberian elm	---
51B, 51C Kenoma	Lilac	Amur honeysuckle, Manchurian crabapple, Amur maple, autumn-olive.	Green ash, hackberry, Austrian pine, Russian-olive, eastern redcedar, jack pine.	Honeylocust	---
52C Nowata Variant	Amur honeysuckle, fragrant sumac, lilac.	Autumn-olive	Austrian pine, eastern redcedar, Russian-olive, bur oak, hackberry, green ash, honeylocust.	Siberian elm	---
62B*: Macksburg	Lilac	Amur honeysuckle, autumn-olive, Manchurian crabapple, Siberian peashrub.	Eastern redcedar, Russian-olive, Austrian pine, jack pine, hackberry, green ash.	Honeylocust	---
Urban land.					
93 Verdigris	---	Lilac. Amur honeysuckle, Amur maple, autumn-olive.	Eastern redcedar	Austrian pine, honeylocust, eastern white pine, green ash, hackberry, pin oak.	Eastern cottonwood.

* 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	Golf fairways
2C-------------------- Higginsville	Moderate: wetness.	Moderate: wetness.	Severe: slope.	Moderate: wetness.	Moderate: wetness.
5B-------------------- Macksburg	Moderate: percs slowly, wetness.	Moderate: percs slowly, wetness.	Moderate: slope, wetness, percs slowly.	Slight------------	Slight.
6B-------------------- Sharpsburg	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight------------	Slight.
7B-------------------- Deepwater	Slight----------	Slight----------	Moderate: slope.	Slight------------	Slight.
7C-------------------- Deepwater	Slight----------	Slight----------	Severe: slope.	Slight------------	Slight.
8*. Pits					
9D-------------------- Snead	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: erodes easily.	Moderate: slope, thin layer.
10D*: Snead-----------------	Moderate: slope, large stones.	Moderate: slope, large stones.	Severe: slope.	Severe: erodes easily.	Moderate: large stones, thin layer.
Rock outcrop.					
10F*: Snead-----------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, erodes easily.	Severe: slope.
Rock outcrop.					
11C------------------- Greenton	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness.
13B------------------- Sampsel	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
13C------------------- Sampsel	Severe: wetness.	Severe: wetness.	Severe: slope.	Severe: wetness.	Severe: wetness.
14B------------------- Barco	Slight----------	Slight----------	Moderate: slope, depth to rock.	Slight------------	Moderate: thin layer.
17B------------------- Polo	Slight----------	Slight----------	Moderate: slope.	Slight------------	Slight.
17C------------------- Polo	Slight----------	Slight----------	Severe: slope.	Slight------------	Slight.
18B, 18C-------------- Summit	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Severe: erodes easily.	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	Golf fairways
19B: Weller	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Slight	Slight.
19C2: Weller	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Severe: slope.	Slight	Slight.
22C: Oska	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, depth to rock, percs slowly.	Slight	Moderate: thin layer.
28D: Coweta	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, small stones, depth to rock.	Moderate: large stones.	Severe: thin layer.
29D: Norris	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, small stones, depth to rock.	Slight	Severe: thin layer.
32: Freeburg	Severe: flooding.	Moderate: wetness, percs slowly.	Moderate: wetness, flooding.	Moderate: wetness.	Moderate: wetness, flooding.
33: Zook	Severe: wetness, flooding.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
34: Blackoar	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
36: Bremer	Severe: wetness, flooding.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
37: Moniteau	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
40: Haig	Severe: wetness, percs slowly.	Severe: percs slowly.	Severe: wetness, percs slowly.	Moderate: wetness.	Moderate: wetness.
47C: Mandeville	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: thin layer.
49D: Eram	Moderate: slope, wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Severe: slope.	Severe: erodes easily.	Moderate: slope, thin layer.
51B, 51C: Kenoma	Severe: percs slowly.	Severe: percs slowly.	Severe: percs slowly.	Slight	Slight.
52C: Nowata Variant	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Severe: erodes easily.	Moderate: large stones, thin layer.
62B*:					
Macksburg	Moderate: percs slowly, wetness.	Moderate: percs slowly, wetness.	Moderate: slope, wetness, percs slowly.	Slight	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	Golf fairways
62B*:					
Urban land.					
93--------------------- Verdigris	Severe: flooding.	Slight----------	Moderate: flooding.	Slight------------	Moderate: flooding.

* 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	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
2C: Higginsville	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
5B: Macksburg	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
6B: Sharpsburg	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
7B: Deepwater	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
7C: Deepwater	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
8*. Pits										
9D: Snead	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
10D*:										
Snead	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
Rock outcrop.										
10F*:										
Snead	Very poor.	Very poor.	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
Rock outcrop.										
11C: Greenton	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
13B, 13C: Sampsel	Fair	Fair	Fair	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
14B: Barco	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
17B: Polo	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
17C: Polo	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
18B: Summit	Good	Good	Fair	Good	Good	Poor	Poor	Good	Good	Poor.
18C: Summit	Fair	Good	Fair	Good	Good	Poor	Very poor.	Fair	Good	Very poor.
19B: Weller	Good	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
19C2: Weller	Fair	Fair	Fair	Fair	Fair	Very poor.	Poor	Fair	Fair	Very poor.
22C: Oska	Fair	Good	Good	Fair	Fair	Poor	Poor	Fair	Fair	Poor.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
28D: Coweta	Very poor.	Poor	Poor	Very poor.	Very poor.	Very poor.	Very poor.	Poor	Very poor.	Very poor.
29D: Norris	Poor	Fair	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Very poor.	Very poor.
32: Freeburg	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
33: Zook	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
34: Blackoar	Good	Good	Good	Fair	Fair	Good	Fair	Good	Fair	Fair.
36: Bremer	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
37: Moniteau	Fair	Fair	Fair	Fair	Fair	Good	Fair	Fair	Fair	Fair.
40: Haig	Good	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
47C: Mandeville	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
49D: Eram	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
51B: Kenoma	Good	Good	Fair	Fair	Fair	Poor	Fair	Good	Fair	Poor.
51C: Kenoma	Fair	Good	Fair	Fair	Fair	Poor	Poor	Fair	Fair	Poor.
52C: Nowata Variant	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
62B*:										
Macksburg	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
Urban land.										
93: Verdigris	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor.

* 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 and 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	Lawns and landscaping
2C: Higginsville	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell, slope.	Severe: low strength, frost action.	Moderate: wetness.
5B: Macksburg	Severe: wetness.	Severe: shrink-swell.	Severe: wetness.	Severe: shrink-swell.	Severe: low strength, frost action, shrink-swell.	Slight.
6B: Sharpsburg	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
7B: Deepwater	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
7C: Deepwater	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
8*. Pits						
9D: Snead	Severe: depth to rock, wetness.	Severe: shrink-swell.	Severe: wetness, depth to rock.	Severe: shrink-swell, slope.	Severe: low strength, shrink-swell.	Moderate: thin layer.
10D*: Snead	Severe: depth to rock, wetness.	Severe: shrink-swell.	Severe: wetness, depth to rock.	Severe: shrink-swell, slope.	Severe: low strength, shrink-swell.	Moderate: large stones, thin layer.
Rock outcrop.						
10F*: Snead	Severe: depth to rock, wetness, slope.	Severe: shrink-swell, slope.	Severe: wetness, depth to rock, slope.	Severe: shrink-swell, slope.	Severe: low strength, slope, shrink-swell.	Severe: slope.
Rock outcrop.						
11C: Greenton	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, shrink-swell.	Moderate: wetness.
13B, 13C: Sampsel	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: wetness, shrink-swell.	Severe: shrink-swell, wetness.	Severe: low strength, frost action, wetness.	Severe: wetness.
14B: Barco	Moderate: depth to rock.	Moderate: shrink-swell.	Moderate: depth to rock, shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: thin layer.
17B: Polo	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
17C: Polo	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.

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	Lawns and landscaping
18B, 18C---------- Summit	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.	Slight.
19B, 19C2--------- Weller	Severe: wetness.	Severe: shrink-swell.	Severe: shrink-swell, wetness.	Severe: shrink-swell.	Severe: shrink-swell, frost action, low strength.	Slight.
22C--------------- Oska	Severe: depth to rock.	Severe: shrink-swell.	Severe: depth to rock, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.	Moderate: thin layer.
28D--------------- Coweta	Severe: depth to rock.	Moderate: slope, depth to rock, large stones.	Severe: depth to rock.	Severe: slope.	Moderate: depth to rock, slope, large stones.	Severe: thin layer.
29D--------------- Norris	Severe: depth to rock.	Moderate: slope, depth to rock.	Severe: depth to rock.	Severe: slope.	Moderate: depth to rock, slope, frost action.	Severe: thin layer.
32---------------- Freeburg	Severe: wetness.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.
33---------------- Zook	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, low strength, frost action.	Moderate: wetness, flooding.
34---------------- Blackoar	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.	Severe: wetness.
36---------------- Bremer	Severe: wetness.	Severe: wetness, shrink-swell, flooding.	Severe: wetness, shrink-swell, flooding.	Severe: wetness, shrink-swell, flooding.	Severe: low strength, frost action.	Moderate: wetness.
37---------------- Moniteau	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding, wetness.	Severe: wetness.
40---------------- Haig	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
47C--------------- Mandeville	Moderate: depth to rock, slope.	Slight---------	Moderate: depth to rock.	Moderate: slope.	Severe: low strength.	Moderate: thin layer.
49D--------------- Eram	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, shrink-swell.	Moderate: slope, thin layer.
51B, 51C---------- Kenoma	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.	Slight.
52C--------------- Nowata Variant	Moderate: depth to rock.	Moderate: shrink-swell, large stones.	Moderate: depth to rock, shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, large stones.	Moderate: large stones.

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	Lawns and landscaping
62B*:						
Macksburg--------	Severe: wetness.	Severe: shrink-swell.	Severe: wetness.	Severe: shrink-swell.	Severe: low strength, frost action, shrink-swell.	Slight.
Urban land.						
93----------------- Verdigris	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding.

* 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," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominate soil condition and 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
2C: Higginsville	Severe: wetness.	Severe: slope, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey, wetness.
5B: Macksburg	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
6B: Sharpsburg	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
7B: Deepwater	Severe: wetness.	Severe: wetness.	Moderate: wetness, too clayey.	Slight	Fair: too clayey, wetness.
7C: Deepwater	Severe: wetness.	Severe: slope, wetness.	Moderate: wetness, too clayey.	Slight	Fair: too clayey, wetness.
8*. Pits					
9D: Snead	Severe: depth to rock, wetness.	Severe: depth to rock, slope.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
10D*:					
Snead	Severe: depth to rock, wetness.	Severe: depth to rock, slope.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Rock outcrop.					
10F*:					
Snead	Severe: depth to rock, wetness, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope, too clayey.	Severe: depth to rock, slope.	Poor: area reclaim, too clayey, hard to pack.
Rock outcrop.					
11C: Greenton	Severe: wetness, percs slowly.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
13B: Sampsel	Severe: wetness, percs slowly.	Moderate: depth to rock.	Severe: depth to rock, wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
13C: Sampsel	Severe: wetness, percs slowly.	Severe: slope.	Severe: depth to rock, wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
14B: Barco	Severe: depth to rock.	Severe: seepage, depth to rock.	Severe: depth to rock.	Severe: depth to rock, seepage.	Poor: area reclaim.

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
17B: Polo	Moderate: percs slowly.	Moderate: seepage, slope.	Severe: too clayey.	Slight	Poor: too clayey.
17C: Polo	Moderate: percs slowly.	Severe: slope.	Severe: too clayey.	Slight	Poor: too clayey.
18B: Summit	Severe: wetness, percs slowly.	Moderate: slope.	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
18C: Summit	Severe: wetness, percs slowly.	Severe: slope.	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
19B: Weller	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey, hard to pack.
19C2: Weller	Severe: percs slowly, wetness.	Severe: slope.	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey, hard to pack.
22C: Oska	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
28D: Coweta	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim, small stones.
29D: Norris	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim, small stones.
32: Freeburg	Severe: flooding, wetness, percs slowly.	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: too clayey, wetness.
33: Zook	Severe: percs slowly, wetness, flooding.	Severe: flooding.	Severe: wetness, too clayey, flooding.	Severe: wetness, flooding.	Poor: too clayey, wetness, hard to pack.
34: Blackoar	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
36: Bremer	Severe: percs slowly, wetness.	Severe: wetness, flooding.	Severe: wetness.	Severe: wetness.	Poor: wetness.
37: Moniteau	Severe: flooding, wetness, percs slowly.	Slight	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
40: Haig	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
47C: Mandeville	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.

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
49D------------------ 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.
51B, 51C------------ Kenoma	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight-----------	Poor: too clayey, hard to pack.
52C------------------ Nowata Variant	Severe: percs slowly.	Moderate: depth to rock.	Severe: depth to rock, large stones.	Moderate: depth to rock.	Poor: small stones.
62B*:					
Macksburg-----------	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Urban land.					
93------------------- Verdigris	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.

* 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," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition and does not eliminate the need for onsite investigation]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
2C-----Higginsville	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
5B-----Macksburg	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
6B-----Sharpsburg	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
7B, 7C-----Deepwater	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
8*. Pits				
9D-----Snead	Poor: area reclaim, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim.
10D*, 10F*:				
Snead-----	Poor: area reclaim, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim.
Rock outcrop.				
11C-----Greenton	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
13B, 13C-----Sampsel	Poor: low strength, shrink-swell, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
14B-----Barco	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones, thin layer.
17B, 17C-----Polo	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
18B, 18C-----Summit	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
19B, 19C2-----Weller	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
22C-----Oska	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
28D-----Coweta	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.
29D-----Norris	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
32: Freeburg	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
33: Zook	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
34: Blackoar	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
36: Bremer	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
37: Moniteau	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
40: Haig	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
47C: Mandeville	Poor: area reclaim, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
49D: Eram	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
51B, 51C: Kenoma	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
52C: Nowata Variant	Poor: area reclaim.	Improbable: excess fines, large stones.	Improbable: excess fines, large stones.	Poor: small stones.
62B*:				
Macksburg	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
Urban land.				
93: Verdigris	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.

* 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 and 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
2C----------------- Higginsville	Moderate: slope, seepage.	Moderate: wetness.	Frost action, slope.	Wetness, slope, erodes easily.	Erodes easily, wetness.	Erodes easily.
5B----------------- Macksburg	Moderate: seepage, slope.	Moderate: wetness.	Frost action, slope.	Wetness, slope.	Erodes easily, wetness.	Erodes easily.
6B----------------- Sharpsburg	Moderate: seepage, slope.	Slight---------	Deep to water	Slope----------	Erodes easily	Erodes easily.
7B, 7C------------ Deepwater	Moderate: seepage, slope.	Slight---------	Deep to water	Slope----------	Erodes easily	Erodes easily.
8*. Pits						
9D----------------- Snead	Severe: slope.	Severe: thin layer.	Percs slowly, depth to rock, slope.	Wetness, percs slowly.	Slope, depth to rock, erodes easily.	Slope, erodes easily, depth to rock.
10D*, 10F*:						
Snead------------	Severe: slope.	Severe: thin layer.	Percs slowly, depth to rock, large stones.	Wetness, percs slowly.	Slope, depth to rock, erodes easily.	Slope, erodes easily, depth to rock.
Rock outcrop.						
11C---------------- Greenton	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, slope.	Wetness, percs slowly, slope.	Erodes easily, wetness.	Wetness, erodes easily.
13B, 13C---------- Sampsel	Moderate: depth to rock, slope.	Severe: hard to pack, wetness.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Erodes easily, wetness.	Erodes easily, wetness.
14B---------------- Barco	Moderate: seepage, depth to rock, slope.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
17B, 17C---------- Polo	Moderate: seepage, slope.	Slight---------	Deep to water	Slope----------	Favorable------	Favorable.
18B---------------- Summit	Slight---------	Severe: hard to pack.	Percs slowly---	Wetness, percs slowly.	Erodes easily, wetness.	Erodes easily, percs slowly.
18C---------------- Summit	Moderate: slope.	Severe: hard to pack.	Percs slowly, slope.	Wetness, percs slowly.	Erodes easily, wetness.	Erodes easily, percs slowly.
19B, 19C2--------- Weller	Moderate: slope.	Moderate: hard to pack, wetness.	Slope, percs slowly, frost action.	Wetness, percs slowly, slope.	Wetness, erodes easily.	Percs slowly, erodes easily.
22C---------------- Oska	Moderate: depth to rock, slope.	Moderate: thin layer, hard to pack.	Deep to water	Percs slowly, depth to rock, slope.	Depth to rock, erodes easily, percs slowly.	Erodes easily, depth to rock, percs slowly.
28D---------------- Coweta	Severe: depth to rock, slope.	Severe: piping.	Deep to water	Large stones, droughty, depth to rock.	Slope, large stones, depth to rock.	Large stones, slope, droughty.

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
29D---------------- Norris	Severe: depth to rock, slope.	Severe: piping.	Deep to water	Droughty, depth to rock, slope.	Slope, depth to rock.	Slope, droughty, depth to rock.
32---------------- Freeburg	Slight---------	Severe: wetness.	Flooding, frost action.	Wetness, erodes easily.	Erodes easily, wetness.	Erodes easily.
33---------------- Zook	Slight---------	Severe: hard to pack, wetness.	Flooding, percs slowly, frost action.	Wetness, percs slowly.	Not needed-----	Not needed.
34---------------- Blackoar	Moderate: seepage.	Severe: piping, wetness.	Flooding, frost action.	Wetness, flooding.	Wetness--------	Wetness.
36---------------- Bremer	Slight---------	Severe: wetness, hard to pack.	Frost action---	Wetness--------	Wetness--------	Wetness.
37---------------- Moniteau	Slight---------	Severe. wetness.	Percs slowly, flooding, frost action.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
40---------------- Haig	Slight---------	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
47C--------------- Mandeville	Moderate: seepage, depth to rock, slope.	Severe: thin layer.	Depth to rock, slope, erodes easily.	Depth to rock, slope, erodes easily.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
49D--------------- Eram	Severe: slope.	Moderate: thin layer, hard to pack, wetness.	Percs slowly, depth to rock, slope.	Wetness, percs slowly, depth to rock.	Slope, depth to rock, erodes easily.	Slope, erodes easily, depth to rock.
51B--------------- Kenoma	Slight---------	Severe: hard to pack.	Deep to water	Percs slowly, erodes easily.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
51C--------------- Kenoma	Moderate: slope.	Severe: hard to pack.	Deep to water	Percs slowly, slope, erodes easily.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
52C--------------- Nowata Variant	Moderate: depth to rock.	Severe: large stones.	Deep to water	Large stones, rooting depth.	Large stones, erodes easily.	Large stones, erodes easily.
62B*:						
Macksburg--------	Moderate: seepage, slope.	Moderate: wetness.	Frost action, slope.	Wetness, slope.	Erodes easily, wetness.	Erodes easily.
Urban land.						
93---------------- Verdigris	Moderate: seepage.	Moderate: piping.	Deep to water	Flooding-------	Favorable------	Favorable.

* 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: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
2C---------------- Higginsville	0-9	Silt loam--------	CL	A-4, A-6	0	100	100	95-100	95-100	25-35	8-15
	9-18	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	35-45	15-22
	18-32	Silty clay loam	CL	A-7	0	100	100	95-100	90-100	40-50	20-25
	32-65	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	35-45	15-22
5B---------------- Macksburg	0-10	Silt loam--------	ML, OL, MH, OH	A-7	0	100	100	100	95-100	40-55	15-25
	10-58	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	100	95-100	40-60	20-35
	58-72	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
6B---------------- Sharpsburg	0-12	Silty clay loam	CL, CH	A-7, A-6	0	100	100	100	95-100	35-55	18-32
	12-39	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	100	95-100	40-60	20-35
	39-60	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
7B, 7C------------ Deepwater	0-11	Silt loam--------	CL	A-4, A-6	0	100	100	90-100	70-95	25-40	7-15
	11-62	Silty clay loam, clay loam.	CL	A-6, A-7	0	100	85-100	80-100	75-95	35-50	15-26
8*. Pits											
9D---------------- Snead	0-11	Silty clay loam	CL	A-6, A-7	0-10	90-100	90-100	90-100	80-95	30-45	10-25
	11-38	Silty clay, clay	CH, CL	A-7	0-10	90-100	90-100	90-100	80-100	45-60	25-40
	38-50	Weathered bedrock	---	---	---	---	---	---	---	---	---
10D*, 10F*:											
Snead------------	0-14	Flaggy silty clay loam.	CL	A-6, A-7	10-40	70-90	60-85	55-80	50-75	30-45	10-25
	14-25	Flaggy silty clay, silty clay, stony silty clay.	CH, CL	A-7	10-50	70-90	60-85	55-80	50-75	45-60	25-40
	25-50	Weathered bedrock	---	---	---	---	---	---	---	---	---
Rock outcrop.											
11C--------------- Greenton	0-16	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	95-100	35-45	15-25
	16-60	Silty clay loam, silty clay.	CH	A-7	0	100	100	95-100	95-100	50-70	35-45
13B, 13C---------- Sampsel	0-14	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-99	35-50	15-25
	14-60	Silty clay loam, silty clay, clay.	CH	A-7	0	100	100	97-100	95-100	52-75	35-47
14B--------------- Barco	0-7	Loam-------------	ML, CL-ML, CL	A-4, A-6	0	100	100	85-95	50-75	22-35	2-14
	7-30	Loam, sandy clay loam, clay loam.	CL, SC	A-6	0-5	85-100	85-100	80-98	45-80	25-40	11-22
	30-41	Weathered bedrock	---	---	---	---	---	---	---	---	---
	41	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
17B, 17C---------- Polo	0-14	Silt loam--------	CL-ML, CL	A-4, A-6	0	100	100	95-100	90-100	25-40	5-15
	14-29	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	30-45	10-25
	29-60	Silty clay, silty clay loam.	CL	A-7, A-6	0	100	100	95-100	90-100	35-50	15-25
18B, 18C---------- Summit	0-15	Silty clay loam	CL, CH	A-6, A-7	0	90-100	90-100	85-100	80-99	35-60	11-30
	15-20	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
	20-42	Clay, silty clay	CH, CL	A-7	0	85-100	85-100	80-100	80-98	41-70	18-40
	42-64	Clay, silty clay, silty clay loam.	CH, CL	A-7	0	98-100	98-100	96-100	80-98	41-70	18-40

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
19B, 19C2: Weller	0-11	Silt loam	ML, CL	A-6, A-4	0	100	100	100	95-100	25-40	5-15
	11-43	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	100	95-100	45-65	30-40
	43-62	Silty clay loam	CH, CL	A-7	0	100	100	100	95-100	40-55	20-30
22C: Oska	0-18	Silty clay loam	ML, CL	A-6, A-7	0	100	100	96-100	90-100	38-50	12-22
	18-36	Clay, silty clay, silty clay loam.	CH, CL	A-7	0	100	100	96-100	95-100	45-60	20-35
	36	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
28D: Coweta	0-8	Loam	ML, CL, SM, SC	A-4	0-30	70-100	70-100	60-90	36-85	<31	NP-10
	8-19	Fine sandy loam, gravelly loam, clay loam.	ML, CL, SM, SC	A-2, A-4, A-6	0-25	55-75	55-75	45-70	30-65	<31	NP-12
	19-46	Weathered bedrock	---	---	---	---	---	---	---	---	---
29D: Norris	0-15	Silty clay loam, shaly silty clay loam.	ML, CL, SM, SC	A-4	2-10	65-90	50-80	45-75	40-55	<25	2-8
	15-26	Weathered bedrock	---	---	---	---	---	---	---	---	---
32: Freeburg	0-17	Silt loam	CL, CL-ML	A-4, A-6	0	100	100	90-100	90-100	15-35	5-15
	17-41	Silty clay loam	CL	A-6, A-7	0	100	100	85-100	85-100	30-45	15-25
	41-60	Clay loam, silty clay loam.	CL	A-6, A-7	0	100	100	85-100	70-100	30-45	15-25
33: Zook	0-20	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	45-65	20-35
	20-72	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	60-85	35-55
34: Blackoar	0-60	Silt loam	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-18
36: Bremer	0-16	Silty clay loam	CH, CL	A-7	0	100	100	100	95-100	45-60	25-40
	16-47	Silty clay loam, silty clay.	CH, MH	A-7	0	100	100	100	95-100	50-65	20-35
	47-60	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	40-60	25-40
37: Moniteau	0-14	Silt loam	CL-ML, CL	A-4, A-6	0	100	100	90-100	85-100	25-35	5-15
	14-69	Silty clay loam	CL	A-6, A-7	0	100	100	85-100	80-95	30-45	15-25
40: Haig	0-10	Silt loam	CL	A-6, A-7	0	100	100	100	95-100	35-45	15-25
	10-20	Silty clay loam, silty clay.	CL, CH	A-7	0	100	100	100	95-100	40-55	20-30
	20-37	Silty clay	CH	A-7	0	100	100	100	95-100	50-65	30-40
	37-60	Silty clay loam	CL, CH	A-7, A-6	0	100	100	100	95-100	35-55	20-30
47C: Mandeville	0-8	Silt loam	CL, CL-ML	A-4	0	100	100	90-100	75-95	20-30	5-10
	8-30	Silt loam, shaly loam, silty clay loam.	CL	A-6, A-4	0-5	60-95	60-90	55-90	50-90	28-40	8-20
	30-37	Weathered bedrock	---	---	---	---	---	---	---	---	---
49D: Eram	0-19	Silty clay loam	CL	A-6, A-7	0	85-100	85-100	85-100	75-95	33-48	12-25
	19-35	Clay, silty clay, clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	90-100	85-98	37-65	15-35
	35-63	Weathered bedrock	---	---	---	---	---	---	---	---	---
51B, 51C: 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
	8-60	Silty clay, clay	CH	A-7	0	85-100	85-100	85-100	85-100	50-75	30-48

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
52C--------------- Nowata Variant	0-7	Silt loam--------	CL	A-4, A-6	0-15	85-100	80-100	75-95	70-95	30-37	8-13
	7-14	Silt loam, silty clay loam, gravelly silt loam.	CL, GC, SC	A-2, A-4, A-6	0-30	40-90	35-90	35-85	30-85	30-40	8-18
	14-23	Gravelly silty clay loam, very gravelly silty clay loam, very cherty silty clay loam.	GC, GP-GC	A-2, A-6, A-7	0-65	15-50	10-50	10-45	5-40	33-42	12-19
	23-49	Gravelly silty clay loam, clay, cherty silty clay loam.	GC, GP-GC	A-2, A-6, A-7	0-65	15-50	10-50	10-45	5-40	37-50	15-25
	49	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
62B*: Macksburg--------	0-19	Silt loam--------	ML, OL, MH, OH	A-7	0	100	100	100	95-100	40-55	15-25
	19-58	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	100	95-100	40-60	20-35
	58-72	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
Urban land.											
93--------------- Verdigris	0-13	Silt loam--------	CL, CL-ML, ML	A-4, A-6	0	100	100	95-100	65-100	22-38	2-13
	13-61	Silt loam, silty clay loam.	CL	A-4, A-6, A-7	0	100	100	95-100	80-100	30-45	8-23

* 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 "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	Shrink-swell potential	Erosion factors K	Erosion factors T	Organic matter
	In	Pct	G/cm^3	In/hr	In/in	pH				Pct
2C---------------- Higginsville	0-9	22-27	1.30-1.50	0.6-2.0	0.21-0.24	5.6-7.3	Low-----------	0.37	5	3-4
	9-18	27-35	1.30-1.40	0.6-2.0	0.15-0.19	5.1-6.5	Moderate-----	0.37		
	18-32	27-35	1.40-1.50	0.6-2.0	0.14-0.19	5.1-6.5	Moderate-----	0.37		
	32-65	27-33	1.50-1.60	0.6-2.0	0.14-0.19	5.1-6.5	Moderate-----	0.37		
5B---------------- Macksburg	0-10	25-34	1.30-1.35	0.6-2.0	0.21-0.23	5.1-6.5	Moderate-----	0.32	5	3-4
	10-58	36-42	1.35-1.40	0.2-0.6	0.18-0.20	5.1-6.0	High----------	0.43		
	58-72	30-38	1.40-1.45	0.6-2.0	0.18-0.20	5.6-6.5	Moderate-----	0.43		
6B---------------- Sharpsburg	0-12	27-34	1.30-1.35	0.6-2.0	0.21-0.23	5.1-6.5	Moderate-----	0.32	5	3-4
	12-39	36-42	1.35-1.40	0.2-0.6	0.18-0.20	5.1-6.0	Moderate-----	0.43		
	39-60	28-32	1.40-1.45	0.6-2.0	0.18-0.20	6.1-6.5	Moderate-----	0.43		
7B, 7C------------ Deepwater	0-11	15-27	1.20-1.40	0.6-2.0	0.21-0.24	5.1-7.3	Low-----------	0.32	5	2-5
	11-62	27-35	1.40-1.60	0.6-2.0	0.18-0.20	5.1-6.5	Moderate-----	0.43		
8*. Pits										
9D---------------- Snead	0-11	20-40	1.30-1.40	0.2-0.6	0.21-0.24	6.1-7.3	Moderate-----	0.37	3	2-4
	11-38	40-60	1.25-1.35	0.06-0.2	0.12-0.14	6.6-8.4	High----------	0.32		
	38-50	---	---	---	---	---	--------------	----		
10D*, 10F*:										
Snead------------	0-14	20-40	1.30-1.40	0.2-0.6	0.14-0.18	6.1-7.3	Moderate-----	0.32	3	2-4
	14-25	40-60	1.25-1.35	0.06-0.2	0.07-0.11	6.6-8.4	High----------	0.24		
	25-50	---	---	---	---	---	--------------	----		
Rock outcrop.										
11C--------------- Greenton	0-16	27-40	1.30-1.45	0.2-0.6	0.12-0.18	5.6-6.5	Moderate-----	0.37	2	1-3
	16-60	35-50	1.35-1.50	0.06-0.2	0.11-0.15	5.6-7.3	High----------	0.37		
13B, 13C---------- Sampsel	0-14	25-35	1.30-1.50	0.2-0.6	0.21-0.24	5.6-7.3	Moderate-----	0.37	3-2	3-4
	14-60	35-60	1.40-1.60	0.06-0.2	0.11-0.13	5.6-7.8	High----------	0.37		
14B--------------- Barco	0-7	10-25	1.20-1.45	2.0-6.0	0.16-0.21	5.1-6.0	Low-----------	0.28	4	1-3
	7-30	18-35	1.40-1.60	0.6-2.0	0.12-0.16	4.5-6.5	Moderate-----	0.28		
	30	---	---	---	---	---	--------------	----		
17B, 17C---------- Polo	0-14	22-30	1.10-1.40	0.6-2.0	0.22-0.24	5.6-6.5	Low-----------	0.32	5	2-5
	14-29	27-35	1.20-1.40	0.6-2.0	0.18-0.20	5.1-6.5	Moderate-----	0.32		
	29-60	34-42	1.20-1.40	0.6-2.0	0.12-0.18	5.1-6.5	Moderate-----	0.32		
18B, 18C---------- Summit	0-15	27-45	1.25-1.50	0.2-0.6	0.16-0.20	5.6-7.3	Moderate-----	0.37	5	1-3
	15-20	32-45	1.35-1.65	0.2-0.6	0.10-0.18	5.6-7.3	High----------	0.37		
	20-42	40-60	1.35-1.60	0.06-0.2	0.10-0.18	5.6-8.4	High----------	0.32		
	42-64	35-55	1.40-1.65	0.06-0.2	0.10-0.18	6.6-8.4	High----------	0.32		
19B, 19C2--------- Weller	0-11	16-27	1.35-1.45	0.6-2.0	0.22-0.24	4.5-7.3	Low-----------	0.43	3	1-2
	11-43	28-48	1.35-1.50	0.06-0.2	0.12-0.18	4.5-6.0	High----------	0.43		
	43-62	28-40	1.40-1.55	0.2-0.6	0.18-0.20	5.1-6.0	High----------	0.43		
22C--------------- Oska	0-18	20-40	1.30-1.40	0.2-0.6	0.18-0.20	5.6-6.5	Moderate-----	0.37	3	1-3
	18-36	35-50	1.35-1.45	0.06-0.2	0.14-0.18	5.6-7.8	High----------	0.37		
	36	---	---	---	---	---	--------------	----		
28D--------------- Coweta	0-8	---	---	2.0-6.0	0.09-0.16	5.1-6.5	Low-----------	0.37	2	.5-1
	8-19	---	---	0.6-2.0	0.09-0.18	5.1-6.5	Low-----------	0.24		
	19-46	---	---	---	---	---	--------------	----		

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	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH				Pct
29D---------------- Norris	0-15	10-27	1.35-1.50	0.6-2.0	0.08-0.18	4.5-5.5	Low----------	0.32	2	1-2
	15-26	---	---	---	---	---	-------------	----		
32---------------- Freeburg	0-17	12-25	1.20-1.45	0.6-2.0	0.22-0.24	6.1-7.3	Low----------	0.37	5	.5-2
	17-41	27-35	1.40-1.50	0.6-2.0	0.18-0.20	5.1-6.0	Moderate-----	0.37		
	41-60	27-35	1.40-1.50	0.2-0.6	0.15-0.19	4.5-5.5	Moderate-----	0.37		
33---------------- Zook	0-20	32-38	1.30-1.35	0.2-0.6	0.21-0.23	5.6-7.3	High---------	0.28	5	5-7
	20-72	36-45	1.30-1.45	0.06-0.2	0.11-0.13	5.6-7.8	High---------	0.28		
34---------------- Blackoar	0-60	18-27	1.35-1.45	0.6-2.0	0.20-0.24	5.6-7.3	Low----------	0.28	5	2-4
36---------------- Bremer	0-16	25-32	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.28	5	5-7
	16-47	35-42	1.30-1.40	0.2-0.6	0.15-0.17	5.6-6.5	High---------	0.28		
	47-60	32-38	1.40-1.45	0.2-0.6	0.18-0.20	5.6-6.5	High---------	0.28		
37---------------- Moniteau	0-14	18-27	1.20-1.40	0.2-0.6	0.21-0.23	5.1-6.5	Low----------	0.43	3	1-2
	14-69	27-35	1.30-1.50	0.06-0.2	0.18-0.20	4.5-6.0	Moderate-----	0.43		
40---------------- Haig	0-10	22-27	1.35-1.40	0.6-2.0	0.22-0.24	5.6-7.3	Moderate-----	0.37	5	3-4
	10-20	28-48	1.30-1.35	0.6-2.0	0.21-0.23	5.1-6.0	High---------	0.37		
	20-37	40-50	1.30-1.45	<0.2	0.12-0.14	5.1-6.0	High---------	0.37		
	37-60	28-40	1.40-1.50	0.2-0.6	0.18-0.20	6.1-7.3	High---------	0.37		
47C--------------- Mandeville	0-8	12-27	1.35-1.45	0.6-2.0	0.22-0.24	5.1-6.5	Low----------	0.37	4	1-2
	8-30	20-30	1.30-1.40	0.6-2.0	0.17-0.22	4.5-6.0	Low----------	0.37		
	30-37	---	---	---	---	---	-------------	----		
49D--------------- Eram	0-19	27-32	1.30-1.60	0.2-0.6	0.15-0.19	5.6-6.5	Moderate-----	0.37	3	1-3
	19-35	35-55	1.45-1.75	0.06-0.2	0.14-0.18	5.1-7.3	High---------	0.37		
	35-63	---	---	---	---	---	-------------	----		
51B, 51C---------- Kenoma	0-8	18-27	1.35-1.45	0.2-0.6	0.22-0.24	5.1-6.5	Low----------	0.43	4	2-4
	8-60	40-60	1.40-1.50	<0.06	0.10-0.15	5.1-7.8	High---------	0.32		
52C--------------- Nowata Variant	0-7	15-27	1.30-1.50	0.6-2.0	0.15-0.22	5.6-6.5	Low----------	0.37	2	1-3
	7-14	20-32	1.40-1.70	0.6-2.0	0.11-0.16	5.6-6.5	Low----------	0.37		
	14-23	27-35	1.45-1.75	0.2-0.6	0.08-0.12	5.6-7.3	Moderate-----	0.32		
	23-49	27-35	1.45-1.75	0.2-0.6	0.08-0.12	5.6-7.3	Moderate-----	0.32		
	49	---	---	---	---	---	-------------	----		
62B*:										
Macksburg--------	0-19	25-34	1.30-1.35	0.6-2.0	0.21-0.23	5.1-6.5	Moderate-----	0.32	5	3-4
	19-58	36-42	1.35-1.40	0.2-0.6	0.18-0.20	5.1-6.0	High---------	0.43		
	58-72	30-38	1.40-1.45	0.6-2.0	0.18-0.20	5.6-6.5	Moderate-----	0.43		
Urban land.										
93---------------- Verdigris	0-13	15-27	1.30-1.40	0.6-2.0	0.20-0.24	5.6-7.3	Low----------	0.32	5	2-4
	13-61	18-35	1.40-1.65	0.6-2.0	0.17-0.22	5.6-7.3	Moderate-----	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 "rare," "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				
2C----------------- Higginsville	C	None---------	---	---	1.5-3.0	Apparent	Nov-Apr	>60	---	High-----	Moderate	Moderate.
5B----------------- Macksburg	B	None---------	---	---	2.0-4.0	Apparent	Nov-Apr	>60	---	High-----	High-----	Moderate.
6B----------------- Sharpsburg	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Moderate.
7B, 7C----------- Deepwater	B	None---------	---	---	3.0-4.5	Perched	Nov-Mar	>60	---	---	High-----	Moderate.
8*. Pits												
9D----------------- Snead	D	None---------	---	---	2.0-3.0	Perched	Nov-Mar	20-40	Soft	Moderate	High-----	Low.
10D*, 10F*: Snead-------------	D	None---------	---	---	2.0-3.0	Perched	Nov-Mar	20-40	Soft	Moderate	High-----	Low.
Rock outcrop.												
11C----------------- Greenton	C	None---------	---	---	1.0-3.0	Perched	Nov-Apr	>60	---	Moderate	High-----	Moderate.
13B, 13C----------- Sampsel	D	None---------	---	---	0-1.5	Perched	Nov-Apr	40-70	Soft	High-----	High-----	Low.
14B----------------- Barco	B	None---------	---	---	>6.0	---	---	20-40	Soft	---	Low------	Moderate.
17B, 17C----------- Polo	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
18B, 18C----------- Summit	C	None---------	---	---	2.0-3.0	Perched	Dec-Apr	>60	---	---	High-----	Low.
19B, 19C2---------- Weller	C	None---------	---	---	2.0-4.0	Apparent	Nov-May	>60	---	High-----	High-----	High.
22C----------------- Oska	C	None---------	---	---	>6.0	---	---	20-40	Hard	Moderate	Moderate	Moderate.
28D----------------- Coweta	C	None---------	---	---	>6.0	---	---	10-20	Soft	---	Low------	Moderate.
29D----------------- Norris	D	None---------	---	---	>6.0	---	---	8-20	Soft	Moderate	Low------	High.

See footnote at end of table.

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

Soil name and map symbol	Hydrologic 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				
32----------------- Freeburg	C	Occasional	Brief-----	Dec-Jun	1.5-3.0	Apparent	Nov-May	>60	---	High-----	High-----	High.
33----------------- Zook	C/D	Occasional	Brief to long.	Dec-Jun	1.0-3.0	Apparent	Nov-May	>60	---	High-----	High-----	Moderate.
34----------------- Blackoar	B/D	Occasional	Brief to long.	Dec-Jun	0-1.0	Apparent	Nov-May	>60	---	High-----	High-----	Low.
36----------------- Bremer	C	Rare---------	---	---	1.0-2.0	Apparent	Nov-Jul	>60	---	High-----	Moderate	Moderate.
37----------------- Moniteau	C/D	Occasional	Brief-----	Dec-Jun	0-2.0	Apparent	Nov-May	>60	---	High-----	High-----	High.
40----------------- Haig	C/D	None---------	---	---	1.0-2.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
47C---------------- Mandeville	B	None---------	---	---	>6.0	---	---	20-40	Soft	Moderate	Low-------	Moderate.
49D---------------- Eram	C	None---------	---	---	2.0-3.0	Perched	Dec-Apr	20-40	Soft	---	High-----	Moderate.
51B, 51C----------- Kenoma	D	None---------	---	---	>6.0	---	---	>60	---	---	High-----	Moderate.
52C---------------- Nowata Variant	B	None---------	---	---	>6.0	---	---	40-60	Hard	---	Moderate	Moderate.
62B*:												
Macksburg---------	B	None---------	---	---	2.0-4.0	Apparent	Nov-Apr	>60	---	High-----	High-----	Moderate.
Urban land.												
93----------------- Verdigris	B	Occasional	Very brief	Dec-Jun	>6.0	---	---	>60	---	---	Low-------	Low.

* 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
Barco	Fine-loamy, mixed, thermic Mollic Hapludalfs
Blackoar	Fine-silty, mixed, mesic Fluvaquentic Haplaquolls
Bremer	Fine, montmorillonitic, mesic Typic Argiaquolls
Coweta	Loamy, siliceous, thermic, shallow Typic Hapludolls
Deepwater	Fine-silty, mixed, thermic Typic Argiudolls
Eram	Fine, mixed, thermic Aquic Argiudolls
Freeburg	Fine-silty, mixed, mesic Aquic Hapludalfs
Greenton	Fine, montmorillonitic, mesic Aquic Argiudolls
Haig	Fine, montmorillonitic, mesic Typic Argiaquolls
Higginsville	Fine-silty, mixed, mesic Aquic Argiudolls
Kenoma	Fine, montmorillonitic, thermic Vertic Argiudolls
Macksburg	Fine, montmorillonitic, mesic Aquic Argiudolls
Mandeville	Fine-loamy, mixed, mesic Typic Hapludalfs
Moniteau	Fine-silty, mixed, mesic Typic Ochraqualfs
Norris	Loamy, mixed, acid, mesic, shallow Typic Udorthents
Nowata Variant	Loamy-skeletal, mixed, thermic Typic Argiudolls
Oska	Fine, montmorillonitic, mesic Typic Argiudolls
Polo	Fine, montmorillonitic, mesic Typic Argiudolls
Sampsel	Fine, montmorillonitic, mesic, sloping Typic Argiaquolls
Sharpsburg	Fine, montmorillonitic, mesic Typic Argiudolls
Snead	Fine, mixed, mesic Aquic Hapludolls
Summit	Fine, montmorillonitic, thermic Vertic Argiudolls
Verdigris	Fine-silty, mixed, thermic Cumulic Hapludolls
Weller	Fine, montmorillonitic, mesic Aquic Hapludalfs
Zook	Fine, montmorillonitic, mesic Cumulic Haplaquolls

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