SOIL SURVEY OF

Montgomery and Warren Counties, Missouri

United States Department of Agriculture
Soil Conservation Service
In cooperation with
Missouri Agricultural Experiment Station

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. 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 who need the information, regardless of race, color, national origin, sex, religion, marital status, or age.
Major fieldwork for this soil survey was completed in the period 1968–74. Soil names and descriptions were approved in 1975. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1975. This survey was made cooperatively by the Soil Conservation Service and the Missouri Agricultural Experiment Station. It is part of the technical assistance furnished to the Montgomery County Soil and Water Conservation District and the Warren County Soil and Water Conservation District.
Soil maps in this survey may be copied without permission, but any enlargement of these maps could cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All of the soils of Montgomery and Warren Counties are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map soil areas are outlined and identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil is described and the tree and shrub group in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the capability groupings, and the woodland management and productivity.

Foresters and others can refer to the section "Woodland Management and Productivity," where management concerns and potential productivity are given for soils of the county.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Use of the Soils for Wildlife."

Engineers and builders can find, under "Engineering Uses of the Soils," tables that contain estimates of soil properties and information about soil features that affect engineering practices.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of the Soils."

Newcomers in Montgomery and Warren Counties may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given in the section "Environmental Factors Affecting Soil Use."

***Cover:* A scenic view showing an area of Gasconade—Rock outcrop complex in foreground and Blake, Haynie, and Booker soils on flood plains of the Missouri River in background.**

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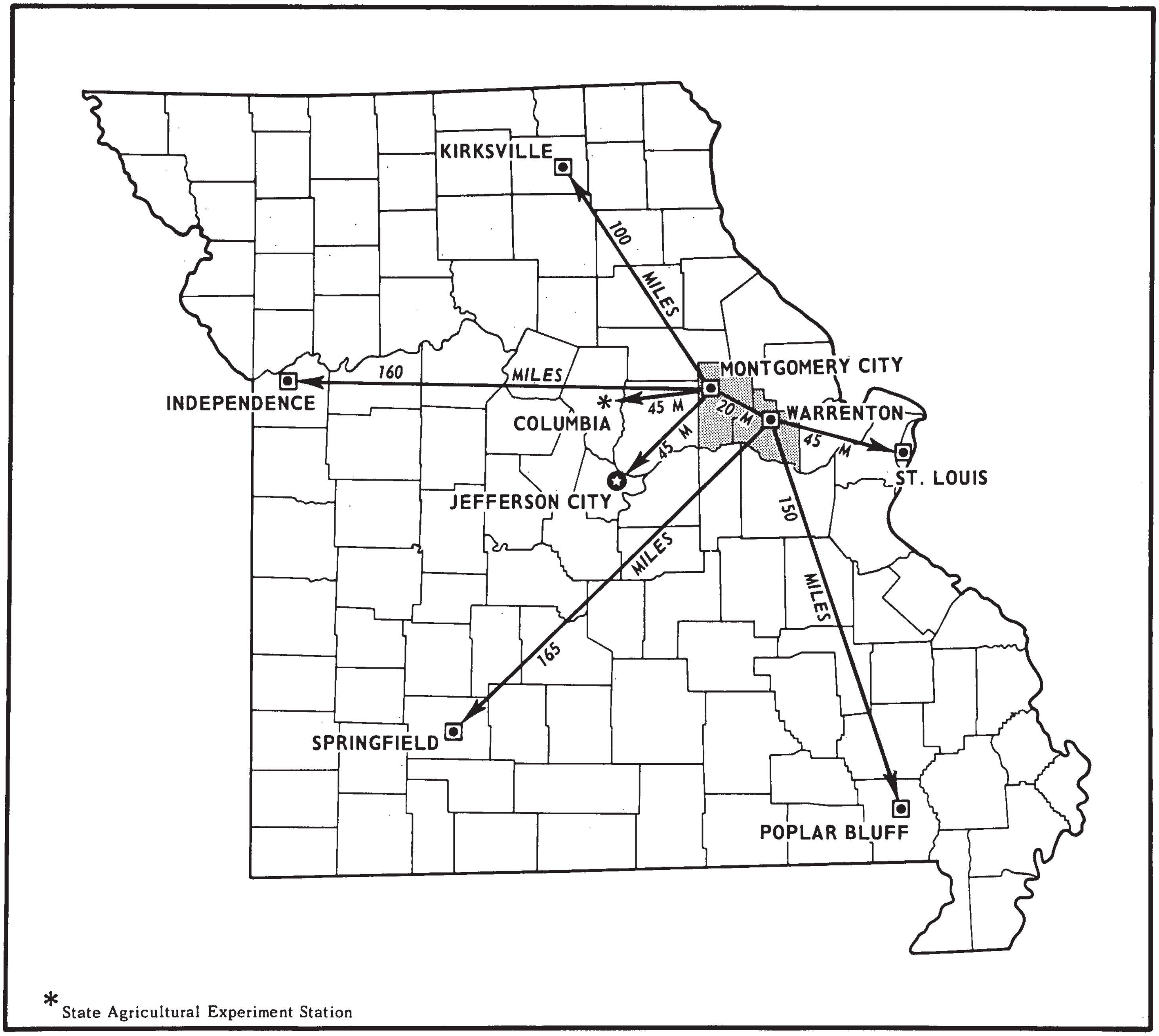

Location of Montgomery and Warren Counties in Missouri.

SOIL SURVEY OF MONTGOMERY AND WARREN COUNTIES, MISSOURI

SURVEY BY ROBERT J. HELD, SOIL CONSERVATION SERVICE

FIELDWORK BY ROBERT J. HELD, PARTY LEADER, KENNETH E. BENHAM, GARY W. STURDEVANT, AND RICHARD L. TUMMONS, SOIL CONSERVATION SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE [1]

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE MISSOURI AGRICULTURAL EXPERIMENT STATION

MONTGOMERY AND WARREN COUNTIES are in the east-central part of Missouri (See illustration on facing page.) Montgomery County is about 533 square miles, or 341,120 acres, and Warren County is about 428 square miles, or 273,920 acres. The survey area is 961 square miles or 615,040 acres. Montgomery City, in the west-central part of Montgomery County, is the county seat and largest town in the county. In 1970 the population of Montgomery City was 2,187, and the population of the county was 11,000. Warrenton is the county seat of Warren County. It had a population of 2,057 in 1970 and is the largest town in Warren County. It is in the north-central part of the county. Warren County had a 1970 population of 9,699.

Although there is some business and industry, most of the acreage in the survey area is economically dependent upon farming. Much of the business is also farm related.

About 80 percent of the acreage of Montgomery County and 65 percent of the acreage of Warren County were in farms in 1969 (*13*).[2] Cropland made up about 66 percent of Montgomery County and 55 percent of Warren County. About 21 percent of Montgomery County and 33 percent of Warren County were in woodland. Most of the remainder was open pasture.

Corn, soybeans, and wheat are the principal crops. Livestock, mostly beef cattle and hogs, is the biggest income product of the two-county area. Mixed livestock and cash-grain farming dominates the prairie region in the northern half of the survey area and the area of deep loess soils bordering the Missouri River flood plain. The bottom lands along the Missouri, Loutre, and Cuivre Rivers are used almost exclusively for cash-grain farming. The sale of timber products is important economically in the steep, dissected areas between the prairie region and the major flood plains.

The need for erosion control on sloping cropland overshadows all other management concerns in farming the soils of Montgomery and Warren Counties. Soils of the Mexico and Armster series in the prairie region are susceptible to severe sheet erosion, as are the Hatton and Keswick soils in the adjoining area of glacial and loessial soils. Winfield and Menfro soils, in the deep loess area bordering the Missouri River flood plain, are subject to both sheet and gully erosion. Upland soils of the Putnam and Marion series and bottom land soils of the Booker and Waldron series are wet.

Most of the bottom land and some of the nearly level or gently sloping uplands have a potential for increased yields under supplemental irrigation. Many areas of the narrow bottom land along small tributary streams have a good potential for growing walnut or other high-value trees. Some areas of Menfro and Winfield soils have a good potential for orchards and vineyards.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Montgomery and Warren Counties, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed steepness, length, and shape of slopes, the size and nature of streams, the kinds of native plants or crops, the kinds of rock and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a

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[1] E. REX BUTLER, RICHARD W. FENWICK, and ROBERT M. HAMBY, Soil Conservation Service, also made significant contributions to the fieldwork.

[2] Italicized numbers in parentheses refer to References, page 83.

town or other geographic feature near the place where a soil of that series was first observed and mapped. Mexico and Gasconade, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Menfro silt loam, 5 to 9 percent slopes, eroded, is one of several phases within the Menfro series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units are shown on the soil map of Montgomery and Warren Counties: soil complexes and undifferentiated groups.

A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Blake-Haynie-Waldron complex is an example.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. If there are two or more dominant series represented in the group, the name of the group ordinarily consists of the names of the dominant soils, joined by "and." Chilhowie, Gasconade, and Crider soils, 14 to 35 percent slopes, is an undifferentiated group in Montgomery and Warren Counties.

In most areas surveyed there are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called miscellaneous areas and are given descriptive names. Riverwash is a miscellaneous area in this survey.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory measurements and for engineering tests. Laboratory data from the same kind of soil in other places are also assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kind of soil. Yields under defined management are estimated for all the soils.

Soil scientists observe how soils behave when used as a growing place for native and cultivated plants, and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this to the slow permeability of the soil or its high water table. They see that streets, road pavements, and foundations for houses are cracked on a named kind of soil and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the map units in the survey area. A map unit is a landscape that has a distinctive pattern of soils in defined proportions. It typically consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one map unit can occur in another, but in different patterns.

A map showing units for land use planning is useful to people who want to have a general idea of the soils in a survey area, who want to compare different parts of that area, or who want to locate large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide for broad planning on a watershed, a wooded tract, or a wildlife area or for broad planning of recreational facilities, community developments, and such engineering works as transportation corridors. It is not a suitable map for detailed planning for management of a farm or field or for selecting the exact location of a road or building or other structure, because the soils within a map unit ordinarily vary in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The boundaries and names of soil units in Warren County do not agree completely with those in the published soil survey of St. Charles County. The Goss-Gasconade-Chilhowie unit in Warren County joins Steep Stony land-Huntington in St. Charles County. The Keswick-Lindley unit in Warren County joins the

Lindley-Marion unit in St. Charles Cunty. The Mexico-Armster-Putnam unit in Warren County joins the Mexico and the Lindley-Marion units in St. Charles County. The St. Charles County soil survey was completed prior to adoption of the present soil classification systems.

The map units in Montgomery and Warren Counties are discussed in the following paragraphs.

1. Mexico-Armster-Putnam

Deep soils that formed in loess and glacial till and are nearly level to moderately sloping and somewhat poorly drained, moderately well drained, and poorly drained

This map unit (fig. 1) consists of a mainly loess-covered glacial till plain that occupies most of the higher areas in the survey area. It is made up of all the upland soils that formed under prairie grasses.

This map unit, the most extensive of any in the survey area, includes about 35 percent of the total acreage in the two counties. It makes up about 50 percent of Montgomery County and about 17 percent of Warren County. This map unit is about 52 percent Mexico soils, 20 percent Armster soils, 8 percent Putnam soils, and 20 percent minor soils.

Mexico soils are gently sloping and somewhat poorly drained. They are mostly on long side slopes, downslope from the nearly level Putnam soils. In many places, however, they are on crests of divides. Mexico soils are upslope from the moderately sloping Armster soils. Their surface layer typically is very dark grayish brown silt loam. The subsoil is silty clay loam in the upper part, silty clay in the middle part, and silty clay loam in the lower part. It has dark grayish brown, grayish brown, strong brown, yellowish brown, and red mottles.

Armster soils are moderately sloping and moderately well drained. They are downslope from Mexico soils. The surface layer typically is very dark grayish brown loam. The subsoil is brown clay loam in the upper part and brown, yellowish brown, and red clay in the lower part.

Putnam soils are nearly level and poorly drained. They are on the highest part of the landscape. The surface layer typically is very dark grayish brown silt loam, and the subsurface layer is light gray silt loam. The subsoil is dark grayish brown, grayish brown, strong brown, brown, yellowish red, and red silty clay.

Among the minor soils in this map unit are Sampsel, Snead, Sharon, and Twomile. The deep, moderately sloping Sampsel soils and the moderately deep, strongly sloping Snead soils formed in weathered interbedded shale and limestone on the uplands. The nearly

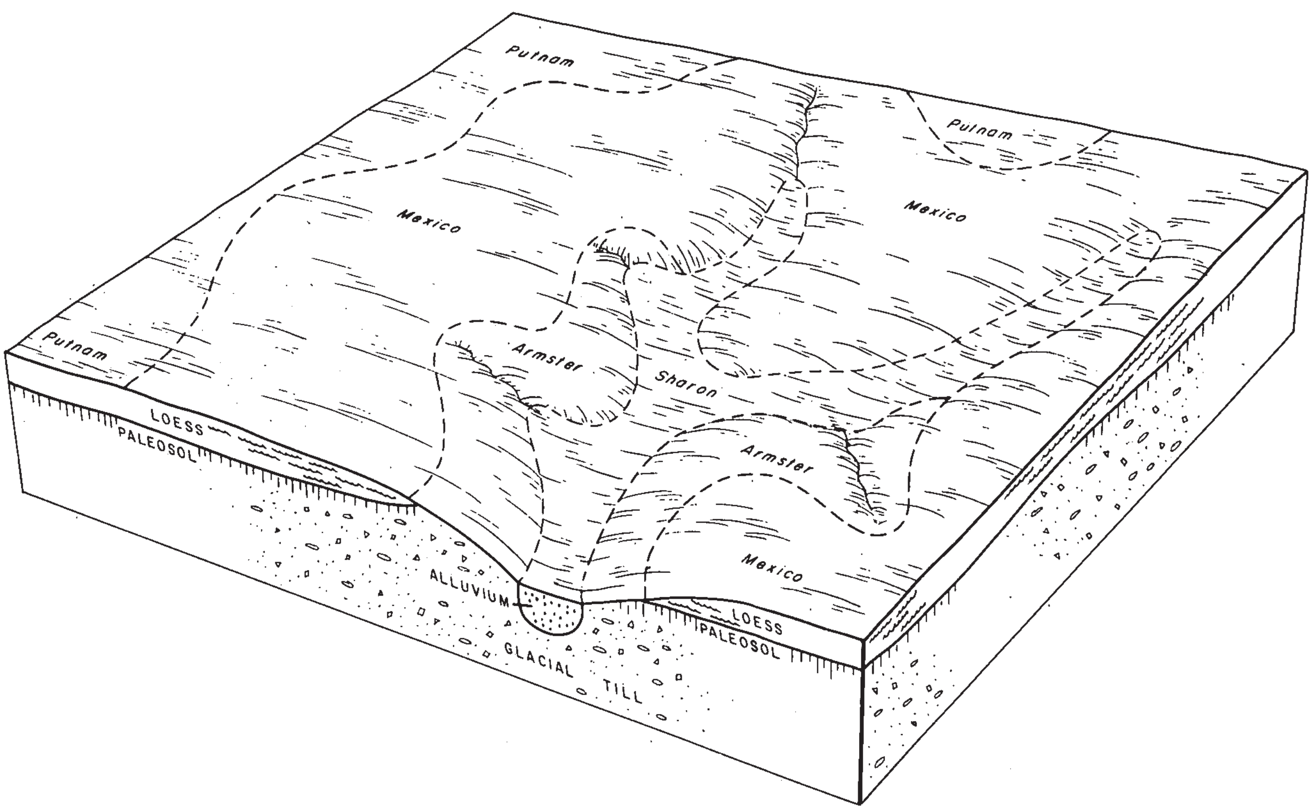

***Figure 1.*—Relationship of the soils in map unit 1 to the landscape and parent materials.**

level, moderately well drained Sharon soils are in areas of narrow bottom land along small streams. The nearly level, poorly drained Twomile soils are on terraces adjacent to this bottom land.

The soils of this map unit are used for corn, soybeans, small grain, and, to a lesser extent, hay and pasture. Control of water erosion (fig. 2) and improving and maintaining fertility and tilth are the main concerns in management. The main enterprises are cash crops and raising and feeding hogs and beef cattle.

Depending on the degree of erosion, the available water capacity ranges from high to low, fertility is medium or low, and the content of organic matter is moderate to low. The soils have a high potential for the crops commonly grown in the survey area. This potential, however, is being seriously reduced by runoff water that erodes the surface layer of Mexico and Armster soils and carries away valuable soil material.

2. Goss-Gasconade-Chilhowie

Deep, shallow, and moderately deep soils that formed in residuum weathered from limestone and shale and are moderately sloping to very steep, well drained and somewhat excessively drained

This map unit (fig. 3) consists of mainly stony soils that are steep to very steep on hillsides and moderately sloping to strongly sloping on narrow tops and points of ridges. Elevation differences of 250 feet or more within one-fourth mile are common. Valleys are deep and narrow, mostly no more than one-fourth mile wide. Ridgetops are winding and narrow, mostly less than one-tenth mile wide. There are many vertical or overhanging cliffs, mostly on lower parts of slopes.

This map unit includes about 21 percent of the total acreage in the two counties. It makes up about 24 percent of Warren County and about 18 percent of Montgomery County. The map unit is about 30 percent Goss soils, 25 percent Gasconade-Rock outcrop complex, 15 percent Chilhowie, Gasconade, and Crider soils that are mapped in an undifferentiated group, and 30 percent minor soils.

Goss soils are well drained. They are mostly steep to very steep and are on the upper parts of hillsides. In many places, however, they are moderately sloping to strongly sloping and are on points and narrow crests of ridges. On generally south facing side slopes, Goss soils are upslope from soils of the Gasconade-Rock outcrop complex. On generally north facing side slopes, they are upslope from Chilhowie, Gasconade, and Crider soils. In most places Goss soils are downslope from ridgetops occupied by soils of the Hatton-Keswick-Marion map unit. The surface layer typically is dark grayish brown very cherty silt loam, and the subsurface layer is brown very cherty silt loam. The subsoil is reddish brown very cherty clay in the upper part and brownish yellow very cherty clay in the lower part.

Soils of the Gasconade-Rock outcrop complex are somewhat excessively drained and are mostly very steep. They are generally on south facing side slopes, downslope from Goss soils. Gasconade soils, however, are also moderately sloping and are on points and crests of ridges. Typically, the surface layer is very dark grayish brown stony silty clay loam. The subsoil is dark brown channery silty clay. Limestone bedrock is at a depth of about 13 inches.

Chilhowie soils are mapped together in an undifferentiated group with Gasconade and Crider soils. They are well drained and are steep to very steep. They are

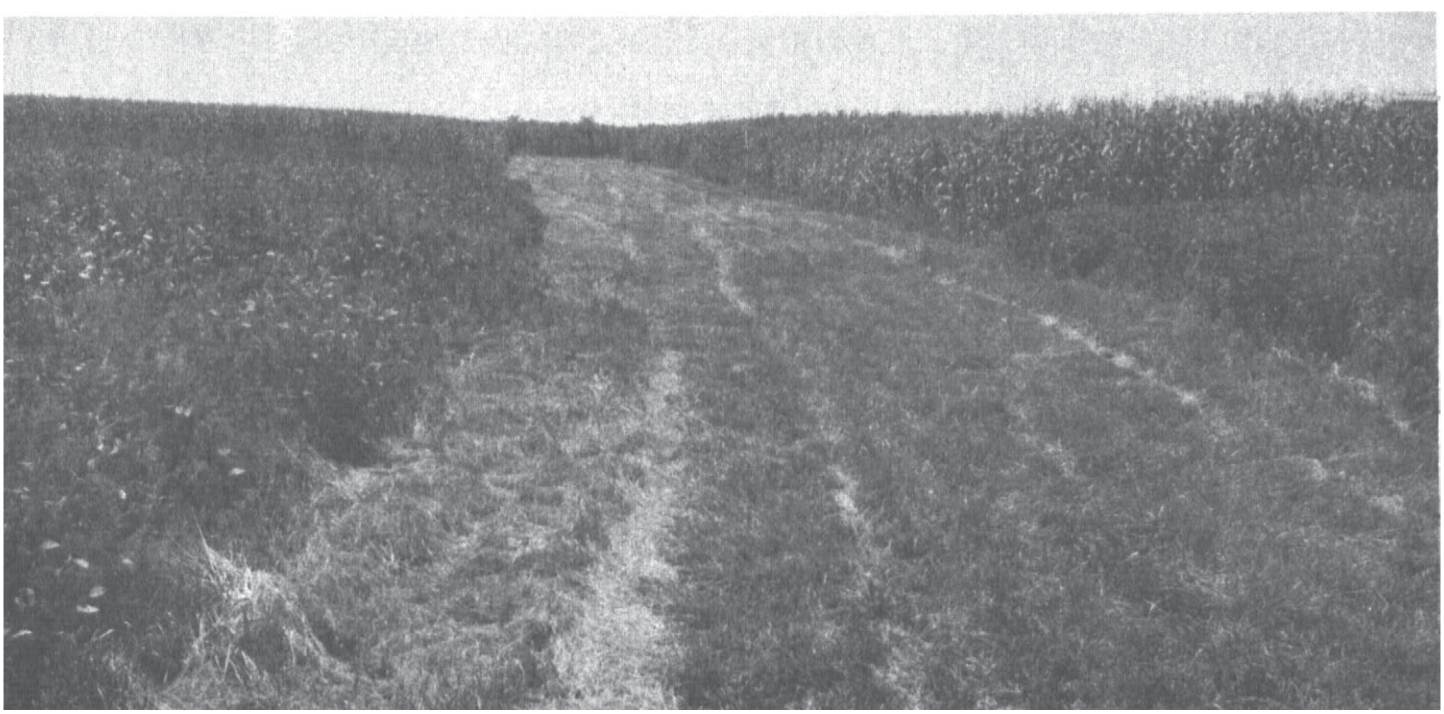

Figure 2.—**Grassed waterway helps to prevent erosion in this field of soybeans and corn on Mexico silt loam, 1 to 5 percent slopes.**

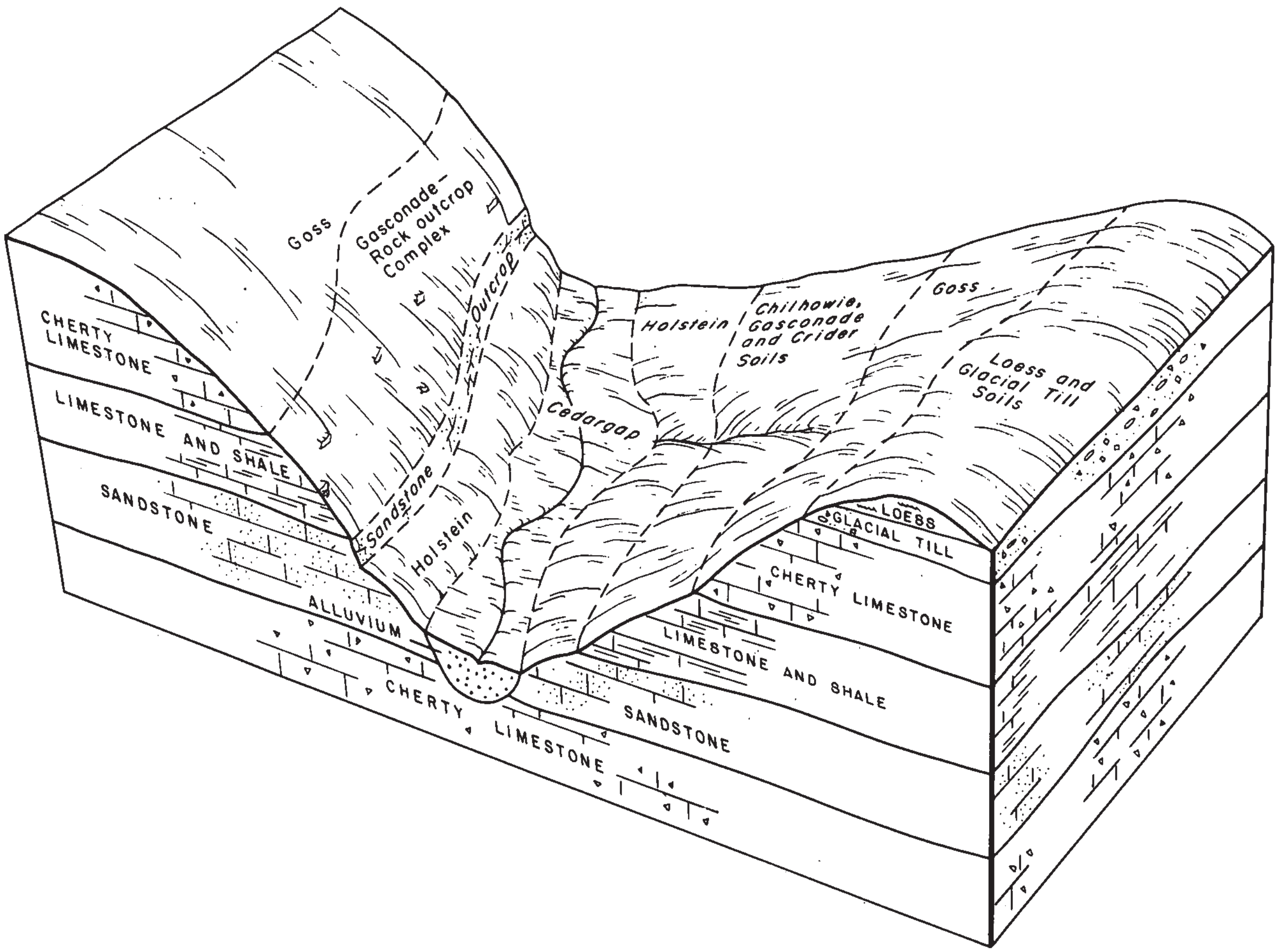

Figure 3.—**Relationship of the soils in map unit 2 to the landscape and parent materials.**

on side slopes. These soils are at the same elevation as the Gasconade-Rock outcrop complex. Chilhowie, Gasconade, and Crider soils occupy the somewhat more stable, generally north facing side slopes, downslope from Goss soils. Typically, the Chilhowie soils have a surface layer of dark reddish brown silty clay loam. The subsoil is reddish brown silty clay in the upper part, dark red clay in the middle part, and dark red very cobbly clay in the lower part. Limestone bedrock is at a depth of 28 inches.

Among the minor soils in this map unit are Holstein, Cedargap, Lindley, Hatton, and Keswick. Also in this map unit are many sandstone outcrops that form vertical or overhanging cliffs. The well drained Holstein soils are on steep foot slopes below sandstone escarpments. The Cedargap soils are in narrow areas of bottom land. The well drained Lindley soils formed in glacial material on steep side slopes at the upper reaches of drainageways in this map unit. The Hatton soils are on the crests of narrow ridges, and Keswick soils are adjacent to them on side slopes.

Timber production, wildlife habitat, recreation, and pasture are the main uses of the soils of this map unit. Use of the area as sites for weekend homes and permanent residences is increasing.

Selective cutting, stand improvement, and fire control are the main concerns in management for timber production. These practices also improve habitat for wildlife, especially deer and wild turkeys. The soils are especially well suited to woodland wildlife, mainly whitetailed deer, wild turkeys, squirrels, raccoons, and a large population of ruffed grouse. Because of the magnificent scenic beauty, recreational use of this map unit is increasing.

3. Keswick-Lindley

Deep soils that formed in glacial till and are moderately sloping to steep, moderately well drained and well drained

This unit (fig. 4) consists of soils that formed in glacial till under forest. It is a band of varying thickness separating the largely loess covered till plain of map unit 1 from the soils that formed in residual materials in map unit 2.

This map unit includes about 15 percent of the total acreage in the two counties. It makes up about 18 percent of Warren County and about 12 percent of Montgomery County. This map unit is about 60 percent Keswick soils, 20 percent Lindley soils, and 20 percent minor soils.

Keswick soils are moderately sloping to strongly sloping and are moderately well drained. They are on side slopes and points of ridgecrests. The surface layer typically is very dark grayish brown silt loam, and the subsurface layer is brown and yellowish brown silt loam. The subsoil is yellowish red clay in the upper part and strong brown clay in the lower part.

Lindley soils are moderately steep to steep and well drained. They are on the more dissected side slopes below Keswick soils. The surface layer typically is dark grayish brown and pale brown loam. The subsoil is strong brown clay loam in the upper part and yellowish brown clay loam in the lower part.

Among the minor soils in this map unit are Hatton, Marion, and Sharon. Hatton and Marion soils are on the crests of narrow ridges that have a thin loess cap. Hatton soils are moderately well drained and are gently sloping to moderately sloping. Marion soils are poorly drained and are nearly level. Sharon soils are in narrow areas of bottom land.

The soils of this map unit are well suited to pasture, woodland, and wildlife habitat. The moderately sloping soils are used for cultivated crops, pasture, and meadow, and, to a lesser extent, woodland. Steeper soils are used mostly for woodland (fig. 5) and wildlife habitat.

In cultivated areas, the main concerns are controlling water erosion and improving and maintaining fertility and tilth. Content of organic matter and natural fertility are low in all these soils.

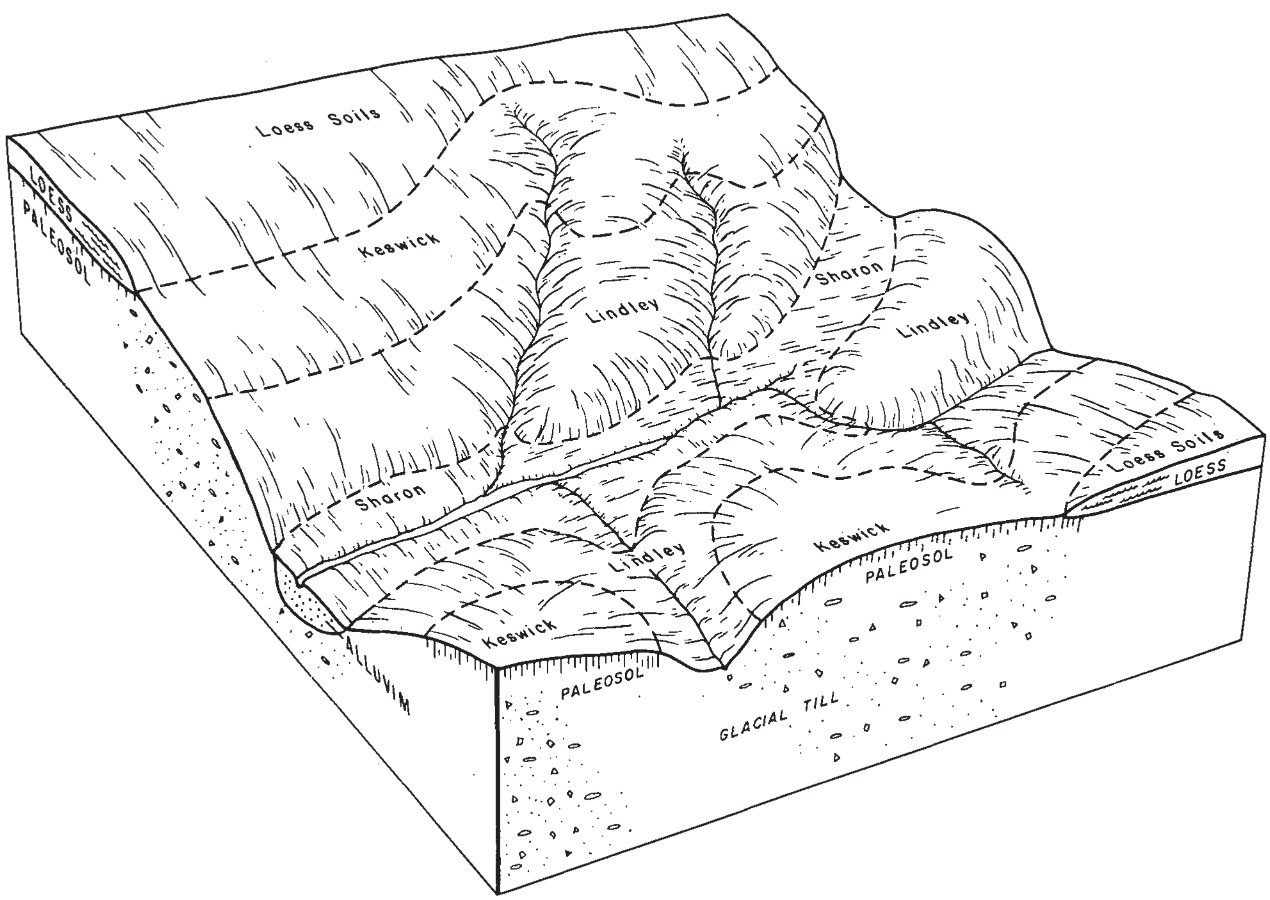

Figure 4.—**Relationship of the soils in map unit 3 to the landscape and parent materials.**

Figure 5.—**The Keswick-Lindley map unit and the Goss-Gasconade-Chilhowie unit provide most of the saw timber harvested in the survey area.**

4. Winfield-Menfro

Deep soils that formed in loess and are gently sloping to steep, moderately well drained and well drained

This map unit (fig. 6) consists of soils formed in loessial deposit on uplands adjacent to the Missouri River flood plain.

This map unit includes about 9 percent of the total acreage of the two counties. It makes up about 13 percent of Warren County and 5 percent of Montgomery County. The map unit is about 45 percent Winfield soils, 25 percent Menfro soils, and 30 percent minor soils.

Winfield soils are gently sloping to steep and are moderately well drained. They are on ridgetops, side slopes, and stream terraces. In most places they are farther from the Missouri River flood plain than Menfro soils. The surface layer typically is dark grayish brown silt loam. The subsoil is strong brown, dark brown, brown, and dark yellowish brown silty clay loam and has a few gray mottles, sand grains, and fine chert fragments in the lower part.

Menfro soils are moderately sloping to steep and are well drained. In most places they are between Winfield soils and those soils on the Missouri River flood plain. In many places they are separated from the flood plain by nearly vertical limestone cliffs. The surface layer typically is brown silt loam. The subsoil is dark brown to brown silt loam in the upper part and dark brown to brown silty clay loam in the lower part.

Among the minor soils in this map unit are Holstein, Dockery, and Nodaway and the Gasconade-Rock outcrop complex. The moderately sloping to steep Holstein soils are on foot slopes below sandstone outcrops. The somewhat poorly drained Dockery soils and moderately well drained Nodaway soils are in narrow areas of bottom land. Soils of the Gasconade-Rock outcrop complex are on the upper reaches of steep drainageways and on nearly vertical cliffs.

The soils of this map unit are used for cultivated crops, pasture, meadow, and woodland. In cultivated areas, control of water erosion is the principal concern in management. Gullying is a very serious hazard. The main enterprises are cash crops and raising and feeding hogs and beef cattle.

Available water capacity is high, fertility is medium or low, and the content of organic matter is low. The soils have a high potential for the crops commonly grown in the survey area if erosion is controlled. Areas at the higher elevations have a high potential for orchards and vineyards. Winfield and Menfro soils have a high potential for timber production.

5. Hatton-Keswick-Marion

Deep soils that formed in loess and glacial till and are nearly level to strongly sloping, moderately well drained and poorly drained

This map unit (fig. 7) consists of narrow, winding ridgetops that overlook the steep hillsides and narrow valleys occupied by the soils of the Goss-Gasconade-Chilhowie map unit. It is at about the same elevation as the prairie soils of the Mexico-Armster-Putnam unit and formed in the same material, but in thinner loess and is under forest vegetation.

This map unit includes about 9 percent of the total acreage in the two counties. It makes up about 15 percent of Warren County and about 5 percent of Montgomery County. The map unit is about 40 percent Hatton soils, 30 percent Keswick soils, 10 percent Marion soils, and 20 percent minor soils.

Hatton soils are moderately well drained and gently sloping to moderately sloping. They are on rounded crests of ridges. The surface layer typically is very dark grayish brown and dark brown silt loam, and the subsurface layer is yellowish brown silt loam. The subsoil is strong brown silty clay loam in the upper part, dark yellowish brown silty clay in the middle

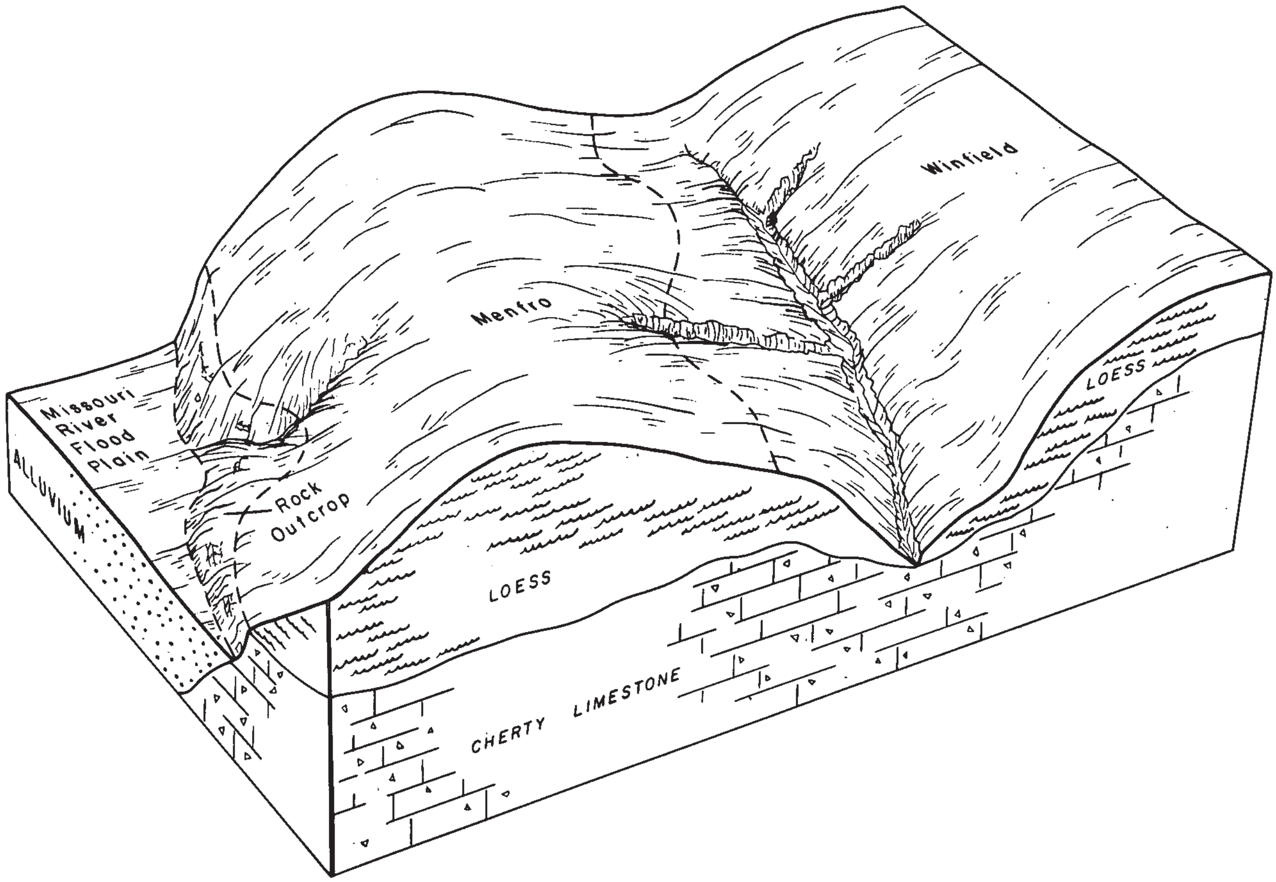

Figure 6.—**Relationship of the soils in map unit 4 to the landscape and parent materials.**

part, and mottled silty clay loam in the lower part. Below this is a fragipan.

Keswick soils are moderately sloping to strongly sloping and are moderately well drained. In most places they are on side slopes, downslope from Hatton soils, but in some places they occupy crests of ridges. The surface layer typically is very dark grayish brown silt loam, and the subsurface layer is brown and yellowish brown silt loam. The subsoil is yellowish red clay in the upper part and strong brown clay in the lower part.

Marion soils are nearly level and are poorly drained. They are upslope from Hatton soils. The surface layer typically is dark grayish brown silt loam, and the subsurface layer is pale brown silt loam. The subsoil is brown silty clay in the upper part and mottled silty clay loam in the lower part.

Among the minor soils in this map unit are Goss, Gasconade, and Cedargap. Goss soils are mostly strongly sloping and are on points of ridges. Gasconade soils are steep to very steep and are on side slopes. Cedargap soils are in narrow areas of bottom land.

About half the acreage of this map unit is used for cultivated crops (fig. 8), pasture, and meadow. The rest is used for woodland, wildlife habitat, and recreation.

Control of water erosion and improvement of fertility and tilth are the main concerns in cultivated areas. Content of organic matter and natural fertility are low in all these soils. The small size and narrow, twisted shape of many of the areas make the soils of this map unit poorly suited to large scale farming.

6. Blake-Haynie-Booker

Deep soils that formed in alluvial sediment and are nearly level, somewhat poorly drained, well drained, and very poorly drained

This map unit consists of the soils of the Missouri River flood plain. Differences in the soils are largely a result of the texture of the material in which they formed. Differences in elevation are slight.

This map unit includes about 5 percent of the total acreage of the two counties. It makes up about 8 per-

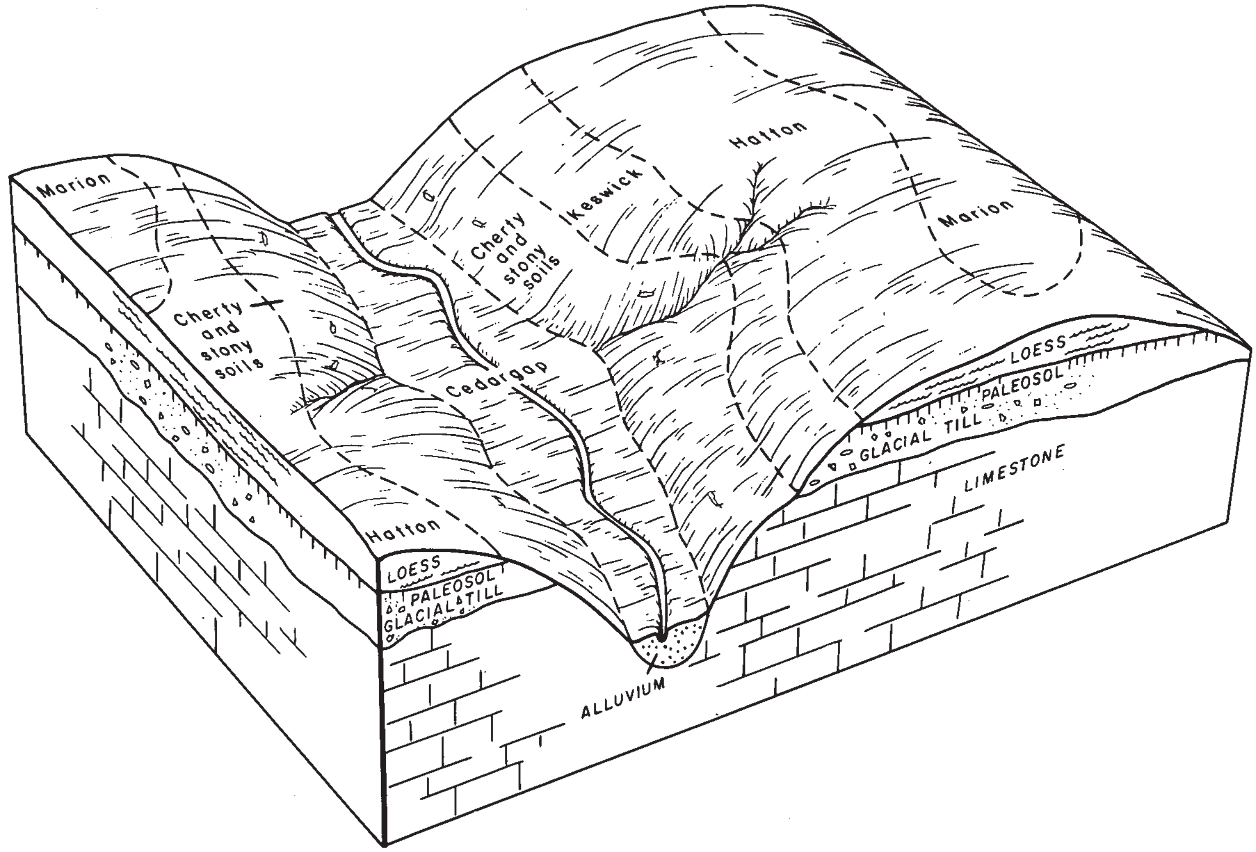

Figure 7.—**Relationship of the soils in map unit 5 to the landscape and parent materials.**

cent of Warren County and 3 percent of Montgomery County. The map unit is about 30 percent Blake soils, 25 percent Haynie soils, 12 percent Booker soils, and 33 percent minor soils. Blake and Haynie soils are mapped separately and in the Blake-Haynie-Waldron complex.

Blake soils are nearly level and somewhat poorly drained. They are mostly intermediate in elevation between higher areas of Haynie soils and lower areas of Booker soils. The surface layer is typically very dark grayish brown silty clay loam underlain by stratified layers of coarser and finer textured material.

Haynie soils are nearly level and well drained. They are mostly on low ridges or natural levees in the highest positions on the flood plain. These soils are typically dark grayish brown and grayish brown very fine sandy loam throughout and have thin lenses of coarser and finer textured material.

Booker soils are mostly nearly level and very poorly drained. They are in low lying slackwater areas. These soils are typically clay throughout. The surface layer is very dark gray in the upper part and very dark brown and gray in the lower part. The subsoil is dark grayish brown in the upper part, very dark brown in the middle part, and dark grayish brown in the lower part.

Among the minor soils in this map unit are Waldron, Hodge, and Modale. The clayey, somewhat poorly drained Waldron soils are intermediate between areas of Blake and Booker soils. The sandy Hodge soils are in areas of swift water deposition, mostly near the river channel or at levee breaks. The Modale soils formed where silty material eroded from local uplands was deposited over clayey Missouri River sediment.

This is the most intensively cultivated soil map unit in the survey area. Corn, soybeans, and wheat (fig. 9) are the main crops. A small acreage of alfalfa is grown, and a small acreage remains in forest, mostly next to the river in areas unprotected by levees.

The main concerns are drainage and protection from flooding by levees. Also, a high water table occurs in times of sustained rises in the Missouri River.

7. Nodaway-Moniteau-Dockery

Deep soils that formed in alluvial sediment and are nearly level, moderately well drained, poorly drained, and somewhat poorly drained

Figure 8.—Grain sorghum on nearly level Marion silt loam. Harvest was delayed by wetness throughout the winter. The harvested soybean field in the background is in an area of Hatton silt loam, 2 to 9 percent slopes.

This map unit (fig. 10) consists of soils on flood plains and terraces along the Loutre River and smaller streams.

This map unit includes about 6 percent of the total acreage in the two counties. It makes up about 7 percent of Montgomery County and about 5 percent of Warren County. The map unit is about 25 percent Nodaway soils, 15 percent Moniteau soils, 15 percent Dockery soils, and 45 percent minor soils.

Nodaway soils are nearly level and moderately well drained. They are mostly on first bottoms next to the streams. They are typically silt loam throughout. The surface layer is very dark grayish brown, and the lower layers are dark brown and dark grayish brown.

Moniteau soils are nearly level and poorly drained. They are on stream terraces that are 4 to 8 feet higher than Nodaway soils. The surface layer typically is dark grayish brown silt loam, and the subsurface layer is dark grayish brown and light brownish gray silt loam. The subsoil is grayish brown silty clay loam.

Dockery soils are nearly level and somewhat poorly drained. In most places they are in pockets, and cutoff streams meander between Nodaway and Moniteau soils. The surface layer typically is dark grayish brown silt loam and is underlain by layers of dark grayish brown silty clay loam and silt loam.

Among the minor soils in this map unit are Sharon, Twomile, Auxvasse, Coland, and Cedargap. In the

Figure 9.—Alfalfa and newly seeded wheat on Blake silty clay loam in foreground. Corn is on Booker clay. Hills in background are in map unit 4.

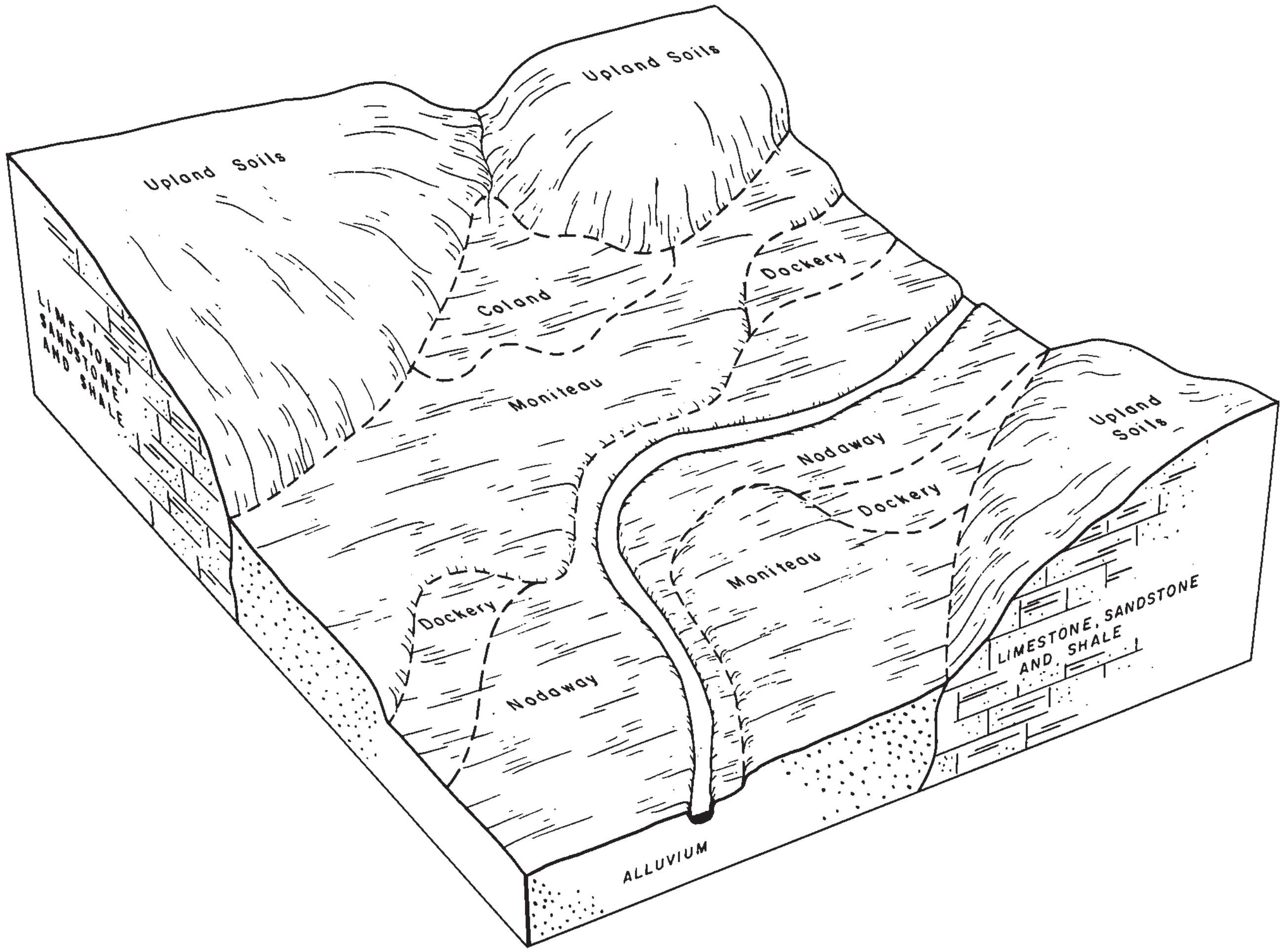

***Figure 10.*—Relationship of the soils in map unit 7 to the landscape and parent materials.**

northern half of the survey area are the moderately well drained Sharon soils on low bottom land and the poorly drained Twomile soils on adjacent stream terraces. The poorly drained Auxvasse soils are on stream terraces at a distinctly higher elevation than Moniteau soils. The poorly drained Coland soils are in alluvial fans next to uplands. The somewhat excessively drained Cedargap soils are in narrow areas of bottom land along smaller creeks and stream branches.

Most areas of this map unit are intensively cultivated. Corn, soybeans, and wheat are the main crops. Meadow crops and pasture are also grown. There is a considerable acreage of woodland, mostly bordering larger streams or in narrow areas of bottom land along smaller tributary streams.

Maintaining and improving fertility and tilth are the main concerns in management. Some areas need drainage. Flooding is a serious hazard, but levees are generally impractical.

Descriptions of the Soils

In this section the soils of Montgomery and Warren Counties are described in detail and their use and management are discussed. Each soil series is described in detail, and then, briefly, the mapping units in that series. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for

those who need to make thorough and precise studies of soils. Color terms are for moist soil unless otherwise stated. The profile described in the soil series is representative for mapping units in that series. If a given mapping unit has a profile in some ways different from the one described in the series, these differences are stated in the description of the mapping unit, or they are apparent in the name of the mapping unit. The description of each mapping unit contains suggestions on how the soil can be managed.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Riverwash, for example, does not belong to a soil series, but nevertheless is listed in alphabetic order along with the soil series.

Preceding the name of each mapping unit is a symbol. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit in which the mapping unit has been placed. The capability unit and the tree and shrub group in which each soil has been placed can be learned by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*10*).

Armster Series

The Armster series consists of deep, moderately well drained, moderately sloping soils on uplands. These soils formed in glacial till under prairie grasses.

In a representative profile the surface layer is very dark grayish brown loam about 6 inches thick. The subsoil is about 46 inches thick and has red mottles throughout. It is friable, brown clay loam in the upper part; firm, brown clay in the middle part; and firm, yellowish brown clay in the lower part. The underlying material is firm, yellowish brown clay loam that has gray mottles.

Permeability is moderately slow. Depending on the degree of erosion, available water capacity is moderate or low, content of organic matter is moderate or low, and fertility is medium or low. Runoff is medium.

Armster soils are used for cultivated crops, pasture, and meadow.

Representative profile of Armster loam, 5 to 9 percent slopes, eroded, in a west facing road cut in Montgomery County, 1,620 feet north of the southwest corner of sec. 1, T. 49 N., R. 4 W.:

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) loam; moderate very fine granular structure; very friable; many roots; medium acid; abrupt smooth boundary.

B1—6 to 10 inches; brown (7.5YR 5/4) clay loam; common fine prominent red (2.5YR 4/8) mottles; strong very fine subangular blocky structure; friable; many roots; common material from horizon above; weak stone line in lower part; strongly acid; clear smooth boundary.

IIB21t—10 to 16 inches; brown (7.5YR 5/4) clay; many fine prominent red (2.5YR 4/8) mottles; moderate very fine subangular blocky structure; firm; common roots; thin continuous clay films; common sand grains and glacial pebbles; very strongly acid; gradual smooth boundary.

IIB22t—16 to 28 inches; yellowish brown (10YR 5/4) clay; common fine prominent red (2.5YR 4/8) mottles; moderate very fine subangular blocky structure; firm; few roots; thin continuous clay films; common sand grains and glacial pebbles; strongly acid; gradual smooth boundary.

IIB23t—28 to 36 inches; yellowish brown (10YR 5/4) clay; common fine prominent red (2.5YR 4/8) mottles and few fine faint grayish brown (10YR 5/2) mottles; moderate very fine subangular blocky structure; firm; few roots; thin continuous clay films; common sand grains and glacial pebbles; strongly acid; clear smooth boundary.

IIB3—36 to 52 inches; yellowish brown (10YR 5/6) clay; common medium prominent gray (10YR 6/1) mottles; weak very fine subangular blocky structure; firm; common sand grains and glacial pebbles; medium acid; clear smooth boundary.

IIC—52 to 60 inches; yellowish brown (10YR 5/6) clay loam; few medium prominent gray (10YR 6/1) mottles; weak very fine subangular blocky structure; firm; common black stains; common sand grains and glacial pebbles; slightly acid.

The solum ranges from 45 to about 70 inches in thickness. The A horizon is loam or light clay loam. In areas where the soil is not eroded, there is a dark grayish brown loam A2 horizon about 4 inches thick. The B1 horizon is brown or dark yellowish brown. In places there is no B1 horizon. The IIB2t horizon has few to common coarse sand grains and glacial pebbles throughout. It is brown, yellowish brown, or dark yellowish and has red mottles. Mottles having chroma of 2 are at a depth of 10 to about 25 inches below the top of the argillic horizon. Reaction is strongly acid or very strongly acid throughout the B1 horizon and IIB2t horizon. The IIC horizon is slightly acid or neutral.

The surface layer of Armster clay loam, 5 to 9 percent slopes, severely eroded, is dark grayish brown, which is outside the range defined for the Armster series. This difference does not affect the use or behavior of the soil.

Armster soils have a darker colored A horizon than Keswick soils, which occur in similar positions and do not have grayish brown mottles in the upper part of the B horizon. They are better drained than the associated Mexico soils, and the upper part of their soil did not form in loess.

AmC2—Armster loam, 5 to 9 percent slopes, eroded. This moderately sloping soil is on side slopes. Most areas are large, long bands downslope from areas of Mexico soils. This soil has the profile described as representative of the series.

Included with this soil in mapping are many small areas where the soil is severely eroded. These areas are indicated on the soil map by a spot symbol. Also included are areas of a similar soil that has more restricted internal drainage and has gray mottles in the upper part of the subsoil.

This soil is suited to grain sorghum, soybeans, small grain, meadow, and pasture (fig. 11). It is also suited to corn, but the moderate available water capacity makes it susceptible to summer drought. Thus, high plant populations should be avoided.

If this soil is cultivated and not protected, the hazard of further erosion is severe. Terraces that have grassed outlets, minimum tillage or no-till farming, and contour cultivation help to control erosion and retard runoff. Using crop residue, barnyard manure, cover crops, and green manure crops helps to control erosion and to maintain organic matter, good tilth, and available water capacity. Improvement and maintenance of fertility can be accomplished by liming and fertilization according to soil tests. Capability unit IIIe–5.

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil	Montgomery		Warren		Total
	Acres	Percent	Acres	Percent	
AmC2—Armster loam, 5 to 9 percent slopes, eroded	33,500	9.8	12,250	4.5	45,750
ArC3—Armster clay loam, 5 to 9 percent slopes, severely eroded	4,600	1.3	400	.1	5,000
Au—Auxvasse silt loam	1,150	.3	400	.1	1,550
Bk—Blake silty clay loam	1,900	.6	5,500	2.0	7,400
Bm—Blake-Haynie-Waldron complex	3,400	1.0	4,700	1.7	8,100
Bo—Booker clay	1,750	.5	2,450	.9	4,200
CaB—Calwoods silt loam, 1 to 5 percent slopes	1,150	.3	1,000	.4	2,150
CbB2—Calwoods silty clay loam, 1 to 5 percent slopes, eroded	2,050	.6	1,800	.7	3,850
Cd—Cedargap silt loam	4,800	1.4	6,100	2.2	10,900
Ce—Cedargap cherty silt loam	4,200	1.2	5,100	1.9	9,300
Cf—Cedargap clay loam, loamy variant	1,300	.4	1,350	.5	2,650
Ch—Chariton silt loam	2,050	.6	300	.1	2,350
CnF—Chilhowie, Gasconade, and Crider soils, 14 to 35 percent slopes	10,100	3.0	7,900	2.9	18,000
Co—Coland clay loam	1,650	.5	500	.2	2,150
CrC—Crider silt loam, 5 to 9 percent slopes	3,450	1.0	350	.1	3,800
CrD2—Crider silt loam, 9 to 14 percent slopes, eroded	3,500	1.0	650	.2	4,150
Do—Dockery silt loam	6,100	1.8	4,900	1.8	11,000
GaC—Gasconade stony silty clay loam, 5 to 9 percent slopes	1,450	.4	950	.3	2,400
GdF—Gasconade-Rock outcrop complex, 14 to 50 percent slopes	15,250	4.5	21,250	7.8	36,500
GoD—Goss very cherty silt loam, 5 to 14 percent slopes	2,600	.8	4,400	1.6	7,000
GoF—Goss soils, 14 to 45 percent slopes	16,750	4.9	21,750	7.9	38,500
HcB—Hatton silt loam, 2 to 9 percent slopes	8,250	2.4	20,000	7.3	28,250
He—Haynie very fine sandy loam	1,200	.4	3,800	1.4	5,000
Hg—Hodge loamy fine sand	500	.1	1,100	.4	1,600
HoC2—Holstein loam, 5 to 9 percent slopes, eroded	750	.2	300	.1	1,050
HoD2—Holstein loam, 9 to 14 percent slopes, eroded	3,400	1.0	2,200	.8	5,600
HrE—Holstein-Rock outcrop complex, 14 to 35 percent slopes	6,300	1.8	9,800	3.6	16,100
KeC2—Keswick silt loam, 5 to 9 percent slopes	23,000	6.7	23,500	8.6	46,500
KeD—Keswick silt loam, 9 to 14 percent slopes	11,000	3.2	25,250	9.2	36,250
KsC3—Keswick clay loam, 5 to 9 percent slopes, severely eroded	4,500	1.3	1,250	.5	5,750
LnE—Lindley loam, 14 to 35 percent slopes	6,700	2.0	11,400	4.2	18,100
Ma—Marion silt loam	1,900	.6	3,200	1.2	5,100
MeC2—Menfro silt loam, 5 to 9 percent slopes, eroded	550	.2	2,550	.9	3,100

TABLE 1.—*Approximate acreage and proportionate extent of the soils*—Continued

Soil	Montgomery Acres	Montgomery Percent	Warren Acres	Warren Percent	Total	Soil	Montgomery Acres	Montgomery Percent	Warren Acres	Warren Percent	Total
MeD2—Menfro silt loam, 9 to 14 percent slopes, eroded	550	.2	3,450	1.3	4,000	Wa—Waldron silty clay	1,350	.4	2,050	.7	3,400
MeE—Menfro silt loam, 14 to 20 percent slopes	250	.1	2,400	.9	2,650	WeB—Weller silt loam, 2 to 5 percent slopes	1,700	.5	250	.1	1,950
MeF—Menfro silt loam, 20 to 35 percent slopes	150	(1)	2,350	.9	2,500	WeC2—Weller silt loam, 5 to 9 percent slopes, eroded	850	.2	350	.1	1,200
MoB—Mexico silt loam, 1 to 5 percent slopes	89,500	26.2	20,500	7.5	110,000	WnB—Winfield silt loam, 2 to 5 percent slopes	700	.2	1,050	.3	1,750
MpB2—Mexico silty clay loam, 1 to 5 percent slopes, eroded	3,050	.9	200	.1	3,250	WnC2—Winfield silt loam, 5 to 9 percent slopes, eroded	1,800	.5	3,300	1.2	5,100
Ms—Modale silt loam	350	.1	1,000	.4	1,350	WnD2—Winfield silt loam, 9 to 14 percent slopes, eroded	2,600	.8	5,800	2.1	8,400
Mu—Moniteau silt loam	4,750	1.4	1,250	.5	6,000						
Nd—Nodaway silt loam	7,400	2.2	3,000	1.1	10,400	WnE—Winfield silt loam, 14 to 20 percent slopes	2,100	.6	2,500	.9	4,600
Pt—Putnam silt loam	13,300	3.9	4,900	1.8	18,200	WnF—Winfield silt loam, 20 to 35 percent slopes	2,300	.7	2,600	.9	4,900
Rv—Riverwash	380	.1	200	.1	580						
SaC2—Sampsel silty clay loam, 5 to 9 percent slopes, eroded	1,950	.6			1,950	Fire clay mines and stockpiles	510	.2	180	.1	690
						Levees	275	.1	385	.1	660
Sh—Sharon silt loam	6,100	1.8	4,200	1.5	10,300	Rock quarry	305	.1	105	(1)	410
SnD—Snead silty clay loam, 9 to 14 percent slopes	1,300	.4			1,300	Water (streams and reservoirs)	1,250	.4	1,850	.7	3,100
						Total	341,120	100.0	273,920	100.0	615,040
Tm—Twomile silt loam	5,600	1.6	1,700	.6	7,300						

[1] Less than .05 percent.

ArC3—Armster clay loam, 5 to 9 percent slopes, severely eroded. This soil has a profile similar to the one described as representative of the series. The surface layer is clay loam because it has been mixed with material from the subsoil as a result of erosion. Other results of the severe erosion are low natural fertility, low available water capacity, and low content of organic matter.

This soil is poorly suited to cultivated crops. Tillage is difficult, and good stands are hard to obtain. Timely fieldwork is critical. The soil is suited to pasture or meadow if fertility requirements are met. Other important pasture maintenance practices are control of brush and weeds by mowing and protection from overgrazing by proper stocking. Capability unit IVe-8.

Auxvasse Series

The Auxvasse series consists of deep, poorly drained, nearly level soils on stream terraces. These soils formed in silty alluvium under hardwood forest.

In a representative profile the surface layer is dark grayish brown silt loam about 8 inches thick. The subsurface layer is light brownish gray silt loam about 7

Figure 11.—**Beef cattle grazing on improved pasture on Armster loam, 5 to 9 percent slopes, eroded.**

inches thick. The subsoil is firm, light brownish gray silty clay about 25 inches thick. The underlying material is brownish gray silty clay loam.

Permeability is very slow, and available water capacity is moderate. Content of organic matter and natural fertility are low. Runoff is slow.

Auxvasse soils are used mainly for field crops, meadow, and pasture. Some areas remain in forest.

Representative profile of Auxvasse silt loam in a cultivated field in Montgomery County, 2,340 feet east and 40 feet south of the northwest corner of sec. 32, T. 47 N., R. 5 W.:

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam; common fine faint brown (10YR 4/3) mottles; moderate very fine granular structure; very friable; many roots; few fine concretions; medium acid; clear smooth boundary.

A2—8 to 15 inches; light brownish gray (10YR 6/2) silt loam; common medium distinct brown (10YR 4/3) mottles; weak very fine granular structure; very friable; common roots; few fine pores; common thick light brownish gray (2.5Y 6/2) silt coats; common fine concretions; strongly acid; abrupt smooth boundary.

B&A—15 to 17 inches; yellowish brown (10YR 5/4) heavy silty clay loam (B2t); strong fine subangular blocky structure; firm; few roots; few fine concretions; thick light brownish gray (10YR 6/2) silt coats (A2) on peds; very strongly acid; abrupt smooth boundary.

B2tg—17 to 40 inches; light brownish gray (10YR 6/2) silty clay; common fine prominent strong brown (7.5YR 5/6) mottles and common medium distinct brownish yellow (10YR 6/6) mottles; moderate very fine subangular blocky structure; firm; common fine and medium concretions; very strongly acid; clear smooth boundary.

Cg—40 to 60 inches; brownish gray (10YR 5/2) silty clay loam; common medium distinct yellowish brown (10YR 5/4) and light olive brown (2.5Y 5/6) mottles; weak medium platy structure; firm; common fine and medium concretions; very strongly acid.

The solum ranges from about 35 to 50 inches in thickness. The A horizon ranges from 14 to 20 inches in thickness. The A2 horizon is light brownish gray or grayish brown. The B2t horizon is silty clay or clay. It has a matrix color of light brownish gray or brownish gray. Reaction is strongly acid or very strongly acid below the Ap horizon.

Auxvasse soils have an abrupt textural change between the A2 horizon and B horizon that the associated Moniteau soils do not have, and they have more clay in the B horizon than those soils. Auxvasse soils have more clay in the B2 horizon than Twomile soils, which are in similar positions and are not brittle and compact in the lower part of the A2 horizon.

Au—Auxvasse silt loam (0 to 2 percent slopes). This soil is on stream terraces along the Loutre and Cuivre

Rivers and smaller streams. Most areas are 5 to 15 acres in size.

This soil is suited to soybeans, grain sorghum, and small grain. It is also suited to corn, but the moderate available water capacity makes it susceptible to summer drought. High plant populations should be avoided. It is poorly suited to alfalfa but well suited to other meadow crops and pasture.

Wetness, the major concern, often delays fieldwork. Some areas need surface drainage to prevent ponding in depressions. Improvement and maintenance of organic matter content, fertility, and tilth are very important. Using crop residue, green manure crops, barnyard manure and liming and fertilization improves and maintains organic matter content, fertility, and tilth.

Important pasture management includes fertility maintenance by liming and fertilizing, control of brush and weeds by mowing, and protection from overgrazing by proper stocking. Capability unit IIIw-2.

Blake Series

The Blake series consists of deep, somewhat poorly drained, nearly level soils on bottom land. These soils formed in Missouri River alluvium under forest consisting mainly of cottonwood, soft maple, sycamore, and willow.

In a representative profile the surface layer is friable, very dark grayish brown silty clay loam about 17 inches thick. The next layer is dark grayish brown silty clay loam 13 inches thick. Below this is a layer of firm, very dark gray silty clay about 5 inches thick. The next layer is very friable, brown very fine sandy loam about 8 inches thick. Layers of brown loamy very fine sand over dark grayish brown very fine sandy loam and dark gray silty clay extend to a depth of 60 inches.

Permeability is moderately slow, and available water capacity is high. Content of organic matter and natural fertility are high. Runoff is slow.

Blake soils are used for field crops and alfalfa.

Representative profile of Blake silty clay loam in a cultivated field in Montgomery County, 180 feet north and 970 feet east of southwest corner of sec. 25, T. 46 N., R. 5 W.:

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silty clay loam; moderate very fine subangular blocky structure; friable; few roots; moderately alkaline; abrupt smooth boundary.

A12—9 to 17 inches; very dark grayish brown (10YR 3/2) silty clay loam; moderate very fine subangular blocky structure; friable; few roots; common lenses of very dark gray (10YR 3/1) silty clay; slight effervescence; mildly alkaline; clear smooth boundary.

C1—17 to 30 inches; dark grayish brown (10YR 4/2) light silty clay loam; common fine distinct dark yellowish brown (10YR 3/4) mottles; moderate fine subangular blocky structure; friable; few roots; common thin lenses and strata of very dark gray (10YR 3/1) clay and brown (10YR 5/3) very fine sand; slight effervescence; mildly alkaline; abrupt smooth boundary.

C2—30 to 35 inches; very dark gray (10YR 3/1) light silty clay; common fine distinct dark yellowish brown (10YR 3/4) mottles; moderate very fine subangular blocky structure; firm; slight effervescence; mildly alkaline; abrupt smooth boundary.

IIC3—35 to 43 inches; brown (10YR 4/3) very fine sandy loam; common fine prominent strong brown (7.5YR 5/6) mottles; massive; very friable; strong effervescence; moderately alkaline; abrupt smooth boundary.

IIIC4—43 to 55 inches; brown (10YR 5/3) loamy very fine sand; single grained; loose; strong effervescence; moderately alkaline; abrupt smooth boundary.

IVC5—55 to 60 inches; dark grayish brown (2.5Y 4/2) very fine sandy loam thinly stratified with dark gray (10YR 4/1) silty clay; massive; friable; strong effervescence; moderately alkaline.

The Ap or A1 horizon is very dark grayish brown, very dark gray, or very dark brown. The IIC horizon is coarse silt loam or very fine sandy loam.

Depth to material coarser textured than silty clay loam is greater than that defined for the Blake series, and in places the material between depths of 40 and 60 inches is coarser than that defined for the series. These differences do not affect the use or behavior of the soils.

Blake soils have less clay between depths of 10 and 40 inches than the associated Waldron and Booker soils. They have more clay than the associated Haynie soils.

Bk—Blake silty clay loam (0 to 2 percent slopes.) This soil is in areas where floodwaters have deposited material in layers that differ in texture. Most areas are 40 to 200 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are many small areas of a similar soil that contains less clay between depths of 10 to 40 inches. Also included are small areas of Waldron and Haynie soils.

Blake soils are used for corn, soybeans, wheat, and alfalfa. They are well suited to these crops if they are protected by levees. Capability unit I-1.

Bm—Blake-Haynie-Waldron complex (0 to 2 percent slopes). This mapping unit is in areas that have an intricate pattern of swales and low natural levees. The complex is about 40 percent Blake silty clay loam, 25 percent Haynie very fine sandy loam, 20 percent Waldron silty clay, and 15 percent other soils. Haynie soils are in the highest positions; Waldron soils are in low, narrow swales; and Blake soils are in intermediate positions.

Included with this unit in mapping are areas of Booker clay in depressions and areas of Hodge loamy fine sand where fast moving water has deposited sandy material.

The soils of this mapping unit are used mostly for corn, soybeans, and wheat, and they are well suited to these crops. In a few areas they are used for woodland and wildlife habitat.

Some swales occupied by Waldron silty clay need surface drainage. Differences in the texture of the surface layer cause tillage concerns. Fall plowing helps improve tilth of Waldron soils. Nitrogen and starter fertilizers can be used effectively.

Low lying areas that are not protected by levees have a very good potential for production of timber, especially cottonwood. Managing woodland for timber is an attractive alternative to the high risk farming practiced in most similar areas. Tree growth rates are very high on all the soils in this unit.

Areas on the river side of the levee also have a very good potential as habitat for woodland and wetland wildlife. Capability unit IIw-2.

Booker Series

The Booker series consists of deep, very poorly drained, nearly level to depressional soils on bottom land. These soils formed in clayey Missouri River slack water alluvium under a mixed vegetation of willows and swamp grasses.

In a representative profile the surface layer is clay about 16 inches thick. It is very dark gray in the upper part and very dark brown in the lower part. The subsoil is firm clay that extends to a depth of 60 inches or more. It is dark grayish brown in the upper part, very dark brown in the middle part, and dark grayish brown in the lower part.

Permeability is very slow, and the available water capacity is moderate. Content of organic matter is moderate, and natural fertility is high. Runoff is very slow or ponded.

Booker soils are used for corn, soybeans, and wheat.

Representative profile of Booker clay in a cultivated field in Montgomery County, 1,160 feet west and 170 feet south of the center of sec. 28, T. 46 N., R. 5 W.:

Ap—0 to 6 inches; very dark gray (10YR 3/1) clay; moderate very fine subangular blocky structure; firm; common roots; neutral; abrupt smooth boundary.

A12—6 to 16 inches; very dark brown (10YR 2/2) clay; weak medium prismatic structure parting to moderate fine subangular blocky; firm; few roots; neutral; clear smooth boundary.

B21—16 to 31 inches; dark grayish brown (2.5Y 4/2) clay; few fine prominent red (2.5YR 4/8) mottles; weak medium prismatic structure parting to moderate fine subangular blocky; firm; common material from A12 horizon filling cracks; neutral; diffuse smooth boundary.

B22—31 to 47 inches; very dark brown (10YR 2/2) clay; few fine faint dark brown (10YR 4/3) mottles; weak medium prismatic structure parting to moderate fine subangular blocky; firm; neutral; clear smooth boundary.

B23—47 to 60 inches; dark grayish brown (2.5Y 4/2) clay; common fine faint brown (10YR 5/3) and prominent strong brown (7.5YR 5/6) mottles; weak medium prismatic structure parting to weak very fine subangular blocky; firm; few fine black iron and manganese concretions; neutral.

The solum ranges from about 45 inches to several feet in thickness. The Ap or A1 horizon is very dark gray, dark gray, very dark grayish brown, or very dark brown clay. The B2 horizon is dark grayish brown, very dark grayish brown, or dark brown and is mottled throughout. It is clay or silty clay, but in many places it has thin lenses of coarser textured material. Reaction is slightly acid or neutral throughout.

Booker soils have more clay throughout than the associated Waldron and Blake soils.

Bo—Booker clay (0 to 2 percent slopes). This soil occupies swales and broad low lying areas. Most areas are 20 to 200 acres in size, and many are long and narrow. Included in mapping are many small areas of Waldron silty clay.

Corn, soybeans, and wheat are the main crops. The soil is suited to these crops if problems of drainage and tilth are properly handled. Most larger areas have been drained, but many small depressions need surface drainage (fig. 12). Lack of suitable outlets is a concern in many places. In years of extremely wet planting seasons or spring flooding, many areas are left idle. Fall plowing helps to improve tilth, and nitrogen and starter fertilizers are also effective. The soil is poorly suited to no-till methods of spring planting. Capability unit IIIw-14.

Figure 12.—**Ponded area in wheat field on Booker clay.**

Calwoods Series

The Calwoods series consists of deep, somewhat poorly drained, gently sloping soils on uplands. These soils formed in loess under forest that replaced the native prairie vegetation.

In a representative profile the surface layer is dark grayish brown silt loam about 4 inches thick. The subsurface layer is brown silt loam about 4 inches thick. The subsoil is about 32 inches thick. The upper part is friable, yellowish brown silty clay loam, the middle part is firm, grayish brown silty clay that has prominent red mottles, and the lower part is firm, grayish brown silty clay loam that has yellowish brown mottles. The underlying material is firm, light brownish gray silty clay loam.

Permeability is very slow. Depending on the degree of erosion, the available water capacity is high or moderate. Content of organic matter and natural fertility are low. Runoff is medium.

Calwoods soils are used mostly for field crops, pasture, and meadow. Many areas are wooded.

Representative profile of Calwoods silt loam, 1 to 5 percent slopes, in a wooded area in Montgomery County, 760 feet south and 100 feet west of northeast corner of sec. 6, T. 49 N., R. 5 W.:

O2—2 inches to 0; very dark brown (10YR 2/2) partly decomposed forest litter.

A1—0 to 4 inches; dark grayish brown (10YR 4/2) and very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) kneaded and light brownish gray (10YR 6/2) dry; moderate fine granular structure; friable; common roots; strongly acid; clear smooth boundary.

A2—4 to 8 inches; brown (10YR 5/3) silt loam, very pale brown (10YR 7/3) dry; weak fine subangular blocky structure; friable; some dark grayish brown (10YR 4/2) coatings on faces of peds; few small very dark brown concretions; common roots; very strongly acid; clear smooth boundary.

B1t—8 to 12 inches; yellowish brown (10YR 5/4) silty clay loam; common fine faint strong brown (7.5YR

5/6) mottles and few fine faint light brownish gray mottles; moderate fine subangular blocky structure; friable; few small very dark brown concretions; common roots; very strongly acid; clear smooth boundary.

B21t—12 to 26 inches; grayish brown (10YR 5/2) silty clay; many fine prominent red (2.5YR 4/6) and dark red (2.5YR 3/6) mottles and few fine faint yellowish brown mottles; moderate very fine subangular blocky structure; firm; thin continuous dark grayish brown (10YR 4/2) clay films on faces of peds; common roots; very strongly acid; clear smooth boundary.

B22t—26 to 33 inches; grayish brown (2.5Y 5/2) silty clay; many fine distinct yellowish brown (10YR 5/4) mottles and few fine distinct strong brown (7.5YR 5/6) mottles; weak very fine subangular blocky structure; firm; thin continuous dark grayish brown (10YR 4/2) clay films on faces of peds; few fine roots; very strongly acid; gradual smooth boundary.

B3t—33 to 40 inches; grayish brown (2.5Y 5/2) heavy silty clay loam; many fine distinct yellowish brown (10YR 5/4) mottles and few fine distinct yellowish brown (10YR 5/8) mottles; weak fine subangular blocky structure; firm; few thin discontinuous dark grayish brown (10YR 4/2) clay films on faces of peds; few fine roots; strongly acid; clear smooth boundary.

IIC—40 to 60 inches; light brownish gray (2.5Y 6/2) silty clay loam; common fine distinct yellowish brown (10YR 5/8) mottles and few fine distinct dark yellowish brown (10YR 4/4) and brown (10YR 5/3) mottles; massive; firm; numerous uncoated sand grains; few fine roots; medium acid; gradual smooth boundary.

The solum ranges from 35 to about 50 inches in thickness. In places in unplowed areas there is a very dark grayish brown A1 horizon 2 or 3 inches thick. In most cultivated areas there is no A2 horizon. The A horizon is medium acid to very strongly acid, except where reaction has been influenced by liming. The B1 horizon is brown or yellowish brown. The B2t horizon has matrix colors of grayish brown or dark grayish brown. It has red mottles in the upper part and strong brown or yellowish brown mottles in the lower part.

Calwoods soils have a lighter colored A horizon than the associated Mexico soils. They formed in material similar to that in which Hatton soils formed, but Hatton soils have a fragipan and Calwoods soils do not.

CaB—Calwoods silt loam, 1 to 5 percent slopes. This soil is mostly on the crests of gently sloping divides between Mexico soils on broad prairie areas and Hatton soils on narrow ridges. Most areas are 30 to 60 acres in size and are irregular in shape. This soil has the profile described as representative of the series.

This soil is suited to corn, grain sorghum, soybeans, small grain, and meadow. Control of erosion is a major concern. Terraces that have proper outlets and contour farming greatly reduce runoff and soil losses. Minimum tillage and no-till farming also helps to control erosion.

Liming and fertilizing according to soil tests improves and maintains fertility. Using crop residue, barnyard manure, and green manure crops helps to maintain organic matter, good tilth, and available water capacity. Capability unit IIe–5.

CbB2—Calwoods silty clay loam, 1 to 5 percent slopes, eroded. This soil is mostly on the crests of gently sloping divides between Mexico soils on prairie areas and Hatton soils on narrow ridges. Most areas are 20 to 40 acres in size and are long and banded. This soil has a profile similar to the one described as representative of the series, but the silty clay loam subsoil is mixed into the surface layer.

This soil is suited to grain sorghum, soybeans, small grain, pasture, and meadow. It is also suited to corn, but the moderate available water capacity makes it susceptible to summer drought.

The hazard of further erosion is severe. Terraces that have grassed outlets, minimum tillage or no-till farming, and contour tillage help control erosion and retard runoff. Using crop residue, barnyard manure, cover crops and green manure crops helps maintain organic matter, good tilth, and the available water capacity. It also helps to control erosion.

Pasture management includes maintenance of fertility by liming and fertilizing, control of brush and weeds by mowing, and prevention of overgrazing by proper stocking. Capability unit IIIe–5.

Cedargap Series

The Cedargap series consists of deep, somewhat excessively drained, nearly level soils on bottom land. These soils formed in alluvium under forest.

In a representative profile the surface layer is very dark grayish brown cherty silt loam about 12 inches thick. The next layer is very dark grayish brown very cherty clay loam about 20 inches thick. Below this, to a depth of 60 inches, is very dark grayish brown very cherty clay.

Permeability is moderately rapid, and available water capacity is moderate. Content of organic matter is high, and natural fertility is medium. Runoff is slow.

Cedargap soils are used for woodland, pasture, field crops, and meadow.

Representative profile of Cedargap cherty silt loam in a wooded area in Warren County, 2,240 feet south and 1,070 feet east of northwest corner of sec. 6, T. 46 N., R. 4 W.:

A1—0 to 12 inches; very dark grayish brown (10YR 3/2) cherty silt loam; moderate very fine granular structure; very friable; many roots; 15 percent chert gravel; neutral; clear smooth boundary.

C1—12 to 32 inches; very dark grayish brown (10YR 3/2) very cherty clay loam; moderate very fine subangular blocky structure; firm; common roots; 60 percent chert fragments; neutral; clear wavy boundary.

C2—32 to 62 inches; very dark grayish brown (10YR 3/2) very cherty clay; moderate very fine subangular blocky structure; firm; few roots; 75 percent chert fragments; neutral.

The A horizon is very dark grayish brown or very dark brown cherty silt loam or silt loam. The C horizon is very dark grayish brown, dark brown, or brown very cherty silty clay loam or very cherty clay.

The material in Cedargap silt loam that is less than 10 percent chert and overlies the more cherty horizons is thicker than that defined for the series, but this difference does not alter use or behavior.

Cedargap soils have cherty horizons that Nodaway and Sharon soils, which occupy similar positions, do not have.

Cd—Cedargap silt loam (0 to 2 percent slopes). This soil is on bottom land along creeks and branches. Most areas are long and narrow. This soil has a profile similar to the one described as representative of the series. About 18 to 30 inches of silt loam, or in places loam that is 2 to 10 percent chert, overlies the more cherty soil material.

Included with this soil in mapping are many small areas of Cedargap cherty silt loam. Also included are areas of a soil that is more acid than Cedargap silt loam.

Many areas are used for row crops, small grain, and meadow. The soil is suited to these uses in areas large enough for practical use of farm machinery. In smaller, narrower areas, pasture and woodland are the most important uses. In many places, the soil is surrounded by a vast acreage of woodland. In years of poor mast production, damage to row crops by wildlife, especially deer and squirrels, can be a serious concern.

Soil treatment according to soil tests maintains and improves fertility, although most areas do not need lime. Using crop residue and barnyard manure also helps to maintain fertility and tilth.

This soil has a good potential for walnut and other high value trees. Capability unit IIs–1.

Ce—Cedargap cherty silt loam (0 to 2 percent slopes). This soil is on stream bottom land. Most areas are very long and narrow and 5 to 30 acres in size. This soil has the profile described as representative of the series. Included in mapping are small areas of Cedargap silt loam.

This soil is used mainly for woodland, pasture, meadow, and wildlife habitat. A few areas are used for cultivated crops. Most areas are too small or too narrow for practical use of large farm machinery. Many areas are isolated and nearly inaccessible.

This soil has a good potential for walnut and other high value trees. Important woodland management includes selective harvest of mature trees, thinning of second growth stands, removal or deadening of cull trees, and control of fire and grazing. These practices also improve areas as habitat for most woodland wildlife.

Important pasture management includes mowing to control weeds and brush and protection from overgrazing by proper stocking. Most areas do not need lime. Capability unit IIIs–1.

Cedargap Variant

Cedargap variant soils are deep, well drained, and nearly level. They are on bottom land. These soils formed in alluvium under forest vegetation.

In a representative profile the surface layer is clay loam about 16 inches thick. It is dark brown in the upper part and dark reddish brown in the lower part. The subsoil is dark reddish brown clay loam about 16 inches thick. The underlying material, to a depth of 60 inches, is dark reddish brown clay loam and has common chert fragments.

Permeability is moderate, and available water capacity is high. Content of organic matter and natural fertility are high. Runoff is slow.

Cedargap variant soils are used for field crops, pasture, and meadow. A few small areas are wooded.

Representative profile of Cedargap clay loam, loamy variant, in a pasture in Warren County, 1,250 feet east and 1,310 feet south of northwest corner of sec. 36, T. 46 N., R. 2 W.:

Ap—0 to 6 inches; dark brown (7.5YR 3/2) light clay loam; moderate very fine granular structure; friable; many roots; slightly acid; abrupt smooth boundary.

A12—6 to 16 inches; dark reddish brown (5YR 3/2) light clay loam; moderate very fine subangular blocky structure; friable; common roots; slightly acid; gradual smooth boundary.

B2—16 to 32 inches; dark reddish brown (5YR 3/4) clay loam; moderate medium prismatic structure parting to weak fine subangular blocky; friable; common roots; common pockets and coatings of A1 material; about 2 percent chert fragments; slightly acid; gradual smooth boundary.

C—32 to 60 inches; dark reddish brown (5YR 3/4) clay loam; weak medium prismatic or massive structure; friable; few roots; about 2 percent chert fragments in the upper part increasing to 10 percent with depth; neutral.

The solum ranges from about 30 to 50 inches in thickness. The A horizon is brown, dark brown, or dark reddish brown. The B horizon and C horizon are clay loam or silty clay loam. They are dark reddish brown, dark brown, or brown.

Cedargap variant soils differ from other Cedargap soils in not having a cherty horizon. They contain more clay and sand throughout than Nodaway and Sharon soils, which occupy slightly lower positions in the landscape.

Cf—Cedargap clay loam, loamy variant (0 to 2 percent slopes). This soil is on low terraces along creeks and branches, generally at a slightly higher elevation than other Cedargap soils. Most areas are 20 to 100 acres in size.

Included with this soil in mapping are areas of a similar soil that has a lighter colored surface layer and contains less sand throughout. Also included are a few small areas of Cedargap cherty silt loam.

This soil is used mostly for corn, soybeans, wheat, pasture, and meadow. Some small areas remain wooded. The soil has a good potential for walnut and other high value trees.

Maintaining fertility and tilth are the main concerns, and using crop residue and animal wastes and fertilizing according to tests are effective. Most areas do not need lime. Capability unit I–1.

Chariton Series

The Chariton series consists of deep, poorly drained, nearly level soils on stream terraces. These soils formed under prairie grass in loess and the underlying alluvium.

In a representative profile the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsurface layer is dark gray silt loam about 4 inches thick. The subsoil is firm silty clay about 30 inches thick. The upper part is dark grayish brown, and the lower part is grayish brown. Yellowish brown mottles are thoughout the subsoil. The underlying material is grayish brown clay loam.

Permeability is slow, and available water capacity is high. Content of organic matter is moderate, and natural fertility is medium. Runoff is slow.

Chariton soils are used for field crops and, to a lesser extent, for meadow and pasture. They are well suited to these uses.

Representative profile of Chariton silt loam in a cultivated field in Warren County, 480 feet west and 1,550 feet south of northeast corner of sec. 25, T. 48 N., R. 3 W.:

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam; moderate very firm granular structure;

very friable; many roots; neutral; abrupt smooth boundary.

A2—8 to 12 inches; dark gray (10YR 4/1) silt loam; few fine distinct dark brown (10YR 3/3) and prominent yellowish brown (10YR 5/4) mottles; moderate very fine granular structure; very friable; common roots; common fine pores; common fine black concretions; slightly acid; abrupt smooth boundary.

B1—12 to 15 inches; mottled dark gray (10YR 4/1) and olive brown (2.5Y 4/4) silty clay loam; common medium faint dark yellowish brown (10YR 4/4) mottles and common fine prominent yellowish brown (10YR 5/6) mottles; moderate very fine subangular blocky structure; friable; few roots; common fine pores; few fine concretions; medium acid; abrupt smooth boundary.

B21t—15 to 18 inches; dark grayish brown (10YR 4/2) light silty clay; common medium distinct dark yellowish brown (10YR 4/4) mottles and few fine prominent yellowish brown (10YR 5/6) mottles; moderate very fine subangular blocky structure; firm; thick continuous clay films; common black concretions and stains; medium acid; clear smooth boundary.

B22t—18 to 26 inches; grayish brown (2.5Y 5/2) silty clay; common medium prominent yellowish brown (10YR 5/6) mottles and few fine distinct dark grayish brown (10YR 4/2) mottles; moderate very fine subangular blocky structure; firm; thick continuous clay films; common black concretions and stains; slightly acid; clear smooth boundary.

B23t—26 to 42 inches; grayish brown (2.5Y 5/2) silty clay; common medium prominent yellowish brown (10YR 5/6) mottles; moderate very fine subangular blocky structure; firm; thick continuous clay films; few fine black concretions and stains; slightly acid; clear smooth boundary.

IIB3—42 to 48 inches; dark grayish brown (2.5YR 4/2) clay loam; common coarse prominent yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; firm; thin patchy clay films; few fine black concretions and stains; neutral; gradual smooth boundary.

IIC—48 to 68 inches; grayish brown (2.5YR 5/2) clay loam; common coarse prominent yellowish brown (10YR 5/8) mottles; massive; firm; few dark gray clay films lining old root channels; few fine black concretions; neutral.

The solum ranges from about 45 to 60 inches in thickness. The A horizon ranges from 9 to 15 inches in thickness. The A2 horizon is dark gray or gray and ranges from 2 to 4 inches in thickness. In places no B1 horizon is present. The B2t horizon has matrix colors of grayish brown or dark grayish brown and has yellowish brown or brown mottles. The IIC horizon is clay loam or silty clay loam.

Chariton soils have more sand in the lower part of the solum than Putnam soils, which have similar internal drainage. They have a darker colored A horizon than Marion and Auxvasse soils, which occupy similar positions.

Ch—Chariton silt loam (0 to 2 percent slopes). This nearly level soil is on stream terraces along the upstream reaches of creeks and branches that drain prairie areas. Most areas are 15 to 40 acres in size.

Included with this soil in mapping are areas of a similar soil that has a lighter colored surface layer.

This soil is well suited to corn, soybeans, grain sorghum, and small grain. It is poorly suited to alfalfa but is well suited to other meadow crops and pasture.

The main concerns are improving and maintaining fertility, increasing organic matter content, and improving tilth. Some areas need surface drainage to prevent ponding in depressions. Liming and fertilization according to soil tests and using crop residue, cover crops, and minimum tillage are effective. Capability unit IIw-2.

Chilhowie Series

The Chilhowie series consists of moderately deep, well drained, moderately steep to steep soils on uplands. These soils formed under hardwood forest in material weathered from limestone and interbedded shale.

In a representative profile the surface layer is reddish brown silty clay loam about 3 inches thick. The subsoil is about 25 inches thick. The upper part is firm, reddish brown silty clay; the middle part is firm, dark red clay; and the lower part is firm, dark red very cobbly clay. Limestone bedrock is at a depth of 28 inches.

Permeability is slow, and available water capacity is low. Content of organic matter is low, and natural fertility is medium. Runoff is rapid.

Chilhowie soils are mostly wooded. A few areas have been cleared and are used for pasture.

Representative profile of Chilhowie silty clay loam in a wooded area of Chilhowie, Gasconade, and Crider soils, 14 to 35 percent slopes, in Warren County, 690 feet west and 10 feet north of center of sec. 33, T. 46 N., R. 2 W.:

A1—0 to 3 inches; reddish brown (5YR 4/4) silty clay loam; moderate very fine subangular blocky structure; friable; many roots; common limestone fragments 2 to 8 inches in diameter; few fine chert fragments; neutral; clear smooth boundary.

B21—3 to 9 inches; reddish brown (2.5YR 4/4) silty clay; moderate very fine subangular blocky structure; firm; common roots; few limestone fragments 2 to 8 inches in diameter; neutral; gradual smooth boundary.

B22—9 to 19 inches; dark red (2.5YR 3/6) clay; moderate very fine subangular blocky structure; firm; common roots; few limestone fragments 2 to 8 inches in diameter; neutral; clear smooth boundary.

B23—19 to 28 inches; dark red (2.5YR 3/6) very cobbly clay; weak very fine subangular blocky structure; firm; common roots; about 60 percent limestone fragments 2 to 8 inches in diameter; mildly alkaline.

R—28 inches; limestone bedrock; weathered cracks contain clayey material.

The solum ranges from 15 to 25 inches in thickness. Weathered limestone fragments commonly are within a depth of 20 inches. Depth to hard limestone bedrock is 20 to 40 inches. Content of limestone fragments is commonly 20 to 35 percent throughout the solum. Reaction is neutral to mildly alkaline throughout.

This soil has a redder B horizon than is defined for the range of the Chilhowie series, but this difference does not affect use or behavior.

Chilhowie soils are deeper to limestone bedrock than the associated Gasconade soils. They are shallower to bedrock than the associated Goss soils and do not have a cherty horizon.

CnF—Chilhowie, Gasconade, and Crider soils, 14 to 35 percent slopes. This mapping unit is on side slopes. It is upslope from Holstein soils and downslope from Goss soils. Slopes are moderately steep to steep. The undifferentiated group is generally about 45 percent Chilhowie soils, 20 percent Gasconade soils, 15 percent Crider soils, and 20 percent other soils. It, however, can contain either one, two, or all of the major soils. The soils are on generally north facing side slopes. In most places these side slopes are opposite those occupied by soils of the Gasconade-Rock outcrop complex.

The well drained, moderately deep Chilhowie soils

are mainly on rather smooth, steep side slopes. The surface layer typically is dark reddish brown silty clay loam about 3 inches thick. The subsoil is dark red clay that has common limestone fragments. Bedrock is at a depth of about 28 inches.

Gasconade soils are shallow and somewhat excessively drained. They are mostly on steep, concave side slopes at about the same elevation as Chilhowie soils. The surface layer typically is very dark grayish brown stony silty clay loam about 6 inches thick. The subsoil is dark brown channery silty clay. Limestone bedrock is at a depth of about 13 inches.

Crider soils are deep and well drained. They are in small, moderately steep to steep convex areas between drainageways at lower elevations within the unit. Typically the surface layer is brown silt loam about 9 inches thick. The subsoil is about 51 inches thick. It is dark brown silty clay loam in the upper part and yellowish red silty clay in the lower part.

Included with this unit in mapping are small areas of Rock outcrop, Goss, and Holstein soils and a soil that is similar to Crider soils except bedrock is at a depth of about 45 to 55 inches.

Except for a small cleared acreage used for pasture, this undifferentiated group is used for woodland, wildlife habitat, and recreation.

Many areas of Chilhowie and Crider soils can be improved as habitat for wildlife, especially deer, grouse, and wild turkeys, by making openings in the hardwood forest canopy. Selective harvest of mature timber is effective. Capability unit VIIs–8.

Coland Series

The Coland series consists of deep, poorly drained, nearly level soils on bottom land. These soils formed in loamy alluvium under mixed grasses and water tolerant trees.

In a representative profile the surface layer is very dark brown and black clay loam about 27 inches thick. The subsoil is firm, very dark gray clay loam about 25 inches thick. The underlying material is firm, dark gray clay loam.

Permeability is moderately slow, and available water capacity is high. Content of organic matter and natural fertility are high. Runoff is slow.

Coland soils are used mostly for row crops, small grain, and meadow. Some areas are used for pasture.

Representative profile of Coland clay loam in a cultivated field in Montgomery County, 190 feet north and 50 feet west of center of sec. 30, T. 47 N., R. 5 W.:

Ap—0 to 9 inches; very dark brown (10YR 2/2) clay loam; moderate very fine subangular blocky structure; friable; common roots; common fine black concretions; slightly acid; abrupt smooth boundary.

A12—9 to 27 inches; black (10YR 2/1) clay loam; moderate very fine subangular blocky structure; firm; common roots; common fine black concretions; slightly acid; clear smooth boundary.

B—27 to 52 inches; very dark gray (10YR 3/1) clay loam; common fine distinct dark yellowish brown (10YR 4/4) and olive brown (2.5Y 4/4) mottles and few fine faint dark grayish brown (10YR 4/2) mottles; moderate medium prismatic structure parting to moderate very fine subangular blocky; firm; few roots; thin discontinuous clay films on faces of primary peds; common fine black concretions; slightly acid; gradual smooth boundary.

C—52 to 60 inches; dark gray (10YR 4/1) clay loam; many fine distinct olive brown (2.5Y 4/4) mottles; weak medium platy structure; firm; common fine black concretions; neutral.

The A1 horizon is black or very dark gray. The B horizon is very dark gray or dark gray. In places sandy loam is below a depth of about 50 inches.

Coland soils have more sand throughout than the associated Moniteau soils, and they have a darker colored A horizon than those soils. They are wetter than the Cedargap variant soils, which formed in similar material.

Co—Coland clay loam (0 to 2 percent slopes). This nearly level soil is on first bottoms, low terraces, and alluvial fans. Most areas are 10 to 40 acres in size.

This soil is used mostly for corn, soybeans, and small grain. Some areas are used for meadow or pasture. The soil is well suited to all these uses if drainage is provided where needed, and drainage ditches that have suitable outlets are needed on many areas.

Fertility can be maintained and improved by soil treatment according to soil tests, and by using crop residue and barnyard manure, and by planting green manure crops. These practices also help to maintain organic matter and tilth. Most areas do not need liming. Capability unit IIw–2.

Crider Series

The Crider series consists of deep, well drained, moderately sloping and strongly sloping soils on uplands. These soils formed in loess and the underlying material weathered from chert free limestone and interbedded shale. Native vegetation is hardwood forest.

In a representative profile the surface layer is brown silt loam about 9 inches thick. The subsoil is about 51 inches thick. The upper part is firm, dark brown silty clay loam; the middle part is firm, yellowish red silty clay loam; and the lower part is firm, yellowish red silty clay.

Permeability is moderate, and the available water capacity is high. Organic matter and natural fertility are low. Runoff is medium or rapid.

Crider soils are used for field crops, meadow, pasture, and woodland.

Representative profile of Crider silt loam, 5 to 9 percent slopes, in a meadow in Montgomery County, 160 feet north and 260 feet east of center of sec. 26, T. 47 N., R. 5 W.:

Ap—0 to 9 inches; brown (10YR 4/3) silt loam; moderate very fine subangular blocky structure; very friable; many roots; slightly acid; clear smooth boundary.

B1—9 to 12 inches; brown (7.5YR 4/4) light silty clay loam; moderate very fine subangular blocky structure; friable; common roots; common material from horizon above; medium acid; clear smooth boundary.

B22t—18 to 28 inches; dark brown (7.5YR 4/4) silty clay loam; moderate very fine subangular blocky structure; firm; common roots; thin discontinuous clay films; strongly acid; clear smooth boundary.

B22t—18 to 28 inches; dark brown (7.5 YR 4/4) silty clay loam; moderate medium prismatic structure parting to moderate fine and very fine subangular blocky; firm; common roots; thin continuous clay films; few black stains; strongly acid; clear smooth boundary.

IIB23t—28 to 41 inches; yellowish red (5YR 5/6) silty clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; moderate medium prismatic structure parting to moderate very fine subangular

blocky; firm; thick continuous clay films on surfaces of primary peds; common black stains; few sand grains; few fine chert fragments; medium acid; clear smooth boundary.

IIB24t—41 to 60 inches; yellowish red (5YR 5/6) silty clay; common medium distinct dark brown (7.5YR 4/4) mottles; weak medium prismatic structure parting to weak fine subangular blocky; firm; thin continuous clay films on faces of primary peds; few sand grains; few fine chert fragments; medium acid.

The solum ranges from 60 to about 70 inches in thickness. Depth to limestone bedrock ranges from about 70 to 80 inches. The Ap or A1 horizon is brown or dark grayish brown. The B horizon is brown or dark brown. The IIB horizon is at a depth of 20 to 40 inches. It has matrix colors of yellowish red or strong brown.

Crider soils contain more clay and are redder in the lower part of the B horizon than Winfield soils, which occupy similar positions. They contain less sand throughout than Holstein soils. Crider soils are redder and contain more clay in the lower part of the B horizon than the associated Hatton soils, and they do not have a fragipan.

CrC—Crider silt loam, 5 to 9 percent slopes. This moderately sloping soil is on crests of ridgetops at elevations somewhat lower than those of Hatton soils. Most areas are long and narrow and range from 10 to 60 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are areas of a similar soil that is 40 to 60 inches deep over bedrock and a few areas where bedrock is at a depth of less than 40 inches and gray mottles are in the lower part of the subsoil. Also included are areas of severely eroded soils. These are indicated on the soil map by a spot symbol.

This soil is used for pasture, meadow, corn, wheat, and small grain and is well suited to alfalfa. Many small areas are used for woodland. Larger areas are suited to cultivated crops if erosion is controlled. Losses of soil and water can be controlled by terraces and grassed waterways, contour farming, and conservation cropping systems. No-till farming and minimum tillage are effective alternative erosion control methods. Areas at higher elevations have a potential for orchards and vineyards.

Fertility can be improved and maintained by liming and fertilization according to soil tests and using crop residue and barnyard manure. Cover crops and green manure crops also help maintain organic matter, available water capacity, and good tilth.

Important pasture management includes fertility maintenance by liming and fertilization, control of brush and weeds by mowing, and protection from overgrazing by proper stocking. Capability unit IIIe–1.

CrD2—Crider silt loam, 9 to 14 percent slopes, eroded. This strongly sloping soil is on side slopes, generally below areas of less sloping Crider soils. Most areas are 10 to 30 acres in size. This soil has a profile similar to the one described as representative of the series, but the depth to the silty clay loam subsoil is generally less.

Included with this soil in mapping are many areas of a similar soil where bedrock is at a depth of 40 to 60 inches and areas where bedrock is at a depth of less than 40 inches. A few areas of limestone bedrock outcrops are indicated on the soil map by Rock outcrop symbols. Also included, on foot slopes, are some areas of a similar soil that has gray mottles in the lower part of the subsoil.

This soil is suited to pasture, meadow, or woodland. In cultivated areas the hazard of further erosion is severe. Terraces that have grassed outlets, minimum tillage or no-till farming, and contour cultivation help control erosion and retard runoff. Important, in cropping sequences, are rotations that include several years of meadow or other cover crops. Using crop residue, cover crops, barnyard manure, and green manure crops helps maintain organic matter, good tilth, and available water capacity. Liming and fertilization according to soil tests improves and maintains fertility.

Woodland can benefit from selective harvest of mature timber, thinning of second growth stands, and control of fire and grazing. These practices also benefit most woodland wildlife.

Important pasture management includes maintenance of fertility by liming and fertilization, control of brush and weeds by mowing, and protection from overgrazing by proper stocking. Capability unit IVe–1.

Dockery Series

The Dockery series consists of deep, somewhat poorly drained, nearly level soils on bottom land. These soils formed in recent alluvium along the Loutre River and smaller streams in the survey area. Native vegetation is forest.

In a representative profile the surface layer is dark grayish brown silt loam about 6 inches thick. The next layer is dark grayish brown silty clay loam about 8 inches thick. Below this is a layer of dark grayish brown silt loam about 34 inches thick. The next layer is dark grayish brown silty clay loam about 12 inches thick.

Permeability is moderately slow, and available water capacity is high. Content of organic matter is moderate, and natural fertility is high. Runoff is slow.

Dockery soils are used mostly for cultivated crops. Some areas are used for pasture or woodland.

Representative profile of Dockery silt loam in a cultivated field in Montgomery County, 1,290 feet south and 410 feet east of center of sec. 5, T. 46 N., R. 5 W.:

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) heavy silt loam; moderate very fine granular structure; friable; few roots; neutral; abrupt smooth boundary.

C1—6 to 14 inches; dark grayish brown (10YR 4/2) light silty clay loam; few fine prominent dark reddish brown (5YR 3/4) and faint dark gray (10YR 4/1) mottles; massive; firm; few roots; neutral; clear smooth boundary.

C2—14 to 38 inches; dark grayish brown (10YR 4/2) silt loam; common fine faint dark brown (10YR 4/3) mottles; weak thin platy structure; thin strata of brown coarse silt; friable; neutral; clear smooth boundary.

C3—38 to 48 inches; dark grayish brown (10YR 4/2) heavy silt loam; common fine prominent dark reddish brown (5YR 3/4) mottles; weak thin platy structure; friable; common black stains; neutral; clear smooth boundary.

C4—48 to 60 inches; dark grayish brown (10YR 4/2) light silty clay loam; common fine distinct brown (10YR 5/3) and dark yellowish brown (10YR 3/4) mottles; massive; friable; neutral.

The solum is less than 10 inches thick. The A horizon is

dark grayish brown or very dark grayish brown. The C horizon commonly has coarser or finer textured lenses less than 6 inches thick.

Dockery soils are wetter than the associated Nodaway soils. They are higher in reaction than Sharon soils, which occupy similar positions.

Do—Dockery silt loam (0 to 2 percent slopes). This soil is on first bottoms. In larger flood plains it is between areas of Nodaway soils that border the stream and areas of Nodaway soils that are on higher stream terraces. In many places it is in old stream meanders that are filled with recent alluvium. It also is in narrow areas of bottom land along many small stream branches. Most areas are 20 to 60 acres in size and have an elongated shape. Included in mapping are areas of a similar soil that contains more sand throughout and has a lighter colored surface layer.

On the larger flood plains, this soil is used mostly for corn and soybeans. Small grain is less extensive in these areas because of the hazard of spring flooding. Narrow areas along small stream branches are used mostly for pasture and woodland.

This soil is well suited to row crops in areas large enough for practical use of large machinery. Flooding is the main hazard, and levee construction is generally impractical. Some ponded areas need surface drainage.

Fertilization according to soil tests is effective. The soil is neutral in most areas and does not need lime. Good tilth and organic matter can be maintained by using crop residues. Capability unit IIw–1.

Gasconade Series

The Gasconade series consists of shallow, somewhat excessively drained, moderately sloping to very steep soils on uplands. These soils formed in material weathered from limestone and thinly interbedded shale. Native vegetation is grasses, forbs, and hardwood trees. The hardwood trees are mostly chinquapin, black oak, and cedar.

In a representative profile the surface layer is very dark grayish brown stony silty clay loam about 6 inches thick. The subsoil is firm, dark brown channery silty clay about 7 inches thick. Limestone bedrock is at a depth of 13 inches.

Permeability is moderately slow, and available water capacity is very low. Content of organic matter is moderate, and natural fertility is medium. Runoff is rapid.

Gasconade soils are used mostly for recreation and wildlife habitat.

Representative profile of Gasconade stony silty clay loam, 5 to 9 percent slopes, in a wooded area in Montgomery County, 290 feet east and 210 feet north of the southwest corner of sec. 5, T. 47 N., R. 5 W.:

A1—0 to 6 inches; very dark grayish brown (10YR 3/2) stony heavy silty clay loam; strong very fine subangular blocky structure; friable; many roots; 10 percent limestone fragments 1 inch to 4 inches long; 20 percent of surface covered by limestone fragments 20 to 50 inches long; neutral; clear smooth boundary.

B2—6 to 13 inches; dark brown (7.5YR 3/2) channery silty clay; moderate very fine subangular blocky structure; firm; common roots; 30 percent limestone fragments 3 to 6 inches long and 10 percent limestone fragments 6 to 20 inches long; neutral.

R—13 inches; limestone bedrock.

The solum ranges from 9 to 20 inches in thickness, and the depth to limestone bedrock is commonly the same as this thickness. The A horizon is very dark grayish brown or very dark brown. The B horizon is dark brown or very dark brown. The content of coarse fragments varies greatly within short horizontal distances.

Gasconade soils have limestone bedrock at a shallower depth than the associated Chilhowie and Goss soils.

GaC—Gasconade stony silty clay loam, 5 to 9 percent slopes. This moderately sloping soil is mostly on crests of ridgetops and points of ridges. Most areas are 10 to 30 acres in size. This soil has the profile described as representative of the series. Stones, mostly limestone, are dominantly 6 inches to 2 feet across and occupy 5 to 20 percent of the surface area.

Included with this soil in mapping are small areas of Rock outcrop that has practically no soil material above the bedrock. Also included are areas where slopes are 9 to 14 percent.

Most areas are covered with mixed grasses and cedars and other hardwoods. They are mainly used for recreation but also serve incidentally as wildlife habitat. Some areas are used for pasture, but production of grasses is limited by droughtiness, and mowing is hampered by large stones. High quality cedar is harvested for posts and other uses in places, but growth is slow. Other hardwoods, mostly black oak and chinquapin oak, seldom reach marketable size or quality. Development of wildlife habitat is severely limited by droughtiness, large stones, and shallow rooting depth.

Some areas afford access by road or trail to the steeper soils below. These areas provide vistas of great scenic beauty, and are favored as cabin sites. Capability unit VIs–8.

GdF—Gasconade-Rock outcrop complex, 14 to 50 percent slopes. This complex is on side slopes in areas that have an intricate pattern of shallow soils and exposed bedrock. Slopes are steep and very steep. The complex is about 50 percent Gasconade soils, 30 percent Rock outcrop, and 20 percent other soils.

The Rock outcrop has little or no soil material above the bedrock. It is mostly very steep and is on south and southwest facing side slopes. Gasconade soils are on the slightly more stable side slopes.

Included with this unit in mapping are areas of Goss soils and many small areas of Chilhowie soils. Also included are areas where slopes are more than 50 percent. In places these areas have vertical or overhanging cliffs.

Most areas support a stand of mixed, poor quality hardwoods or a sparse stand of cedars and grasses. Few trees reach marketable size or quality.

This complex is used mainly for recreation and wildlife habitat. It has severe limitations for both these uses. Steep slopes, large stones, and cliffs limit use to hunting and hiking by the physically fit. Development of wildlife habitat is severely limited by steep slopes, droughtiness, large stones, and the shallow rooting depth. Capability unit VIIs–8.

Goss Series

The Goss series consists of deep, well drained, moderately sloping to very steep soils on uplands. These

soils formed in material weathered from cherty limestone and thinly interbedded shale under forest vegetation.

In a representative profile the surface layer is dark grayish brown very cherty silt loam about 2 inches thick. The subsurface layer is brown very cherty silt loam about 21 inches thick. The subsoil is firm very cherty clay about 38 inches thick. The upper part is reddish brown and the lower part is brownish yellow. The underlying material is very pale brown weathered chert and shale.

Permeability is moderate, and available water capacity is low. Content of organic matter and natural fertility are low. Runoff is rapid.

Most areas remain in mixed hardwood forest. A much smaller acreage has been cleared and is used for pasture. Goss soils are suited to woodland, pasture, woodland wildlife habitat, and recreation.

Representative profile of Goss very cherty silt loam in a wooded area of Goss soils, 14 to 45 percent slopes, in Warren County, 680 feet south and 1,180 feet east of northwest corner of sec. 8, T. 46 N., R. 4 W.:

A1—0 to 2 inches; dark grayish brown (10YR 4/2) very cherty silt loam; moderate very fine granular structure; friable; many roots; 75 percent coarse fragments, mostly angular chert 1 to 4 inches in diameter; medium acid; abrupt smooth boundary.

A2—2 to 23 inches; brown (10YR 5/3) very cherty silt loam; weak fine subangular blocky structure; friable; many roots; 75 percent coarse fragments, mostly angular chert 1 to 4 inches in diameter; strongly acid; abrupt smooth boundary.

B2—23 to 43 inches; reddish brown (5YR 4/4) very cherty clay; strong medium angular and subangular blocky structure; firm; common roots; thick continuous clay films on faces of peds; 75 percent coarse fragments, mostly angular chert 1 to 4 inches in diameter; strongly acid; abrupt wavy boundary.

B3—43 to 61 inches; brownish yellow (10YR 6/6) very cherty clay; weak very fine subangular blocky structure; firm; few roots; thick continuous reddish brown (5YR 4/4) clay films and flows on chert fragments and filling cracks and interstices between coarse fragments; strongly acid; clear wavy boundary.

C—61 to 65 inches; very pale brown (10YR 7/4) weathered chert and shale.

The solum ranges from 55 to about 75 inches in thickness. The A horizon is silt loam or very cherty silt loam. The A2 horizon is brown or pale brown. Chert content of the A2 horizon ranges from about 60 to 80 percent. The B horizon is reddish brown, yellowish red, or strong brown cherty silty clay or cherty clay. Chert content of the B horizon ranges from 65 to 80 percent. The B horizon is medium acid or strongly acid.

Goss soils are deeper over bedrock than the associated Gasconade and Chilhowie soils.

GoD—Goss very cherty silt loam, 5 to 14 percent slopes. This moderately sloping to strongly sloping soil is on the tops and points of ridges. Most areas are 5 to 20 acres in size. This soil has a profile similar to the one described as representative of the series, but the underlying material is a few inches deeper.

Most areas of this soil are used for woodland, wildlife habitat, and recreation. Some areas have been cleared and are used for pasture.

Most woodland is in need of stand improvement by selective harvest and thinning or removal of undesirable trees. Controlling fire and grazing is also a concern.

Most areas used for pasture can be mowed to control weeds and brush, but stand renovation is difficult because of the very cherty surface layer. Droughtiness limits pasture production.

Development for wildlife habitat is limited by droughtiness and the very cherty surface layer. Capability unit VIs–9.

GoF—Goss soils, 14 to 45 percent slopes. These steep to very steep soils are on side slopes. They are generally downslope from ridgetops occupied by Hatton and Keswick soils and upslope from areas of Gasconade-Rock outcrop complex or areas of Chilhowie, Crider, and Gasconade soils. Areas are long and banded and range from about 20 acres to hundreds of acres in size.

This undifferentiated group is about 40 percent Goss very cherty silt loam, which is on south facing side slopes and has the profile described as representative of the series; 40 percent Goss silt loam, which is generally on north facing side slopes and has a surface layer that is less than 10 percent chert; and 10 percent Goss cherty silt loam, which is on side slopes that have intermediate aspects and has a surface layer that is 20 to 50 percent chert.

Included with this unit in mapping are areas of a soil that has a silt loam surface layer and subsurface layer, a silty clay loam subsoil, and a cherty fragipan at a depth of about 24 inches. This included soil is on the less sloping parts of north facing slopes adjacent to Goss silt loam. Areas of it and small areas of other similar soils make up 10 percent of the areas of this mapping unit.

Most areas of Goss soils remain in woodland of mixed hardwoods. A much smaller acreage has been cleared and is used for pasture. These soils are better suited to woodland, woodland wildlife habitat, and recreation than to other uses. Pasture is mostly limited to areas of less sloping Goss silt loam and to areas of the included similar soils on north facing slopes. Growth of timber is also much better on north facing slopes.

The main woodland concerns are selective cutting, stand improvement, and control of fire and grazing. These practices also improve areas as habitat for woodland wildlife. Capability unit VIIs–9.

Hatton Series

The Hatton series consists of deep, moderately well drained, gently sloping and moderately sloping soils on uplands. These soils formed in loess and the underlying glacial sediment under forest vegetation.

In a representative profile the surface layer is very dark grayish brown and dark brown silt loam about 2 inches thick. The subsurface layer is yellowish brown silt loam about 6 inches thick. The subsoil is about 24 inches thick. It is strong brown silt loam and silty clay loam in the upper part, dark yellowish brown silty clay in the middle part, and mottled silty clay loam in the lower part. Below this, to a depth of 60 inches, is mottled silt loam.

Permeability is slow, and the available water capacity is moderate. Content of organic matter and natural fertility are low. Runoff is medium.

Hatton soils are used mainly for pasture and wood-

land, but many areas are used for field crops and meadow.

Representative profile of Hatton silt loam, 2 to 9 percent slopes, in woodland in Warren County, 1,120 feet north and 160 feet west of southeast corner of sec. 2, T. 46 N., R. 2 W.:

A1—0 to 2 inches; very dark grayish brown (10YR 3/2) and dark brown (10YR 4/3) silt loam; moderate very fine granular structure; very friable; many roots; strongly acid; abrupt smooth boundary.

A2—2 to 8 inches; yellowish brown (10YR 5/4) silt loam; weak thin platy structure parting to moderate very fine granular; very friable; many roots; few fine black concretions; very strongly acid; clear smooth boundary.

B1—8 to 13 inches; strong brown (7.5YR 5/6) heavy silt loam; moderate very fine subangular blocky structure; friable; few roots; few fine black concretions; very strongly acid; clear smooth boundary.

B21t—13 to 18 inches; strong brown (7.5YR 5/6) silty clay loam; moderate fine subangular blocky structure; firm; few roots; thin discontinuous clay films; few fine black concretions; very strongly acid; clear smooth boundary.

B22t—18 to 23 inches; dark yellowish brown (10YR 4/4) silty clay; strong fine subangular blocky structure; firm; few roots; thick continuous clay films; thick light gray silt coatings on peds; very strongly acid; clear smooth boundary.

B3t—23 to 32 inches; mottled dark brown (7.5YR 4/4), brown (10YR 4/3), and grayish brown (10YR 5/2) heavy silty clay loam; moderate very fine subangular blocky structure; firm; few roots; thin continuous clay films; few fine black concretions; very strongly acid; gradual smooth boundary.

IIA'2—32 to 37 inches; coarsely mottled grayish brown (10YR 5/2) and brown (7.5YR 4/4) heavy silt loam; moderate medium prismatic structure parting to weak fine subangular blocky; firm; few roots; few fine black concretions; very strongly acid; clear smooth boundary.

IIB'2x—37 to 45 inches; dark yellowish brown (10YR 4/4) silt loam; common coarse prominent light brownish gray (10YR 6/2) mottles; weak fine platy structure; very firm; compact and brittle; shatters under pressure; common fine sand grains; strongly acid; gradual smooth boundary.

IIC2—45 to 60 inches; yellowish brown (10YR 5/4) silt loam; few fine faint dark brown (10YR 4/3) mottles; massive; firm; common fine sand grains; common coarse black iron and manganese stains; medium acid.

The solum ranges from 40 to about 55 inches in thickness. The A1 horizon is very dark grayish brown or dark grayish brown. In plowed areas the Ap horizon is brown or dark grayish brown and generally no A2 horizon is present. The B1 horizon is heavy silt loam or light silty clay loam. Reaction is strongly acid or very strongly acid throughout the solum if the Ap horizon is not limed.

Hatton soils are better drained than the associated Keswick and Marion soils.

HcB—Hatton silt loam, 2 to 9 percent slopes. This soil is on long, narrow ridgetops, generally upslope from Keswick or Goss soils. Areas are large and have a narrow and winding shape.

Included with this soil in mapping are many areas of severely eroded soil that are indicated on the soil map by a spot symbol. In most cultivated areas, some of the subsoil material has been mixed into the plow layer. Also included in mapping are many long, narrow areas of Keswick soils that have slopes of 5 to 9 percent.

This soil is used for woodland, pasture, meadow, wheat, grain sorghum, and corn. It is suited to cultivated crops if erosion is controlled, but terracing is difficult because areas are irregularly shaped and slopes are complex. In cultivated areas erosion can be controlled by no-till farming or minimum tillage and cropping sequences that include meadow and small grain. In most places Hatton soils are surrounded by forests. In years of poor mast production, damage to row crops by wildlife, notably deer and squirrels, can be serious.

An important part of management is the improvement and maintenance of fertility by liming and fertilizing according to soil tests. Using crop residue, green manure crops, and barnyard manure helps to maintain content of organic matter and tilth and also helps to control erosion.

This soil has good potential for orchards and vineyards. Many areas are used for woodland, and stands are mostly white oak, black oak, and hickory. Selective harvest of mature trees, thinning of second growth stands, removal or deadening of cull trees, and control of fire and grazing are good management practices that also enhance the areas as habitat for wildlife, especially deer, grouse, and turkeys.

Important pasture management practices are maintenance of fertility by liming and fertilizing, control of brush and weeds by mowing, and protection from overgrazing by proper stocking. Capability unit IIIe-4.

Haynie Series

The Haynie series consists of deep, well drained, nearly level soils on bottom land. These soils formed in Missouri River alluvium under mixed forest vegetation.

In a representative profile the surface layer is dark grayish brown very fine sandy loam about 7 inches thick. Below this, to a depth of 60 inches, is grayish brown and dark grayish brown very fine sandy loam that has thin lenses of finer and coarser textured material.

Permeability is moderate, and available water capacity is high. Content of organic matter is low, and natural fertility is high. Runoff is slow.

Haynie soils are used for field crops and alfalfa.

Representative profile of Haynie very fine sandy loam in a cultivated field in Montgomery County, 1,420 feet north and 5 feet east of southwest corner of sec. 1, T. 45 N., R. 6 W.:

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) very fine sandy loam; moderate very fine granular structure; very friable; common roots; mildly alkaline; abrupt smooth boundary.

C1—7 to 17 inches; dark grayish brown (10YR 4/2) very fine sandy loam; moderate very fine granular structure; very friable; common roots; common very dark grayish brown (10YR 3/2) wormcasts; slight effervescence; mildly alkaline; abrupt smooth boundary.

C2—17 to 60 inches; grayish brown (10YR 5/2) very fine sandy loam; few fine prominent yellowish red (5YR 5/8) mottles, massive; very friable; few thin lenses of silty clay loam and loamy fine sand; strong effervescence; mildly alkaline.

The solum is less than 10 inches thick, and is equivalent to the Ap or A1 horizon. Texture is mainly very fine sandy loam throughout, but in many places there are thin lenses of coarser or finer textured material.

The A horizon is dark grayish brown, which is outside

the range defined for the Haynie series, but this difference does not alter use or behavior.

Haynie soils contain less clay between depths of 10 and 40 inches than the associated Blake soils. They contain less and finer textured sand than the associated Hodge soils.

He—Haynie very fine sandy loam (0 to 2 percent slopes). This soil generally is on natural levees, which are the highest positions in the Missouri River flood plain. Most areas are elongated in shape and 40 to 100 acres in size.

Included with this soil in mapping were many long, narrow areas of a soil which is similar, but has coarser textured sand at a depth of about 20 to 40 inches, and small areas of another similar soil that has a clay loam surface layer. Also included are small areas of Blake soils.

This soil is used for corn, soybeans, wheat, and alfalfa, and it is well suited to these crops. Because drainage and tilth are good, the soil is generally the first to be planted in the Missouri River flood plain, especially in wet spring planting seasons.

Nitrogen and starter fertilizers are effective. Organic matter and tilth can be maintained by using crop residue. Capability unit I–1.

Hodge Series

The Hodge series consists of deep, somewhat excessively drained, nearly level soils on bottom land. These soils formed in recent sandy Missouri River alluvium. Native vegetation consists mainly of willow, cottonwood, and a sparse growth of grasses.

In a representative profile the surface layer is dark brown loamy fine sand about 10 inches thick. The next layer is dark grayish brown loamy fine sand about 35 inches thick. It has a few thin lenses of very fine sandy loam. Below this is a layer of dark grayish brown very fine sandy loam about 10 inches thick. It is underlain by brown fine sand.

Permeability is rapid, and available water capacity is low. Content of organic matter is low, and natural fertility is medium. Runoff is slow.

Some areas of Hodge soils are used for crops, mainly small grain. Other areas are wooded or are idle.

Representative profile of Hodge loamy fine sand in woodland of Montgomery County, 340 feet west and 990 feet north of southeast corner of sec. 31, T. 46 N., R. 6 W.:

A1—0 to 10 inches; dark brown (10YR 4/3) loamy fine sand; single grained; loose; slight effervescence; mildly alkaline; clear smooth boundary.

C1—10 to 45 inches; dark grayish brown (10YR 4/2) loamy fine sand; single grained; loose; few thin lenses of grayish brown very fine sandy loam; slight effervescence; mildly alkaline; clear wavy boundary.

C2—45 to 55 inches; dark grayish brown (10YR 4/2) very fine sandy loam; massive; friable; few thin lenses of very dark brown silty clay loam; slight effervescence; mildly alkaline; clear wavy boundary.

C3—55 to 60 inches; brown (10YR 5/3) fine sand; single grained; loose; slight effervescence; mildly alkaline.

The thickness of the solum is 10 inches or less and is equivalent to that of the Ap or A1 horizon. The sandy horizons range from 40 inches to several feet in thickness. The A horizon and C horizon are mainly loamy fine sand throughout and have thin lenses of finer textured material.

Hodge soils contain more and coarser textured sand throughout than the associated Haynie soils.

Hg—Hodge loamy fine sand (0 to 2 percent slopes). This soil is in areas next to the Missouri River channel and in other areas of recent deposition. Most areas are 20 to 60 acres in size, but a few are much larger.

Included with this soil in mapping are large areas of a sandy soil that was recently deposited by fast flowing floodwater pouring through levee breaks. This soil differs from other Hodge soils in that the sand is coarser textured and is not so thick. It is generally unsuited to crops, and many areas are being renovated by sand spreading followed by deep plowing.

The low available water capacity limits the suitability of this Hodge soil for crops. Row crops are poorly suited because of the hazard of summer drought. In areas protected by levees, small grain and alfalfa can be grown successfully if fall moisture is adequate to establish a stand. Many areas are too small or are too irregular in shape to be handled separately, and they are farmed with areas of other soils. Capability unit IIIs–1.

Holstein Series

The Holstein series consists of deep, well drained, moderately sloping to steep soils on uplands. These soils formed under hardwood forest in colluvium weathered from sandstone and the overlying limestone and shale.

In a representative profile the upper 5 inches of the surface layer is dark brown loam and the lower 4 inches is strong brown clay loam. The upper 37 inches of the subsoil is firm, yellowish red clay loam, and the lower 19 inches is yellowish red sandy clay loam.

Permeability is moderate, and available water capacity is high. Content of organic matter and natural fertility are low. Runoff is medium to rapid.

Holstein soils are used mostly for pasture and woodland. Some areas are used for field crops and meadow.

Representative profile of Holstein loam, 9 to 14 percent slopes, eroded, in a pasture in Montgomery County, 1,290 feet south and 2,250 feet west of northeast corner of sec. 2, T. 46 N., R. 5 W.:

Ap—0 to 5 inches; dark brown (10YR 4/3) loam; moderate very fine granular structure; very friable; many fine roots; common chert fragments; medium acid; clear smooth boundary.

Ap2—5 to 9 inches; strong brown (7.5YR 5/6) light clay loam; moderate very fine subangular blocky structure; friable; peds surrounded by dark brown (10YR 4/3) loam; moderate very fine granular structure; very friable; many fine roots; common fine chert fragments; medium acid; clear smooth boundary.

B1—9 to 13 inches; yellowish red (5YR 5/6) light clay loam; moderate very fine subangular blocky structure; firm; common fine roots; common dark brown wormcasts; common fine chert fragments; strongly acid; clear smooth boundary.

B21t—13 to 30 inches; yellowish red (5YR 5/6) clay loam; strong fine and medium subangular blocky structure; firm; few fine roots; thick discontinuous clay films on faces of peds; few fine chert fragments; very strongly acid; gradual smooth boundary.

B22t—30 to 46 inches; yellowish red (5YR 5/8) clay loam; moderate medium prismatic structure parting to moderate fine and very fine subangular blocky firm; few fine roots; thin continuous clay films on faces

of prisms; common fine chert fragments; very strongly acid; clear smooth boundary.

B23t—46 to 65 inches; yellowish red (5YR 5/8) sandy clay loam; common coarse distinct brown (7.5YR 5/4) mottles; moderate medium prismatic structure; firm; few fine iron oxide and manganese oxide concretions and coarse black stains; common fine chert fragments; very strongly acid.

The solum is 60 or more inches thick. The A horizon is as much as 15 percent coarse fragments in places. It is typically brown or dark brown. The B2 horizon is clay loam or sandy clay loam. The B horizon is yellowish red, reddish brown, dark brown, or strong brown. Reaction is medium acid or slightly acid in the A horizon, and it ranges from very strongly acid to medium acid in the B horizon.

Holstein soils are thicker than the associated Chilhowie and Gasconade soils. They contain more sand than Winfield and Crider soils, which occupy similar positions.

HoC2—Holstein loam, 5 to 9 percent slopes, eroded. This moderately sloping soil is on convex foot slopes adjoining small stream bottom land. Most areas are 5 to 20 acres in size. This soil has a profile similar to the one described as representative of the series, but the subsoil is mottled with gray.

Included with this soil in mapping are small areas of severely eroded soil that are indicated on the soil map by a spot symbol. Also included were a few areas of a soil that contains more sand in the subsoil than Holstein soils.

This soil is used for pasture and meadow and, to a lesser extent, for corn, soybeans, and small grain. Larger areas are suited to cultivated crops in sequence with small grain and meadow if runoff from adjoining uplands is diverted. Most areas have short slopes and do not require terracing. Further erosion can be controlled by cropping systems that include small grain and meadow as well as row crops, and by no-till farming or minimum tillage.

Improvement and maintenance of fertility is an important concern, and liming and fertilizing according to soil tests is effective. Using crop residue, green manure crops, and barnyard manure helps maintain organic matter content and tilth and also helps control erosion.

Important pasture management practices are maintenance of fertility by liming and fertilization, mowing to control brush and weeds, and proper stocking to avoid overgrazing. Capability unit IIIe–1.

HoD2—Holstein loam, 9 to 14 percent slopes, eroded. This moderately sloping soil is on foot slopes. In most places it is downslope from sandstone bedrock exposures. Most areas are 10 to 60 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are areas of severely eroded soil and many outcrops of sandstone bedrock, both of which are indicated on the soil map by symbols. Also included are small areas of a similar soil that is gray in the subsoil and is less than 60 inches deep to bedrock.

This soil is used mostly for pasture and woodland, but some areas are used for cultivated crops. Larger areas where slopes are smooth are suited to cultivated crops in sequence with small grain and meadow, if erosion is controlled. Terraces and grass waterways need extreme care in design and maintenance because of the hazard of gully erosion. Minimum tillage and cultivation on the contour help control soil and water losses.

Fertility needs can be met by liming and fertilizing according to soil tests. Using crop residue, green manure crops, and barnyard manure maintains organic matter content and tilth and also helps control erosion.

Gullies are common. They can be filled or shaped and seeded to grass, which permits crossing by machinery needed to improve and mow pasture. Other important pasture management practices are maintenance of fertility by liming and fertilization and proper stocking to avoid overgrazing. Capability unit IVe–1.

HrE—Holstein-Rock outcrop complex, 14 to 35 percent slopes. This moderately steep to steep complex is on foot slopes downslope from standstone bedrock exposures. It is about 30 percent Holstein soils, 30 percent soils that differ from Holstein because they contain more sand in the subsoil and are less deep over bedrock, 10 percent very stony soils that have common sandstone bedrock exposures, and 30 percent other soils. Included in mapping are areas where slopes are more than 35 percent. Many of these areas have vertical or overhanging cliffs.

The complex is used mainly for woodland and pasture. Many areas where slopes are less than 20 percent have been cleared and are used for pasture. Areas of steeper soil are nearly all in hardwood forest.

Because of the erosion hazard, renovation of pasture is better accomplished by seeding and treating the soil following minimum tillage. Mowing to control weeds and brush is difficult in those areas that are dissected by steep sided drainageways.

Timber production can be increased by selective cutting, thinning of second growth stands, and removal of undesirable trees. By creating openings in the forest canopy, these practices also improve areas as habitat for wildlife, especially deer, grouse, and turkey.

Recreation use is increasing because of the striking scenic beauty of the landscape. There are many vertical cliffs, water carved sandstone formations, and clear streams. Capability unit VIIs–8.

Keswick Series

The Keswick series consists of deep, moderately well drained, moderately sloping and strongly sloping soils on uplands. These soils formed in glacial deposits under hardwood forest.

In a representative profile the surface layer is very dark grayish brown silt loam about 2 inches thick. The subsurface layer is silt loam about 14 inches thick. It is brown in the upper part and yellowish brown in the lower part. The very firm clay subsoil is about 36 inches thick. It is yellowish red in the upper part and strong brown in the lower part. The underlying material is firm, yellowish brown clay loam.

Permeability is slow. Depending on the degree of erosion, the available water capacity is moderate or low. Content of organic matter and natural fertility are low. Runoff is rapid.

Keswick soils are used for field crops, meadow, pasture, and woodland.

Representative profile of Keswick silt loam, 9 to 14 percent slopes, in a forest in Warren County, 1,320

feet south and 430 feet east of northeast corner of sec. 2, T. 46 N., R. 2 W.:

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

A21—2 to 8 inches; brown (10YR 5/3) silt loam; weak thin platy structure parting to moderate very fine granular; friable; common roots; very strongly acid; clear smooth boundary.

A22—8 to 16 inches; yellowish brown (10YR 5/6) heavy silt loam; moderate very fine subangular blocky structure; friable; common roots; very strongly acid; gradual smooth boundary.

IIB21t—16 to 30 inches; yellowish red (5YR 4/6) clay; common fine distinct brown (7.5YR 4/4), red (2.5YR 4/6), and grayish brown (10YR 5/2) mottles; moderate fine angular blocky structure parting to moderate very fine subangular blocky; very firm; few roots; thick continuous clay films; common rounded glacial pebbles and angular chert fragments; prominent stone line at top of horizon; very strongly acid; clear smooth boundary.

IIB22t—30 to 52 inches; strong brown (7.5YR 5/6) clay; few fine distinct yellowish red (5YR 4/8) mottles; moderate very fine angular and subangular blocky structure; very firm; few roots; thick continuous clay films; common rounded glacial pebbles and angular chert fragments; strongly acid; clear smooth boundary.

IIC—52 to 60 inches; yellowish brown (10YR 5/6) clay loam; common fine distinct grayish brown (10YR 5/2) and prominent yellowish red (5YR 4/8) mottles; moderate fine subangular blocky structure; firm; few roots; common rounded glacial pebbles and angular chert fragments; medium acid.

The solum ranges from about 45 to 72 inches in thickness. In most places a stone line of dominantly chert fragments is at the top of the IIB horizon. The A horizon ranges from about 8 to 20 inches in thickness. It is silt loam or clay loam. The IIB horizon has matrix colors of yellowish red, brown, or strong brown and has grayish brown mottles.

Keswick soils are better drained than the associated Marion soils. They are wetter than the associated Hatton soils. They are wetter than Lindley soils, which formed in similar material, and have a redder subsoil.

KeC2—Keswick silt loam, 5 to 9 percent slopes, eroded. This moderately sloping soil is on crests of ridges and on side slopes. Most areas are 10 to 40 acres in size. This soil is similar to the one described as representative of the series, but it is less sloping and depth to the clay subsoil is greater. Included in mapping are many areas of severely eroded soil that are indicated on the soil map by spot symbols.

This soil is well suited to pasture, meadow, and woodland. It is suited to cultivated crops if erosion is controlled, but terracing is difficult on many areas because slopes are complex. If these areas are cultivated, erosion can be controlled by no-till farming or minimum tillage practices. Cropping systems that include small grain and meadow are needed in all cultivated areas.

Other important management practices are liming and fertilizing according to soil tests for improvement and maintenance of fertility. Using crop residue, green manure crops, and barnyard manure helps maintain organic matter content and tilth and also helps control erosion. Important pasture management practices, in addition to liming and fertilizing, are control of brush and weeds by mowing and proper stocking to prevent overgrazing.

Many areas are used for woodland, and good quality white oak is predominant in the stands. The main concerns are selective harvest of mature trees, thinning of second growth stands, and removal of undesirable trees. These practices also improve areas as habitat for wildlife, especially deer, grouse, and turkeys. Capability unit IIIe–5.

KeD—Keswick silt loam, 9 to 14 percent slopes. This strongly sloping soil is on side slopes. Most areas are large, long, and narrow. This soil has the profile described as representative of the series.

Included with this soil in mapping are many small areas of Lindley loam, 14 to 35 percent slopes, on short slopes at drainageways. Areas of severely eroded soil are included and are indicated on the soil map by spot symbols. Also included are areas of a soil similar to Keswick soils, except for a surface layer that is 10 to 35 percent chert.

This soil is used mostly for woodland and pasture, and it is well suited to these uses. It is poorly suited to cultivated crops.

Most areas are in woodland, and good quality white oak is dominant. The main concerns are selective harvest of mature trees, thinning of second growth stands, and removal or deadening of undesirable trees. These practices also improve the areas as habitat for wildlife, especially deer, grouse, and turkeys. Important pasture management practices are renovation of stands, control of grazing, and mowing to control weeds and brush. Capability unit IVe–4.

KsC3—Keswick clay loam, 5 to 9 percent slopes, severely eroded. This soil has a profile similar to the one described as representative of the series, but erosion has removed nearly all of the surface layer. The subsoil material has mixed into the plow layer, and the former silt loam surface layer is now clay loam. Most areas are 3 to 15 acres in size.

This soil is poorly suited to cultivated crops. It is better suited to pasture, wildlife habitat, or reforestation. Many small areas are impractical to use separately and are farmed with adjacent Keswick or Hatton soils, but production of cultivated crops is generally poor.

Important pasture management practices are establishment and renovation of stands, controlled grazing, and mowing to control brush and weeds.

Many abandoned areas serve incidentally as wildlife habitat. These areas can be improved by plantings that provide food for wildlife. Capability unit IV–8.

Lindley Series

The Lindley series consists of deep, well drained, moderately steep and steep soils on uplands. These soils formed in glacial till under hardwood forest.

In a representative profile the surface layer is dark grayish brown loam about 2 inches thick. The subsurface layer is pale brown loam about 2 inches thick. The subsoil is firm clay loam about 41 inches thick. It is strong brown in the upper part and yellowish brown mottled with gray in the lower part. The underlying material is yellowish brown clay loam that has gray mottles.

Permeability is moderately slow, and available water capacity is high. Content of organic matter and natural fertility are low. Runoff is rapid.

Lindley soils are used for woodland and pasture.

Representative profile of Lindley loam, 14 to 35 percent slopes, in woodland in Warren County, 150 feet west and 90 feet south of northeast corner of sec. 1, T. 46 N., R. 3 W.:

A1—0 to 2 inches; dark grayish brown (10YR 4/2) loam; moderate very fine granular structure; very friable; many roots; common small angular chert fragments and rounded glacial pebbles; medium acid; abrupt smooth boundary.

A2—2 to 4 inches; pale brown (10YR 6/3) loam; weak thin platy structure parting to moderate very fine granular; very friable; many roots; few small angular chert fragments and rounded glacial pebbles; very strongly acid; abrupt smooth boundary.

B&A—4 to 6 inches; strong brown (7.5YR 5/6) light clay loam (B2); strong fine subangular blocky structure; firm; peds surrounded by pale brown (10YR 6/3) loam (A2); common roots; few small angular chert fragments and rounded glacial pebbles; very strongly acid; abrupt smooth boundary.

B21—6 to 11 inches; strong brown (7.5YR 5/6) clay loam; moderate fine subangular blocky structure; firm; few roots; few small angular chert fragments and rounded glacial pebbles; thin continuous clay films on faces of peds; very strongly acid; clear smooth boundary.

B22—11 to 22 inches; yellowish brown (10YR 5/6) clay loam; moderate very fine subangular blocky structure; firm; few roots; few small angular chert fragments and rounded glacial pebbles; thin continuous clay films on faces of peds; very strongly acid; gradual smooth boundary.

B23—22 to 36 inches; yellowish brown (10YR 5/6) clay loam; common medium distinct light gray (10YR 7/2) mottles; moderate very fine subangular blocky structure; firm; few roots; few small angular chert fragments and rounded glacial pebbles; thin continuous clay films on faces of peds; very strongly acid; clear smooth boundary.

B3—36 to 45 inches; yellowish brown (10YR 5/6) clay loam; common medium distinct light gray (10YR 7/2) mottles; weak medium prismatic structure parting to weak fine subangular blocky; firm; few roots; common black stains; thin discontinuous clay films on faces of peds; few small angular chert fragments and rounded glacial pebbles; slightly acid; clear smooth boundary.

C—45 to 60 inches; yellowish brown (10YR 5/6) light clay loam; common medium distinct light gray (10YR 7/2) mottles; massive; firm; few roots; common medium carbonate concretions; few small angular chert fragments and rounded glacial pebbles; mildly alkaline.

The solum ranges from 35 to about 50 inches in thickness. Typically, rounded glacial pebbles and small angular chert fragments are mixed throughout. The A horizon ranges from 4 to 10 inches in thickness.

Lindley soils contain less clay and have a yellower B horizon than Keswick soils, which formed in similar material.

LnE—Lindley loam, 14 to 35 percent slopes. This soil is on side slopes. Most areas are large and fairly regular in shape. Slopes are moderately steep to very steep.

Included with this soil in mapping are areas of a soil similar to Lindley soils except for a cherty surface layer. This soil is mostly at the southern limit of soils that formed in glacial material and is adjacent to Gasconade and Goss soils. A few such areas are also in the Cuivre River Watershed.

Most areas are in hardwood forest, and good quality white oak is dominant. These areas are a major source of timber for staves and lumber. Wildlife habitat and recreation are other important uses.

Concerns when managing woodland are selective harvest of mature trees, thinning of second growth stands, and removal of cull trees. These practices also enhance the value of these areas as habitat for woodland wildlife, especially deer, grouse, and turkeys.

Some areas have been cleared and are used for pasture. The use of machinery needed to mow and renovate pastures is difficult in most places because of steep and complex slopes.

Recreation use is increasing, and many ponds and lakes have been built. Capability unit VIe-4.

Marion Series

The Marion series consists of deep, poorly drained, nearly level soils on uplands. These soils formed in loess under hardwood forest on narrow ridgetops.

In a representative profile the surface layer is dark grayish brown silt loam about 2 inches thick. The subsurface layer is pale brown silt loam about 11 inches thick. The subsoil is about 53 inches thick. It is brown silty clay in the upper part and mottled, grayish brown and yellowish brown silty clay loam in the lower part.

Permeability is very slow, and available water capacity is moderate. Content of organic matter and natural fertility are low. Runoff is slow.

Marion soils are used for field crops, meadow, pasture, and forest.

Representative profile of Marion silt loam in woodland in Warren County, 990 feet east and 480 feet south of northwest corner of sec. 8, T. 46 N., R. 4 W.:

A1—0 to 2 inches; dark grayish brown (10Y 4/2) silt loam; moderate very fine granular structure; very friable; many roots; medium acid; abrupt smooth boundary.

A21—2 to 6 inches; pale brown (10YR 6/3) silt loam; few fine distinct yellowish brown (10YR 5/8) mottles; weak very fine granular structure; very friable; many roots; common fine concretions; very strongly acid; abrupt smooth boundary.

A22—6 to 13 inches; pale brown (10YR 6/3) silt loam; weak very fine granular structure; very friable; many roots; common fine concretions; very strongly acid; abrupt smooth boundary.

B&A—13 to 15 inches; brown (10YR 5/3) silty clay loam (B2t); strong fine subangular blocky structure; firm; few fine concretions; thick very pale brown (10YR 7/3) silt coats (A2); very strongly acid; abrupt smooth boundary.

B2t—15 to 36 inches; brown (10YR 5/3) silty clay; few fine faint gray (10YR 5/1) mottles; weak very fine subangular blocky structure; firm; common roots; continuous moderately thick clay films on faces of peds; few very fine concretions; very strongly acid; clear smooth boundary.

B3—36 to 66 inches; mottled light grayish brown (10YR 6/2) and yellowish brown (10YR 5/8) silty clay loam; moderate thin platy structure; firm; few roots; few very fine concretions; very strongly acid.

The solum ranges from 40 to more than 60 inches in thickness. The A horizon ranges from 10 to 14 inches in thickness. The A2 horizon has matrix colors of gray, light gray, light brownish gray, or pale brown. The B2 horizon has matrix colors of brown or yellowish brown and is mottled with gray or grayish brown throughout.

Marion soils have a lighter colored A horizon and a browner B horizon than Putnam soils, which formed in similar material. They are wetter than the associated Hatton soils.

Ma—Marion silt loam (0 to 2 percent slopes). This nearly level soil is on long, narrow ridgetops. Most areas are 2 to 20 acres in size.

Included with this soil in mapping were many small areas of a similar soil that has a grayer subsoil. This included soil is mostly in slight depressions.

This soil is used for pasture, meadow, wheat, grain sorghum, corn, and woodland. Many small areas are farmed with adjacent Hatton soils. Woodland that is dominantly post oak and hickory covers many small areas.

This soil is better suited to pasture or meadow than to cultivated crops. Excess water or lack of water by season is the main limitations. Some depressional areas need surface drainage. Wetness often delays fieldwork in spring and fall, and the moderate available water capacity makes the soil susceptible to summer drought.

Fertility can be improved and maintained by liming and fertilizing according to soil tests. Organic matter and tilth can be maintained by using crop residue, green manure crops, and barnyard manure. Woodland responds poorly to management. Important pasture management practices are fertility maintenance by liming and fertilization, control of brush and weeds by mowing, and protection from overgrazing by proper stocking. Capability unit IIIw–2.

Menfro Series

The Menfro series consists of deep, well drained, moderately sloping to steep soils on uplands adjacent to flood plains of the Missouri River. These soils formed in loess under hardwood forest.

In a representative profile the surface layer is brown to dark brown silt loam about 7 inches thick. The subsoil is dark brown to brown and is about 50 inches thick. It is friable heavy silt loam in the upper part and firm silty clay loam in the lower part. The underlying material is friable, dark brown to brown silt loam.

Permeability is moderate, and available water capacity is high. Content of organic matter is low, and natural fertility is medium. Runoff is medium to rapid.

Menfro soils are used for field crops, meadow, pasture, and woodland. Gully erosion is a serious concern wherever water is concentrated on these soils. Terraces and grassed waterways require extreme care in design and maintenance.

Representative profile of Menfro silt loam, 5 to 9 percent slopes, eroded, in a cultivated area in Warren County, 1,320 feet east and 520 feet north of center of sec. 21, T. 46 N., R. 4 W.:

Ap—0 to 7 inches; brown to dark brown (10YR 4/3) silt loam; moderate very fine granular structure; very friable; many roots; slightly acid; abrupt smooth boundary.

B1—7 to 11 inches; dark brown to brown (7.5YR 4/4) heavy silt loam; moderate very fine subangular blocky structure; friable; many roots; common small pores; medium acid; clear smooth boundary.

B21—11 to 22 inches; dark brown to brown (7.5YR 4/4) silty clay loam; moderate fine prismatic structure parting to moderate very fine subangular blocky; firm; many roots; thin continuous clay films; medium acid; gradual smooth boundary.

B22—22 to 31 inches; dark brown to brown (7.5YR 4/4) light silty clay loam; moderate medium prismatic structure parting to moderate fine subangular blocky; firm; few roots; thin continuous clay films; few fine black concretions; medium acid; gradual smooth boundary.

B23—31 to 43 inches; dark brown to brown (7.5YR 4/4) light silty clay loam; moderate medium prismatic structure parting to weak fine subangular blocky; firm; few roots; thin discontinuous clay films; few fine black concretions; slightly acid; gradual smooth boundary.

B31—43 to 57 inches; dark brown to brown (7.5YR 4/4) light silty clay loam; moderate medium prismatic structure parting to weak medium subangular blocky; firm; few roots; thin discontinuous clay films; slightly acid; gradual smooth boundary.

C—57 to 72 inches; dark brown to brown (7.5YR 4/4) silt loam; massive; friable; few roots; slightly acid.

The solum ranges from about 50 to 70 or more inches in thickness. The A horizon is brown or dark brown. The B horizon is dark brown to brown. It is slightly acid to strongly acid.

Menfro soils formed in thicker loess than the associated Winfield soils.

MeC2—Menfro silt loam, 5 to 9 percent slopes, eroded. This moderately sloping soil is on ridgetops and high stream benches. Most areas are 10 to 50 acres in size. This soil has the profile described as representative of the series. Runoff is medium. Included in mapping are areas of less sloping Menfro soils.

This soil is used for corn, soybeans, small grain, meadow, and pasture. It is well suited to these uses and is responsive to soil treatment. The potential is good for orchards and vineyards in areas high enough not to be damaged by spring frost.

Erosion control and improving and maintaining fertility and organic matter are the main concerns. If the soil is cultivated, losses of soil and water can be controlled by various combinations of terraces that have proper outlets, grassed waterways, conservation cropping systems that include meadow and small grain, contour farming, and minimum tillage and no-till systems. Grassed waterways require careful design and maintenance to prevent serious gully erosion.

Liming and fertilizing according to soil tests improve and maintain fertility. Organic matter and tilth can be maintained by using green manure crops, crop residue, and barnyard manure.

Important pasture management practices are fertility maintenance by liming and fertilizing, control of brush and weeds by mowing, and protection from overgrazing by proper stocking. Capability unit IIIe–1.

MeD2—Menfro silt loam, 9 to 14 percent slopes, eroded. This strongly sloping soil is on side slopes and ridges. Most areas are 20 to 60 acres in size. This soil has a profile similar to the one described as representative of the series, but the depth to the silty clay loam subsoil is less. Included in mapping are many small areas of severely eroded soil that has a silty clay loam surface layer. These areas are indicated on the soil map by spot symbols.

This soil is used for pasture, meadow, wheat, corn, and soybeans. The potential is fair for orchards and vineyards in areas high enough not to be damaged by spring frost.

If this soil is cultivated, terraces that have grassed waterways and contour farming are needed. Meadow and small grain are important inclusions in cropping

sequences. Minimum tillage and no-till systems control losses of soil and water. Terraces that have steep, grassed back slopes should be used. Gullying is a severe hazard, and careful design and maintenance of waterways is important.

Liming and fertilizing according to soil tests improve and maintain fertility. Organic matter and tilth can be maintained by the use of cover crops, crop residue, green manure crops, and barnyard manure. These practices also help to control erosion.

Important pasture management includes fertility maintenance by liming and fertilization, control of brush and weeds by mowing, and protection from overgrazing by proper stocking. Capability unit IIIe–1.

MeE—Menfro silt loam, 14 to 20 percent slopes. This moderately steep soil is on side slopes. Most areas are 15 to 40 acres in size. Runoff is rapid. This soil has a profile similar to the one described as representative of the series, but depth to the underlying material is less. Included in mapping are areas of severely eroded soil that has a silty clay loam surface layer. These areas are indicated on the soil map by a spot symbol.

This soil is too steep to be cultivated regularly. Cultivated crops can be grown occasionally without a serious erosion problem resulting, but meadow, pasture, and woodland are better uses.

Gullies are common, and they should be shaped and seeded to grass. This practice helps control erosion and permits crossing by machinery needed to mow and improve pasture. Another pasture management concern is protection from overgrazing by proper stocking. Capability unit IVe–1.

MeF—Menfro silt loam, 20 to 35 percent slopes. This steep soil is downslope from other Menfro soils. Most areas are 10 to 30 acres in size. Runoff is very rapid. This soil has a profile similar to the one described as representative of the series, but the depth to the underlying material is considerably less. Small outcrops of bedrock, mostly in drainageways, are common.

Included with this soil in mapping are many small areas where the depth to bedrock is about 40 to 60 inches. Also included are some areas of nearly vertical limestone bluffs along the Missouri River bottom land. These are indicated on the soil map by the symbol for Rock outcrop.

This soil is used for pasture and woodland. Pasture renovation and management are difficult in most areas because slopes are steep and dissected.

This soil is very well suited to woodland. Native woodland is mostly good quality white oak and other hardwoods. Management concerns are selective cutting of mature trees, thinning of second growth stands, and removal of undesirable trees. Other concerns are control of fire and grazing. Capability unit VIe–1.

Mexico Series

The Mexico series consists of deep, somewhat poorly drained, gently sloping soils on uplands. These soils formed in loess under tall prairie grass.

In a representative profile the surface layer is very dark grayish brown silt loam about 7 inches thick. The subsurface layer is dark grayish brown silt loam about 2 inches thick. The subsoil is about 34 inches thick. It is friable, dark grayish brown, red, and yellowish brown silty clay loam in the upper part; firm, dark grayish brown and grayish brown silty clay in the middle part; and firm, grayish brown and yellowish brown silty clay loam in the lower part. The underlying material is grayish brown and yellowish brown clay loam in the upper part and gray silty clay in the lower part.

Permeability is very slow. Depending on the degree of erosion, available water capacity is high to moderate, content of organic matter is moderate to low, and natural fertility is medium to low. Runoff is medium.

Mexico soils are used mostly for field crops and rotation meadow. They are well suited to cultivation except in areas where they are severely eroded. Some areas are used for pasture.

Representative profile of Mexico silt loam, 1 to 5 percent slopes, in a cultivated field in Montgomery County, 245 feet south and 245 feet east of northwest corner of sec. 33, T. 49 N., R. 5 W.:

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam; weak fine granular structure; very friable; many roots; remnants of material similar to A2 horizon in lower part; slightly acid; abrupt smooth boundary.

A2—7 to 9 inches; dark grayish brown (10YR 4/2) silt loam; common medium distinct brown (10YR 5/3) mottles; few peds of red (2.5YR 4/6) silty clay loam in lower inch; weak fine subangular blocky structure; friable; many roots; medium acid; clear smooth boundary.

B21t—9 to 14 inches; mottled dark grayish brown (10YR 4/2), red (2.5YR 4/6), and yellowish brown (10YR 5/6) silty clay loam; moderate fine subangular blocky structure; friable; few roots; thin patchy clay films on faces of peds; strongly acid; clear smooth boundary.

B22t—14 to 20 inches; dark grayish brown (10YR 4/2) silty clay; many medium prominent red (2.5YR 4/6) mottles and common medium distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; firm; strongly acid; clear smooth boundary.

B23t—20 to 25 inches; grayish brown (10YR 5/2) silty clay; common fine distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) mottles; very weak fine subangular blocky structure; firm; medium acid; clear smooth boundary.

B3—25 to 43 inches; mixed grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) silty clay loam; weak coarse subangular blocky structure; firm; slightly acid; clear smooth boundary.

IIC1—43 to 79 inches; mixed grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) clay loam; massive; firm; common dark stains; few pebbles; neutral: clear smooth boundary.

IIC2—79 to 94 inches; mixed gray (10YR 6/1) and strong brown (7.5YR 5/6) silty clay; massive; firm; neutral.

The solum ranges from 20 to 45 inches in thickness. Depending on the degree of erosion, the A horizon ranges from about 6 to 14 inches in thickness. It is silt loam or silty clay loam. The B21t horizon is dark grayish brown, red, and yellowish brown silty clay loam or silty clay. The B22t horizon and B23t horizon are silty clay or clay. The C horizon is clay loam, silty clay loam, or silty clay.

Because of a loss of material by erosion, the A horizon of Mexico silty clay loam, 1 to 5 percent slopes, eroded, has colors that are outside the range defined for the series. This difference, however, does not alter use or behavior of the soil.

Mexico soils are browner in the upper part of the B horizon, have a thinner loess cap, and are steeper than the associated Putnam soils. They have loess over the glacial till that the associated Armster soils do not have. Mexico soils have a darker colored Ap or A1 horizon than the associated Calwoods soils.

MoB—Mexico silt loam, 1 to 5 percent slopes. This is the most extensive soil in the survey area. It is on long, gentle side slopes. It is downslope from the nearly level Putnam soils and upslope from the moderately sloping Armster soils. In many places it occupies the crests of gently sloping divides. Most areas are 80 to 400 acres in size and are farmed with adjacent Putnam soils. Available water capacity is high. Content of organic matter is moderate, and natural fertility is medium. Included in mapping are many small areas of eroded Mexico soils. They are indicated on the soil map by spot symbols.

This soil is used mainly for corn, soybeans, wheat, and rotation meadow, but some areas are in permanent pasture. The soil is well suited to these uses.

Control of erosion is a critical concern. Terraces that have grassed waterways, suitable cropping systems, and minimum tillage and no-till systems are effective control measures. Another important concern is improving and maintaining fertility by liming and fertilizing. Organic matter and tilth can be maintained by green manure crops, crop residue, and barnyard manure. These practices also help in the control of erosion. Capability unit IIe-5.

MpB2—Mexico silty clay loam, 1 to 5 percent slopes, eroded. This soil is on the lower parts of long, gentle side slopes and in areas around the heads of drainageways. It is generally downslope from less eroded Mexico soils and upslope from Armster soils. Most areas are 5 to 15 acres in size. Available water capacity is moderate. Content of organic matter and natural fertility are low. This soil has a profile similar to the one described as representative of the series, but nearly all of the surface layer has been removed by erosion. Included in mapping are some small areas of Mexico silt loam.

This soil is moderately well suited to cultivation. In most places areas are farmed along with adjacent Mexico silt loam. Tillage is difficult and good stands are difficult to obtain in some years. This soil is well suited to pasture, and many larger areas are used for pasture. Fertility requirements are high, and crop production is considerably less than that of Mexico silt loam.

Important management practices are control of weeds and brush by mowing, maintenance of fertility by liming and fertilization, and protection from overgrazing by proper stocking. Capability unit IIIe-5.

Modale Series

The Modale series consists of deep, somewhat poorly drained, nearly level soils on bottom land. These soils formed in silty alluvium eroded from nearby uplands and in underlying clayey Missouri River flood plain deposits. Native vegetation is trees and other forest plant life.

In a representative profile the surface layer is dark grayish brown and very dark grayish brown silt loam about 14 inches thick. The next layer is silt loam about 16 inches thick. It is yellowish brown in the upper part and brown in the lower part, and it has grayish brown mottles throughout. Below this is firm, mottled silty clay that is dark gray in the upper part and grayish brown in the lower part.

Permeability is moderate in the upper part of the soil and slow in the lower part. Available water capacity is high. Content of organic matter is moderately low, and natural fertility is high. Runoff is slow.

Except for a few small areas, Modale soils are used for field crops and alfalfa.

Representative profile of Modale silt loam in a cultivated field in Montgomery County, 40 feet west and 100 feet north of center of sec. 29, T. 46 N., R. 5 W.:

Ap—0 to 10 inches; dark grayish brown (10YR 4/2) silt loam; moderate very fine granular structure; very friable; common roots; neutral; abrupt smooth boundary.

A12—10 to 14 inches; very dark grayish brown (10YR 3/2) silt loam; common medium distinct dark yellowish brown (10YR 4/4) mottles; moderate very fine granular structure; very friable; common roots; neutral; clear smooth boundary.

C1—14 to 24 inches; yellowish brown (10YR 5/4) silt loam; common fine faint dark yellowish brown (10YR 4/4) mottles and few fine distinct grayish brown (10YR 5/2) mottles; weak very fine subangular blocky structure; friable; few roots; neutral; clear smooth boundary.

C2—24 to 30 inches; brown (10YR 5/3) silt loam; common fine faint grayish brown (10YR 5/2) mottles increasing to many with depth; few fine distinct yellowish brown (10YR 5/8) mottles in upper half; weak very fine subangular blocky structure; friable; few roots; common black iron and manganese stains; mildly alkaline; clear smooth boundary.

IIC3—30 to 48 inches; dark gray (10YR 4/1) silty clay; few fine faint brown (10YR 4/3) mottles; moderate very fine subangular blocky structure; firm; common very dark brown iron and manganese stains; mildly alkaline; gradual smooth boundary.

IIC4—48 to 60 inches; grayish brown (2.5Y 5/2) silty clay; common medium distinct dark yellowish brown (10YR 4/4) mottles and few fine distinct dark brown (10YR 3/3) mottles; moderate fine angular and subangular blocky structure; firm; mildly alkaline.

Depth to the clayey IIC horizon ranges from 18 to 30 inches. The upper 18 to 30 inches of the soil is silt loam. The A horizon is dark grayish brown or very dark grayish brown. The IIC horizon is silty clay or clay, and the matrix color is dark gray, gray, or grayish brown.

These soils are somewhat browner than those defined for the range of the Modale series, and they do not have free carbonates. These features do not affect use or behavior.

Modale soils differ from the associated Booker and Waldron soils because the upper part of the solum formed in silty material.

Ms—Modale silt loam (0 to 2 percent slopes). This soil is in areas in the Missouri River flood plain where small streams have deposited silty material eroded from nearby uplands. Most areas are 40 to 100 acres in size.

This soil is used mainly for corn, soybeans, wheat, and alfalfa, and it is well suited to these crops. It is easily tilled and highly productive. Nitrogen and starter fertilizers are effective. Organic matter and tilth can be maintained by using crop residue. Levees protect the soil from all but the most severe floods. Capability unit I-1.

Moniteau Series

The Moniteau series consists of deep, poorly drained, nearly level soils on stream terraces. These soils formed in alluvium under forest vegetation.

In a representative profile the surface layer is dark grayish brown silt loam about 7 inches thick. The sub-

surface layer is silt loam about 13 inches thick. It is dark grayish brown in the upper part and light brownish gray in the lower part. The subsoil is firm, grayish brown silty clay loam about 35 inches thick. The underlying material is gray silty clay loam.

Permeability is slow, and available water capacity is high. Content of organic matter is moderately low, and natural fertility is low. Runoff is slow.

Moniteau soils are used mostly for field crops. Meadow and pasture are less important uses.

Representative profile of Moniteau silt loam in a cultivated field in Montgomery County, 1,770 feet south and 70 feet west of center of sec. 24, T. 47 N., R. 6 W.:

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

A21—7 to 12 inches; dark grayish brown (10YR 4/2) silt loam; many medium faint grayish brown (10YR 5/2) mottles; moderate thin platy structure parting to moderate very fine subangular blocky; friable; many roots; medium acid; clear smooth boundary.

A22—12 to 20 inches; light brownish gray (10YR 6/2) silt loam; few fine distinct yellowish brown (10YR 5/4) mottles; weak very fine subangular blocky structure; friable; common roots; common light gray silt coatings; few fine concretions; very strongly acid; clear smooth boundary.

B1tg—20 to 30 inches; grayish brown (10YR 5/2) light silty clay loam; few fine yellowish brown (10YR 5/4) mottles; moderate fine subangular blocky structure; firm; few roots; common fine concretions; very strongly acid; gradual smooth boundary.

B2tg—30 to 44 inches; grayish brown (10YR 5/2) silty clay loam; common medium distinct dark yellowish brown (10YR 4/4) mottles and few fine faint brown (10YR 5/3) mottles; moderate medium prismatic structure parting to weak fine subangular blocky; firm; few roots; thin discontinuous clay films; few light gray silt coatings; few small concretions; very strongly acid; gradual smooth boundary.

B3tg—44 to 55 inches; grayish brown (10YR 5/2) light silty clay loam; common medium distinct dark yellowish brown (10YR 4/4) mottles and few fine faint brown (10YR 5/3) mottles; weak medium prismatic structure parting to weak very fine subangular blocky; firm; very strongly acid; gradual smooth boundary.

C—55 to 65 inches; gray (10YR 5/1) silty clay loam; many coarse faint grayish brown (10YR 5/2) mottles and common coarse distinct dark yellowish brown (10YR 4/4) mottles; massive; firm; strongly acid.

The solum ranges from 45 to about 60 inches in thickness. The A horizon ranges from about 15 to 22 inches in thickness. The A2 horizon has matrix colors of dark grayish brown, grayish brown, or light brownish gray. The B horizon has matrix colors of grayish brown or gray.

Moniteau soils contain less clay in the B2t horizons than the associated Auxvasse soils. They have a thinner A horizon than Twomile soils, which formed in similar materials, and the lower part of the A2 horizon is not compact and brittle.

Mu—Moniteau silt loam (0 to 2 percent slopes). This soil is on stream terraces along the Loutre River and some of the smaller streams. Most areas are 40 to 120 acres in size. Included in mapping were areas of similar soils that have a browner subsoil and areas where the surface layer is darker colored.

This soil is used mostly for corn and soybeans and is well suited to these crops. It is moderately well suited to small grain and rotation meadow and poorly suited to alfalfa.

Excess water and low natural fertility are the main concerns of management. Occasional flooding is a hazard. Some areas are ponded and need surface drainage. Liming and fertilization according to soil tests improves and maintains fertility. Organic matter and soil tilth can be maintained by using crop residue and green manure crops. Capability unit IIIw–2.

Nodaway Series

The Nodaway series consists of deep, moderately well drained, nearly level soils on bottom land. They formed under forests in recently deposited alluvium.

In a representative profile the surface layer is very dark grayish brown silt loam about 6 inches thick. Below this is a layer of dark brown silt loam about 11 inches thick. The next layer is dark grayish brown silt loam about 43 inches thick.

Permeability is moderate, and available water capacity is very high. Content of organic matter is moderately low, and natural fertility is moderate. Runoff is slow.

Nodaway soils are used mostly for corn and soybeans.

Representative profile of Nodaway silt loam in a cultivated field in Montgomery County, 680 feet west and 160 feet north of center of sec. 29, T. 47 N., R. 5 W.:

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) silt loam; moderate very fine granular structure; very friable; common roots; neutral; abrupt smooth boundary.

C1—6 to 17 inches; dark brown (10YR 4/3) silt loam; weak very fine granular structure; thin discontinuous brown (10YR 5/3) lenses and strata; very friable; common roots; neutral; clear smooth boundary.

C2—17 to 60 inches; dark grayish brown (10YR 4/2) silt loam; weak very fine granular structure; very friable; few roots; common thin lenses of brown sandy loam and dark gray silty clay loam; neutral.

The thickness of the solum is less than 10 inches and is equivalent to that of the Ap or A1 horizon. The A horizon is very dark grayish brown, dark grayish brown, or brown. The C horizon is dark grayish brown and brown. The soil is mainly silt loam throughout, but in many places there are thin lenses of coarser textured material. Reaction is neutral.

Nodaway soils have higher reaction than Sharon soils, which occupy similar positions. They are better drained than the associated Dockery and Moniteau soils.

Nd—Nodaway silt loam (0 to 2 percent slopes). This soil is on first bottoms in areas of recent deposition along the Loutre and Cuivre Rivers and creeks and stream branches. Most areas are 20 to 100 acres in size. Included in mapping are areas of a similar soil that contains more sand throughout and has a lighter colored surface layer.

This soil is used mostly for corn and soybeans, because these crops are seldom damaged by floods. Small grain is less extensive because of the hazard of spring floods. The soil is easily tilled, and it drys out quickly in the spring. Some narrow areas along small streams are used for pasture. Other small, narrow areas remain wooded and have a good potential for walnut and other high value trees.

This soil is subject to frequent flooding, and levee protection is impractical. Nitrogen and mixed fertilizer are effective. Lime is not needed on most areas. Tilth and organic matter can be maintained by using crop residue. Capability unit IIw-1.

Putnam Series

The Putnam series consists of deep, poorly drained, nearly level soils on upland divides. These soils formed in loess under tall prairie grass.

In a representative profile the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsurface layer is light gray silt loam about 7 inches thick. The subsoil is firm and very firm, dark grayish brown and grayish brown silty clay about 29 inches thick. It has prominent yellowish red and red mottles. The underlying material is gray silty clay loam.

Permeability is very slow, and available water capacity is high. Content of organic matter is moderate, and natural fertility is medium. Runoff is slow, and the hazard of erosion is slight.

Most areas of Putnam soils are used for cultivated crops (fig. 13). A few areas are used for pasture. The soils are well suited to these uses.

Representative profile of Putnam silt loam in a cultivated field in Montgomery County, 2,250 feet east and 50 feet south of northwest corner of sec. 10, T. 50 N., R. 6 W.:

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

A21—8 to 12 inches; light gray (10YR 6/1) silt loam; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium platy structure; friable; common roots; strongly acid; abrupt smooth boundary.

A22—12 to 15 inches; light gray (10YR 6/1) silt loam; common fine faint dark grayish brown (10YR 4/2) and dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; friable; common roots; strongly acid; abrupt smooth boundary.

B21—15 to 20 inches; dark grayish brown (10YR 4/2) silty clay; common fine prominent yellowish red (5YR 4/6) and red (2.5YR 4/6) mottles; strong fine angular blocky structure; very firm; few roots; thick continuous very dark grayish brown (10YR 3/2) clay films; very strongly acid; abrupt smooth boundary.

B22t—20 to 26 inches; dark grayish brown (10YR 4/2) silty clay; common medium faint dark yellowish brown (10YR 4/4) mottles; moderate medium angular blocky structure; very firm; few roots; thick continuous very dark grayish brown (10YR 3/2) clay films; very strongly acid; clear smooth boundary.

B31t—26 to 32 inches; grayish brown (2.5YR 5/2) silty clay; many medium distinct yellowish brown (10YR 5/4) mottles and common fine prominent yellowish red (5YR 5/8) mottles; moderate medium subangular blocky structure; firm; few roots; thin discontinuous clay films; strongly acid; gradual smooth boundary.

B32t—32 to 44 inches; grayish brown (2.5YR 5/2) silty clay; common medium distinct strong brown (7.5YR 5/8) and brown (7.5YR 4/4) mottles; moderate medium subangular blocky structure; firm; few roots; strongly acid; gradual smooth boundary.

C—44 to 60 inches; gray (10YR 5/1) silty clay loam; few medium prominent yellowish red (5YR 5/6) mottles and few medium distinct brown (7.5YR 4/4) mottles; massive; friable; medium acid.

The solum ranges from about 40 to 50 inches in thickness. The A horizon ranges from 15 to 18 inches in thickness. In

Figure 13.—**Soybeans on nearly level Putnam silt loam. Newly harvested wheatfield is at right.**

most places it is very dark grayish brown to dark grayish brown. The A2 horizon is gray or light gray. The B2 horizon has matrix colors of dark grayish brown and grayish brown, and the upper part is mottled with red or yellowish red.

Putnam soils formed in the same kind of material as Mexico and Marion soils. They have a thick A2 horizon that Mexico soils do not have, and they are less sloping than those soils. Putnam soils have a darker colored Ap horizon than Marion soils and have a grayer B horizon.

Pt—Putnam silt loam (0 to 2 percent slopes). This soil generally is in areas of 40 to 100 acres on broad upland divides. Slopes are generally less than 1 percent.

Corn, soybeans, wheat, and red clover are the main crops. Improving and maintaining fertility and tilth are the main concerns. Liming and fertilizing according to soil tests improves and maintains fertility. Using crop residue, green manure crops, and barnyard manure maintains organic matter and tilth.

Wetness is a hazard that sometimes delays fieldwork. A few areas are ponded and need surface drainage. Capability unit IIw–2.

Riverwash

Rv—Riverwash (0 to 2 percent slopes). This miscellaneous area consists of gravel and sandbars along the major rivers and creeks. It has no vegetation in most places, but some areas support willows that provide a small amount of wildlife cover. Riverwash has no farming value but is locally important as a source of road building material. Capability unit VIIIs–1.

Sampsel Series

The Sampsel series consists of deep, somewhat poorly drained, moderately sloping soils on uplands. These soils formed in material weathered from interbedded shale and limestone under a mixed vegetation of prairie grasses and trees.

In a representative profile the surface layer is black silty clay loam about 6 inches thick. The subsoil is firm clay about 36 inches thick. It is dark grayish brown in the upper part and grayish brown in the lower part. The underlying material is firm, light gray clay.

Permeability is slow, and available water capacity is moderate. Content of organic matter and natural fertility are high. Runoff is medium.

Sampsel soils are used for field crops, pasture, and meadow.

Representative profile of Sampsel silty clay loam, 5 to 9 percent slopes, eroded, in an idle field in Montgomery County, 245 feet south and 1,990 feet west of northeast corner of sec. 34, T. 50 N., R. 4 W.:

Ap—0 to 6 inches; black (10YR 2/1) heavy silty clay loam; few fine distinct dark grayish brown (2.5Y 4/2) mottles; moderate very fine subangular blocky structure; firm; many roots; neutral; abrupt smooth boundary.

B21t—6 to 20 inches; dark grayish brown (2.5Y 4/2) clay; common fine prominent yellowish brown (10YR 5/6) and faint light olive brown (2.5Y 5/4) mottles; moderate very fine subangular blocky structure; firm; few roots; few fine black concretions; slightly acid; clear smooth boundary.

B22t—20 to 42 inches; grayish brown (2.5Y 5/2) clay; common fine prominent yellowish brown (10YR 5/6) and faint light olive brown (2.5Y 5/4) mottles; weak fine subangular blocky structure; firm; few roots; few fine black concretions; neutral; abrupt smooth boundary.

C—42 to 60 inches; light gray (10YR 6/1) clay; massive; firm; common fine white carbonate concretions; slight effervescence; mildly alkaline.

The solum ranges from about 36 to 55 inches in thickness. The Ap horizon is black, very dark brown, or very dark grayish brown. In places a black A1 horizon underlies the Ap horizon. The Ap horizon and A1 horizon range from 6 to 12 inches in thickness. The B horizon is clay or silty clay. It has matrix colors of dark grayish brown, grayish brown, or light olive brown. Reaction is neutral or slightly acid throughout the solum.

These Sampsel soils have a dark colored A horizon that is not as thick as that defined for the Sampsel series. This difference, however, does not alter their use or behavior.

Sampsel soils have a thicker solum than Snead soils, which formed in the same kind of material. They have a darker colored, more clayey A horizon than the associated Armster soils, which formed in glacial till.

SaC2—Sampsel silty clay loam, 5 to 9 percent slopes, eroded. This moderately sloping soil is mostly on ridge points and side slopes that are downslope from Armster soils. Most areas are in irregular bands 40 to 120 acres in size. Included in mapping are small outcrops of limestone bedrock and areas of severely eroded soil, both of which are indicated on the soil map by symbols.

This soil is used mostly for corn, soybeans, small grain, pasture, and meadow. It is suited to these uses if erosion is controlled.

Terraces that have grassed waterways, contour farming, minimum tillage, and no-till cropping systems are effective in controlling erosion. Rotations should include cover crops. Using crop residue, barnyard manure, and green manure crops helps maintain tilth and content of organic matter. Soil treatment according to tests improves and maintains fertility. Most areas of this soil do not need lime.

Important pasture management practices are mowing to control weeds and brush and protection from overgrazing by proper stocking. Capability unit IIIe–5.

Sharon Series

The Sharon series consists of deep, moderately well drained, nearly level soils on bottom land. These soils formed in silty alluvium under mixed forest.

In a representative profile the surface layer is dark grayish brown silt loam about 7 inches thick. Below this is a layer of brown to dark brown silt loam about 23 inches thick. The next layer is very dark grayish brown silt loam about 12 inches thick. Below this is a layer of gray silt loam about 18 inches thick.

Permeability is moderate, and available water capacity is very high. Content of organic matter is moderately low, and natural fertility is low. Runoff is slow.

Sharon soils are used for field crops, meadow, pasture, and woodland.

Representative profile of Sharon silt loam in woodland of Montgomery County, 1,920 feet north and 690 feet east of southwest corner of sec. 31, T. 48 N., R. 3 W.:

A1—0 to 7 inches; dark grayish brown (10YR 4/2) silt loam; moderate very fine granular structure; very friable; many roots; weakly stratified; medium acid; clear smooth boundary.

C1—7 to 22 inches; brown to dark brown (10YR 4/3) silt loam; common fine faint dark grayish brown

(10YR 4/2) mottles; moderate very fine granular structure; very friable; common roots; weakly stratified; strongly acid; clear smooth boundary.

C2—22 to 30 inches; brown to dark brown (10YR 4/3) silt loam; common fine faint dark grayish brown (10YR 4/2) and brown (10YR 5/3) mottles; massive; very friable; few roots; stratified; very strongly acid; clear smooth boundary.

IIA1b—30 to 42 inches; very dark grayish brown (10YR 3/2) silt loam; common medium distinct brown (10YR 4/3) mottles; weak fine subangular blocky structure; friable; few roots; very strongly acid; clear smooth boundary.

IIA2b—42 to 60 inches; gray (10YR 6/1) silt loam; common fine distinct dark yellowish brown (10YR 4/4) mottles; massive; friable; few roots; very strongly acid.

The thickness of the solum is generally less than 10 inches and is equivalent to that of the Ap or A1 horizon. The soil material is mainly silt loam to a depth of 40 inches, but there are thin lenses of coarser textured material. Sandy loam or loam is below this depth in places. Reaction is strongly acid or very strongly acid below the Ap horizon.

These soils have chroma 2 mottles above a depth of 20 inches that are not in the defined range of the series. This difference does not alter their use or behavior.

Sharon soils are more acid than Nodaway soils and Dockery soils, which occupy similar positions. They differ from the associated Cedargap soils in not having a cherty horizon.

Sh—Sharon silt loam (0 to 2 percent slopes). This soil is along the Cuivre River and its tributary creeks and branches.

Included with this soil in mapping are areas of a similar soil that is somewhat wetter and has a grayer subsurface layer. Also included are small areas of Nodaway and Cedargap soils.

This soil is used mostly for corn, soybeans, small grain, and meadow. Many long, narrow areas of this soil, mostly along the smaller tributary streams, are used for pasture or woodland. These areas have a good potential for walnut and other high value trees.

Areas large enough for the practical use of farm machinery are well suited to row crops. Flooding is a hazard, especially along the larger streams. Some ponded areas need surface drainage.

Fertility can be maintained by soil treatment according to tests. Using crop residue and green manure crops maintains organic matter and tilth. Capability unit IIw–1.

Snead Series

The Snead series consists of moderately deep, moderately well drained, strongly sloping soils on uplands. These soils formed in material weathered from interbedded shale and limestone under a mixed vegetation of trees and prairie grasses.

In a representative profile the surface layer is very dark brown silty clay loam about 12 inches thick. The firm silty clay subsoil is about 12 inches thick. It is yellowish brown in the upper part and light olive brown in the lower part. The underlying material is grayish brown weathered shale.

Permeability is slow, and available water capacity is moderate. Content of organic matter and natural fertility are high. Runoff is rapid.

Snead soils are used mostly for pasture. Some areas are in poor quality forest.

Representative profile of Snead silty clay loam, 9 to 14 percent slopes, in a pasture in Montgomery County, 1,220 feet west and 2,640 feet north of southeast corner of sec. 6, T. 49 N., R. 3 W.:

A1—0 to 12 inches; very dark brown (10YR 2/2) light silty clay loam; moderate very fine subangular blocky structure; friable; many roots; common fine black concretions; slightly acid; clear smooth boundary.

B2—12 to 21 inches; yellowish brown (10YR 5/4) light silty clay; common fine distinct dark grayish brown (10YR 4/2) mottles; moderate very fine subangular blocky structure; firm; common fine black concretions; common thin weathered shale fragments 1 to 2 inches in length; few elongated limestone fragments 2 to 6 inches in length; neutral; clear smooth boundary.

B3—21 to 24 inches; light olive brown (2.5YR 5/6) light silty clay; many fine distinct brownish yellow (10YR 6/8) mottles; moderate very fine subangular blocky structure; firm; common thin weathered shale fragments 1 to 2 inches in length; moderately alkaline; clear smooth boundary.

C—24 to 60 inches; grayish brown (2.5Y 5/2) silty clay; rock structure of weathered shale; firm; moderately alkaline.

The solum ranges from about 15 to 30 inches in thickness. The A horizon ranges from 6 to about 14 inches in thickness. It is black, very dark brown, or very dark grayish brown. The B horizon is silty clay or clay. It has matrix colors of grayish brown, yellowish brown, or light olive brown.

Snead soils have a thinner solum than Sampsel soils, which formed is similar material. They have a thicker solum than the associated Gasconade soils, which are underlain by limestone bedrock.

SnD—Snead silty clay loam, 9 to 14 percent slopes. This strongly sloping soil is in areas generally downslope from Sampsel or Armster soils and upslope from Gasconade soils. Most areas are in irregular bands 60 to 200 acres in size. Included in mapping are many small limestone bedrock outcrops and areas of severely eroded soil, both of which are indicated on the soil map by symbols.

This soil is poorly suited to cultivation because of the rock outcrops and severe hazard of erosion. Most areas are used for and are well suited to pasture. The soil is poorly suited to woodland. Many otherwise idle areas, covered with brush and low quality trees, serve incidentally as wildlife habitat.

The major pasture concerns are weed and brush control, stand renovation, and protection from overgrazing. Capability unit IVe–11.

Twomile Series

The Twomile series consists of deep, poorly drained, nearly level soils on stream terraces. These soils are on second bottoms along the Cuivre River and many of the smaller streams. They formed in loess or silty alluvium under hardwood.

In a representative profile the surface layer is dark grayish brown silt loam about 9 inches thick. The subsurface layer is silt loam about 24 inches thick. It is grayish brown in the upper part, light brownish gray in the middle part, and gray in the lower part. The material in the lower part is compact and brittle and has many concretions. The subsoil is firm silty clay loam about 29 inches thick. It is grayish brown in the upper part and gray and grayish brown in the lower

part. The underlying material is gray and grayish brown clay loam.

Permeability is slow, and available water capacity is moderate. Content of organic matter and natural fertility are low. Runoff is slow, or the surface is ponded.

Twomile soils are used mostly for field crops, meadow, and pasture. Some areas are wooded.

Representative profile of Twomile silt loam in a cultivated field in Montgomery County, 40 feet south and 10 feet west of northeast corner of sec. 1, T. 50 N., R. 5 W.:

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) silt loam; moderate very fine granular structure; very friable; few roots; medium acid; abrupt smooth boundary.

A21—9 to 16 inches; grayish brown (10YR 5/2) silt loam; common medium distinct dark yellowish brown (10YR 3/4) mottles; weak fine subangular blocky structure; very friable; few roots; common fine black iron and manganese oxide concretions; very strongly acid; abrupt smooth boundary.

A22—16 to 24 inches; light brownish gray (10YR 6/2) silt loam; common fine prominent dark yellowish brown (10YR 3/4) mottles; weak medium platy structure; friable; few roots; common fine and medium black iron and manganese oxide concretions; strongly acid; clear smooth boundary.

A23x—24 to 33 inches; gray (10YR 6/1) silt loam; white (10YR 8/1) dry; common medium prominent dark brown (10YR 4/3) and strong brown (7.5YR 5/6) mottles; weak thick platy structure; firm; compact with a variable weakly and moderately expressed brittleness when moist; many fine and medium iron oxide and manganese oxide concretions; very strongly acid; abrupt smooth boundary.

B2t—33 to 52 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine prominent strong brown (7.5YR 5/8) and distinct dark brown (10YR 3/3) mottles; moderate very fine subangular blocky structure; firm; thick discontinuous dark gray (10YR 4/1) clay films on faces of peds; very strongly acid; clear smooth boundary.

B3—52 to 62 inches; gray (10YR 6/1) and grayish brown (10YR 5/2) silty clay loam; common medium distinct dark yellowish brown (10YR 4/4) mottles and few fine prominent yellowish red (5YR 4/6) mottles; weak medium platy structure; firm; common fine iron oxide and manganese oxide concretions; very strongly acid; gradual wavy boundary.

IIC—62 to 72 inches; gray (10YR 6/1) and grayish brown (10YR 5/2) clay loam; massive; firm; common fine iron oxide and manganese oxide concretions and dark brown stains; about 5 percent rounded chert pebbles; strongly acid.

The solum ranges from about 50 inches to more than 60 inches in thickness. The A horizon is silt loam 26 to 36 inches in thickness. Depth to the hard and brittle lower part of the A2 horizon ranges from 22 to 28 inches. The A2 horizon is grayish brown, light brownish gray, and gray. It has common to many concretions. The B horizon has matrix colors of dark gray, gray, grayish brown, and dark grayish brown.

Twomile soils differ from Auxvasse, Chariton, and Moniteau soils, which formed in similar material, in having a hard and brittle lower part of the A2 horizon. Additionally, they contain less clay in the B horizon than Auxvasse and Chariton soils and have a lighter colored A horizon than Chariton soils.

Tm—Twomile silt loam (0 to 2 percent slopes). This nearly level soil is on stream terraces along the Cuivre River and many of its tributary creeks and branches. Most areas are 40 to 100 acres in size. Included in mapping are areas of a similar soil, but its dark colored surface layer formed in material eroded from nearby upland soils.

This soil is used for corn, soybeans, small grain, meadow, and pasture. A few areas are wooded.

This soil is suited to cultivated crops, pasture, and some meadow crops. It is poorly suited to alfalfa, but is well suited to cool season pasture grasses. Because the hard, compact subsurface layer resists penetration by water and roots, the soil tends to be droughty in summer and wet in spring. Some areas are ponded and need surface drainage. The soil is subject to floods of brief duration.

Fertility can be improved and maintained by liming and fertilizing according to soil tests. Tilth and organic matter can be maintained by using green manure crops and crop residues.

The main pasture concerns are maintaining fertility by liming and fertilization, control of weeds and brush by mowing, and protection from overgrazing by proper stocking. Capability unit IIIw-2.

Waldron Series

The Waldron series consists of deep, somewhat poorly drained, nearly level soils on bottom land. These soils formed in Missouri River alluvium under woodland made up mainly of cottonwood, sycamore, soft maple, and willow.

In a representative profile the surface layer is very dark grayish brown silty clay about 7 inches thick. The next layer is very dark grayish brown silty clay about 6 inches thick. Below this is a 15 inch layer of firm, very dark brown and dark grayish brown silty clay loam that is stratified with thin lenses of finer and coarser textured material. The next layer is firm, stratified dark grayish brown silty clay and dark brown silty clay loam that has thin lenses of very fine sandy loam and extends to a depth of 60 inches.

Permeability is slow, and available water capacity is moderate. Content of organic matter is moderate, and natural fertility is high. Runoff is very slow.

Waldron soils are used mostly for row crops and wheat.

Representative profile of Waldron silty clay in a cultivated field in Montgomery County, 1,380 feet south and 30 feet east of center of sec. 25, T. 46 N., R. 5 W.:

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silty clay; moderate very fine subangular blocky structure; firm; few fine roots; mildly alkaline; abrupt smooth boundary.

C1—7 to 13 inches; very dark grayish brown (10YR 3/2) silty clay; weak thick and very thick platy structure parting to moderate very fine subangular blocky; firm; common thin discontinuous brown (10YR 5/3) very fine sandy loam lenses and coatings along horizontal bedding planes and surfaces; few fine roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

C2—13 to 17 inches; very dark brown (10YR 2/2) heavy silty clay loam; weak thick platy structure parting to moderate very fine subangular blocky; firm; common thin brown (10YR 5/3) very fine sandy loam strata; few fine roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

C3—17 to 28 inches; dark grayish brown (10YR 4/2) silty clay loam; common medium faint very dark brown (10YR 3/2) and dark brown (10YR 4/3) mottles; moderate very fine subangular blocky structure; firm; few thin very dark grayish brown (10YR

3/2) silty clay strata; dark red iron oxide and manganese oxide stains on horizontal surfaces of strata; slight effervescence; mildly alkaline; abrupt smooth boundary.

C4—28 to 40 inches; dark grayish brown (10YR 4/2) silty clay; moderate very fine subangular blocky structure; firm; common thin very dark grayish brown (10YR 3/2) silty clay loam strata; few pockets of brown (10YR 5/3) very fine sandy loam; slight effervescence; mildly alkaline; abrupt smooth boundary.

C5—40 to 60 inches; stratified very dark grayish brown (10YR 3/2) silty clay and dark brown (10YR 4/3) heavy silty clay loam; moderate very fine and fine subangular blocky structure; firm; common dark red iron oxide and manganese oxide stains on faces of peds; slight effervescence; mildly alkaline.

The thickness of the solum is less than 10 inches and is equivalent to that of the Ap or A1 horizon. The A horizon is very dark grayish brown or very dark brown. The C horizon is dominantly silty clay loam or silty clay, but in many places there are thin, coarser textured horizons.

Waldron soils differ from the associated Booker soils in having horizons and strata of coarser textured material. They differ from Blake soils, which formed in similar material, in having more clay between depths of 10 and 40 inches.

Wa—Waldron silty clay (0 to 2 percent slopes). This soil is in areas that are slightly higher than the low slackwater areas of Booker soils and somewhat lower than areas of Blake and Haynie soils. Most areas are elongated and are 40 to 200 acres in size. Included in mapping were many small areas of Blake silty clay loam and small areas of Booker clay.

This soil is used mainly for corn, soybeans, and wheat. It is suited to these crops if drainage and tilth concerns are successfully handled.

Some areas need surface drainage. Fall plowing and returning crop residue to the soil improve tilth. No-till farming and minimum tillage are not good substitutes for the mellowing effect of the winter's freezing and thawing after fall plowing. Nitrogen and starter fertilizers can be used effectively. Capability unit IIw-2.

Weller Series

The Weller series consists of deep, moderately well drained, gently sloping and moderately sloping soils on stream terraces. These soils formed under hardwood forest in loess and the underlying alluvium.

In a representative profile the surface layer is dark brown silt loam about 8 inches thick. The upper 3 inches of the subsoil is firm, brown silty clay loam. The lower 39 inches is firm silty clay that is brown and yellowish brown in the upper part and brown, dark brown, and grayish brown in the lower part. The underlying material is grayish brown silty clay loam.

Permeability is slow, and available water capacity is moderate. Content of organic matter is moderate, and natural fertility is low. Runoff is medium.

Weller soils are used mostly for pasture, meadow, and field crops.

Representative profile of Weller silt loam, 2 to 5 percent slopes, in a cultivated field in Montgomery County, 1,220 feet south and 430 feet east of center of sec. 18, T. 46 N., R. 5 W.:

Ap—0 to 8 inches; brown to dark brown (10YR 4/3) silt loam; common fine faint dark grayish brown (10YR 4/2) mottles; moderate very fine granular structure; very friable; many roots; medium acid; clear smooth boundary

B1—8 to 11 inches; brown (10YR 5/3) silty clay loam; moderate very fine subangular blocky structure; firm; common roots; very strongly acid; clear smooth boundary.

B21t—11 to 15 inches; brown (10YR 5/3) silty clay; few fine distinct strong brown (7.5YR 5/6) mottles; strong very fine subangular blocky structure; firm; thin continuous clay films; few fine black concretions; very strongly acid; abrupt smooth boundary.

B22t—15 to 26 inches; yellowish brown (10YR 5/4) silty clay; common fine faint grayish brown (10YR 5/2) mottles; weak very fine subangular blocky structure; firm; thin discontinuous clay films; common fine black concretions; very strongly acid; gradual smooth boundary.

B23t—26 to 36 inches; brown to dark brown (10YR 4/3) silty clay; common medium distinct grayish brown (10YR 5/2) mottles and few fine prominent yellowish red (5YR 4/6) mottles; weak medium prismatic structure parting to weak very fine subangular blocky; firm; thin discontinuous clay films on faces of some peds; common fine black concretions; very strongly acid; gradual smooth boundary.

B24t—36 to 50 inches; grayish brown (10YR 5/2) silty clay; common fine distinct dark yellowish brown (10YR 3/4) mottles; weak medium prismatic structure parting to weak very fine subangular blocky; firm; thin discontinuous clay films on faces of some peds; common fine black concretions; very strongly acid; clear smooth boundary.

C—50 to 60 inches; grayish brown (10YR 5/2) silty clay loam; common medium distinct dark brown (7.5YR 4/4) mottles; massive; firm; common fine and medium black concretions; strongly acid.

The solum ranges from about 48 to more than 60 inches in thickness. The A1 horizon is brown or dark grayish brown. In areas of uneroded soil there is a brown silt loam A2 horizon as much as 4 inches thick. In places material from the B1 horizon has been mixed into the Ap horizon. The B2 horizon has matrix colors of brown, dark brown, and yellowish brown in the upper part and grayish brown in the lower part. Reaction is strongly acid or very strongly acid below the Ap horizon.

Weller soils are better drained than Auxvasse soils, which occupy similar positions and lack an albic horizon. They have more clay in the B horizon than the associated Moniteau and Twomile soils, which are at somewhat lower positions in the landscape.

WeB—Weller silt loam, 2 to 5 percent slopes. This gently sloping soil is on stream terraces along the Loutre and Cuivre Rivers and some smaller streams in the survey area. Most areas are 5 to 20 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are spots of severely eroded soil and areas where the soil has short, steep slopes. These are indicated on the soil map by symbols. Also included were small areas of Auxvasse silt loam.

This soil is used for pasture, meadow, small grain, and row crops. It is well suited to pasture, most meadow crops, and small grain, but is poorly suited to alfalfa. Areas large enough for the practical use of large machinery are suited to row crops if erosion is controlled. In most areas slopes are short and do not require terracing. In places, diversions are needed to intercept runoff from adjoining higher uplands.

If this soil is used for row crops, erosion can be controlled by cropping systems that include small grain and meadow and by contour farming and returning crop residue to the soil. Erosion can also be

controlled by no-till farming, which permits more intensive cropping.

Fertility can be improved and maintained by liming and fertilization according to soil tests. Using crop residue, green manure crops, and barnyard manure maintains organic matter and good tilth.

Important pasture management practices are maintenance of fertility by liming and fertilizing, control of brush and weeds by mowing, and protection from overgrazing by proper stocking. Capability unit IIe–5.

WeC2—Weller silt loam, 5 to 9 percent slopes, eroded. This moderately sloping soil is on stream terraces along the Loutre and Cuivre Rivers and some smaller streams. Most areas are 5 to 20 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner.

Included with this soil in mapping are areas of a soil that is similar except for a few chert fragments throughout the profile and a subsoil that contains less clay. Also included are areas of severely eroded soil and areas where the soil has short, steep slopes. These are indicated on the soil map by symbols.

This soil is used for pasture, meadow, small grain, and row crops. It is well suited to pasture, most meadow crops, and small grain, but it is poorly suited to alfalfa. The soil is more erodible than less sloping Weller soils and thus is less well suited to row crops. Terracing is generally impractical because the slopes are short and complex. In some areas diversions are needed to intercept runoff from adjacent uplands.

If this soil is used for row crops, erosion can be controlled by cropping systems that include more meadow and small grain and contour farming and returning crop residue to the soil, or by no-till farming.

Fertility can be improved and maintained by liming and fertilizing according to soil tests. Using crop residue, green manure crops, and barnyard manure maintains good tilth and content of organic matter.

Important pasture management practices are maintenance of fertility by liming and fertilizing, control of brush and weeds by mowing, and protection from overgrazing by proper stocking. Capability unit IIIe–5.

Winfield Series

The Winfield series consists of deep, moderately well drained, gently sloping to steep soils on uplands and stream terraces. These soils formed in loess and the underlying residuum or outwash material. Native vegetation is hardwood forest.

In a representative profile the surface layer is dark grayish brown silt loam about 6 inches thick. The subsoil is silty clay loam that extends to a depth of 62 inches. It is friable in the upper 6 inches and firm in the lower part. Colors are strong brown, brown to dark brown, and dark yellowish brown. A few sand grains and fine chert fragments are in the lower part of the subsoil.

Permeability is moderate, and available water capacity is high. Content of organic matter and natural fertility are low. Runoff is medium to very rapid.

Winfield soils are used for field crops, pasture, meadow, and woodland. The hazard of gully erosion is serious in areas where water concentrates. If terraces and grassed waterways are used, their design and maintenance require extreme care.

Representative profile of Winfield silt loam, 5 to 9 percent slopes, eroded, in an idle field in Montgomery County, 150 feet west and 90 feet north of center of sec. 23, T. 46 N., R. 6 W.:

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silt loam; moderate very fine granular structure; very friable; many fine roots; few fine iron and manganese concretions; slightly acid; abrupt smooth boundary.

B1—6 to 12 inches; strong brown (7.5YR 5/6) light silty clay loam; moderate very fine subangular blocky structure; friable; few fine roots; few fine iron and manganese concretions; common material from Ap horizon; strongly acid; clear smooth boundary.

B21t—12 to 22 inches; brown to dark brown (7.5YR 4/4) silty clay loam; strong medium prismatic structure parting to moderate very fine subangular blocky; firm; thin gray silt coatings on faces of prisms; few fine iron and manganese concretions; few fine roots; strongly acid; clear smooth boundary.

B22t—22 to 30 inches; dark yellowish brown (10YR 4/4) silty clay loam; common fine distinct strong brown (7.5YR 5/6) and grayish brown (10YR 5/2) mottles; moderate fine subangular blocky structure; firm; few fine roots; thick clay films in old root channels; few coarse black iron and manganese stains; strongly acid; clear smooth boundary.

IIB23t—30 to 43 inches; strong brown (7.5YR 5/6) silty clay loam; common medium distinct grayish brown (10YR 5/2) mottles and common fine distinct brown (10YR 4/3) mottles; moderate very fine subangular blocky structure; firm; thick clay films in old root channels; few fine iron and manganese concretions; few medium sand grains increasing to common as depth increases; few small chert fragments; strongly acid; gradual smooth boundary.

IIB3—43 to 62 inches; dark yellowish brown (10YR 4/4) light silty clay loam; common medium distinct grayish brown (10YR 5/2) and strong brown (7.5YR 5/6) mottles; moderate medium platy structure; firm; few fine iron and manganese concretions; common fine chert fragments; strongly acid.

The solum ranges from 45 to more than 60 inches in thickness. The A horizon is dark grayish brown or brown. In areas of uneroded soil there is a brown or pale brown A2 horizon 2 to 4 inches thick. The B1 horizon is light silty clay loam or heavy silt loam. The B2 horizon has matrix colors of brown to dark brown, dark yellowish brown, and strong brown.

These soils have fine chert fragments and medium sand grains in the lower part of the solum, which are not within the range defined for the Winfield series. These differences do not alter the use or behavior of the soils.

Winfield soils are wetter than the associated Menfro soils.

WnB—Winfield silt loam, 2 to 5 percent slopes. This gently sloping soil is on terraces along streams. Most areas are 5 to 25 acres in size and are long and narrow in shape. Runoff is medium. This soil has a profile similar to the one described as representative of the series, but it is underlain by alluvium instead of loess.

This soil is used for corn, soybeans, small grain, pasture, and meadow. In most areas these soils have short slopes and do not require terraces. Erosion can be controlled by a cropping system that includes meadow and small grain along with row crops, or by minimum tillage or no-till farming.

Fertility can be improved and maintained by liming and fertilization according to soil tests. Organic mat-

ter and good tilth can be maintained by using crop residue, green manure crops, and barnyard manure.

Important pasture management practices are fertility maintenance by liming and fertilizing, control of brush and weeds by mowing, and protection from overgrazing by proper stocking. Capability unit IIe–1.

WnC2—Winfield silt loam, 5 to 9 percent slopes, eroded. This moderately sloping soil is in long, narrow areas on ridgetops. Most areas are 20 to 100 acres in size. Runoff is medium. This soil has the profile described as representative of the series.

This soil is used for corn, soybeans, small grain, meadow, and pasture. Where protected from erosion, it is suited to cropping systems that include row crops, small grain, and meadow. The potential for orchards and vineyards is good in areas high enough to escape spring frost damage.

In cultivated areas, terraces that have grassed outlets and contour farming and suitable cropping systems control losses of soil and water. Careful maintenance of terraces and waterways is critical because the hazard of gully erosion is severe. Minimum tillage and no-till cropping systems are also effective in erosion control.

Fertility can be improved and maintained by liming and fertilizing according to soil tests. Using crop residue, green manure crops, and barnyard manure maintains good tilth and content of organic matter.

Good pasture management practices are fertility maintenance by liming and fertilizing, control of brush and weeds by mowing, and protection from overgrazing by proper stocking. Capability unit IIIe–1.

WnD2—Winfield silt loam, 9 to 14 percent slopes, eroded. This strongly sloping soil is on ridgetops and side slopes. Most areas are 20 to 80 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer is browner. Included in mapping are many small areas of severely eroded soil that has a silty clay loam surface layer. These areas are indicated on the soil map by a spot symbol.

This soil is used for pasture, meadow, wheat, corn, and soybeans. A few areas remain wooded. The potential for orchards and vineyards is fair in areas high enough to escape spring frost damage.

If erosion is controlled, the soil is suited to cropping systems that include meadow and small grain and row crops. Terraces that have steep, grassed back slopes and grassed waterways reduce losses of soil and water. Extreme care in design and maintenance are required because the hazard of gully erosion is severe. Minimum tillage and no-till cropping systems are also effective in erosion control.

Liming and fertilization according to soil tests improves and maintains fertility. Good tilth and content of organic matter can be maintained by using crop residue, green manure crops, and barnyard manure.

Important pasture management practices are fertility maintenance by liming and fertilizing, control of brush and weeds by mowing, and protection from overgrazing by proper stocking. Capability unit IVe–1.

WnE—Winfield silt loam, 14 to 20 percent slopes. This moderately steep soil is on side slopes. Most areas are 20 to 80 acres in size. This soil has a profile similar to the one described as representative of the series, but the subsoil is generally thinner. Included in mapping are small areas of severely eroded silty clay loam. The areas are indicated on the soil map by a spot symbol.

If runoff from upslope areas is diverted by terraces, this soil can be cultivated occasionally without serious erosion. Meadow, pasture, and woodland, however, are better uses for this soil. If the soil is used occasionally for row crops, a single year of a row crop should follow several years of cover crops. Minimum tillage and returning crop residue to the soil are important.

Important pasture management practices are fertility maintenance by liming and fertilizing, control of brush and weeds by mowing, and protection from overgrazing by proper stocking.

Some areas remain in native forests that is predominantly high quality white oak. Selective harvest, thinning of second growth stands, removal of cull trees, and control of fire and grazing are concerns. Capability unit IVe–1.

WnF—Winfield silt loam, 20 to 35 percent slopes. This steep soil is on the lower part of side slopes. Most areas are 20 to 80 acres in size. Runoff is very rapid. This soil has a profile similar to the one described as representative of the series, but the subsoil is thinner and the depth to chert fragments is less. Included in mapping, around small bedrock outcrops at the heads of drainageways, are many small areas of a soil that has bedrock at a depth of 20 to 40 inches.

This soil is unsuited to cultivation. Pasture and woodland are the best uses. The soil is well suited to woodland, but pasture is difficult to manage because the slopes are steep and dissected.

Good pasture management practices are mowing to control weeds and brush where slopes permit and proper stocking to avoid overgrazing.

Many areas are used for woodland. Selective cutting of mature trees, thinning of some second growth stands, removal of cull trees, and control of fire and grazing are concerns. By creating openings in the forest canopy, these practices also improve habitat for woodland wildlife, especially deer, grouse, and turkeys. Capability unit VIe–1.

Use and Management of the Soils

Presented in this section are basic practices of management for soils used for crops and pasture; predicted average yields of the principal field and pasture crops; and use of the soils for woodland, wildlife, and recreation; and use of the soils in engineering work.

Cultivated Crops and Pasture

About two-thirds of Montgomery County and a little over one-half of Warren County are cultivated. Corn, soybeans, and wheat are the main crops. Grain sorghum is another important crop, and a small acreage of oats and barley is grown.

About 12 percent of each county is used for open pasture. Native bluegrass dominates most of the pasture, but there is a substantial and increasing acreage of improved pasture. A very few remnants of native prairie remain in the survey area.

Control of water erosion on cropland is the overriding concern in managing most of the upland soils in the survey area. Most sloping soils have been damaged to some degree by sheet, rill, or gully erosion. In most places a combination of mechanical and vegetative practices are needed to control erosion. Exceptions to this are the nearly level upland soils, on which wetness is the major concern. Wetness is also a concern on some heavy textured bottom land soils where surface drainage is needed. Seeding and renovation of more pasture is another need.

All the soils need management that helps conserve water, maintains or increases the content of organic matter and fertility, and promotes good tilth.

Good management increases yields and ensures an adequate economic return. A conservation cropping system combines suitable crop rotations with needed management and conservation practices to prevent soil deterioration. Technical assistance in the planning and application of practices for a particular field or farm can be obtained from the Soil Conservation Service through the Soil and Water Conservation Districts in the respective counties.

The management practices needed for soils that are suitable for crops and pastures are briefly discussed in the following paragraphs. This discussion supplements the management suggestions regarding specific practices given for each mapping unit.

High fertility levels increase the yields of grain and forage. Crop cover reduces the destructive impact of raindrops on the soil. Crop residue left on the surface helps maintain the content of organic matter and keep the soil porous, thereby increasing the intake rate and the available water capacity.

Managing plant residue so that it is left on or near the surface also retards runoff and helps to control erosion. Effectiveness depends on the amount of residue and the length of time it is left on the surface. Thus, higher yields leave more residue, and a comparable yield of corn leaves substantially more than soybeans. Spring plowing that allows residue to remain on the surface over winter is more effective than fall plowing, which leaves the surface bare. Tillage that leaves residue on the surface during the growing season is still more effective. Minimum tillage practices help to maintain good tilth, increase infiltration, and reduce erosion. The use of chisel plows, direct planting of conventionally plowed fields, and other special techniques reduce the amount of actual tillage. Currently, no-till planters are gaining acceptance.

Some soils can be continuously intertilled without excessive erosion or reduced yields. These are soils on bottom lands and nearly level uplands. Special management for intensive cropping generally includes maintaining fertility, managing crop residue, and minimum tillage. There is a potential for supplemental irrigation on most bottom land and on level or gently sloping uplands.

Field terraces reduce the length of slope and together with contour tillage are very effective erosion control measures on sloping soils. A system of terraces that are nearly parallel to each other is much preferred because it greatly reduces point rows and makes farming more convenient.

Properly located and constructed grassed waterways serve as outlets to terrace systems. These waterways are designed to be crossable and convenient for farming with large equipment.

Cross slope channels are used to reduce the length of very long, gentle slopes. These channels, except for a much wider horizontal spacing, are very similar to field terraces. Diversion terraces are designed and constructed to protect cultivated soils from water that runs off higher lying pasture or woodland.

Drainage ditches need suitable outlets, and these are available in most places. There are a few exceptions in the flood plains of the Missouri and Loutre Rivers.

Control of flooding on the flood plains of some streams in the survey area is feasible under existing conservation programs. One such program is "The Small Watershed Program" (Public Law 566). Currently, efforts by landowners are underway in Montgomery, Warren, and adjoining counties to initiate flood control and other conservation measures in the watersheds of the Cuivre and Loutre Rivers, through the organization of watershed subdistricts.

Most bottom land in the Missouri River flood plain is protected from flooding in greater or lesser degree by levees. The fact that such protection can never be complete was demonstrated in the great floods in 1951 and 1973 when even the highest levees were breached, causing extensive damage to land and property.

Many good stands of high-yielding grass-legume pastures have been established in the two counties and more are needed.

The following combination of management practices helps ensure the establishment and maintenance of good pasture: (1) plow early in summer, (2) lime and fertilize according to soil tests, (3) seed a mixture of good, clean suited grasses and legumes, (4) control weeds and brush, (5) topdress with fertilizer if needed and economically practical, and (6) maintain stand and high plant vigor by adjusting livestock numbers according to forage available and by periodically rotating pastures. It is often desirable to use pasture for a short period of intensive grazing followed by a longer period of rest.

Good pasture management can extend the grazing season considerably, but supplemental hay is needed every year in Warren and Montgomery Counties. The amount of hay needed varies depending on the type of livestock enterprises, the forage species, the severity of the winter, and the amount and duration of snow cover.

Capability Grouping

Some readers, particularly those who farm on a large scale, may find it practical to use and manage alike some of the different kinds of soil on their farm. These readers can make good use of the capability classification system, a grouping that shows, in a general way, the suitability of soils primarily for cultivated crop production.

The grouping is based on permanent limitations of soils when used for field crops, the risk of damage when they are farmed, and the way the soils respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the

soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations for range, for woodland, or for engineering.

In the capability system, all kinds of soil are grouped at three levels: the class, the subclass, and the unit. The broadest grouping, the capability class, is designated by Roman numerals I to VIII. In class I are the soils that have the fewest limitations, the widest range of use, and the least risk of damage when they are tilled. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and land forms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products. The subclass indicates major kinds of limitations within the classes. Within most of the classes there can be as many as four subclasses. The subclasses are indicated by adding a small letter, e, w, s, or c, to the class numeral, for example, IIe. The letter "e" shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; "w" means 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" indicates that the chief limitation is climate that is too cold, or too dry.

In class I there are no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only subclasses w, s, and c, because the soils are subject to little or no erosion but have other limitations that confine their use largely to pasture, range, or wildlife.

Subclasses are further divided into groups called capability units. These are groups of soils that are so much alike that they are suited to the same crops and pasture plants, they require about the same management, and have generally similar productivity and other response to management. Capability units are generally identified by numbers assigned locally, for example, IIw–2 or IIIe–5.

The eight classes in the capability system and the subclasses and units in Montgomery and Warren Counties are described in the list that follows. The unit designation is given in the Guide to Mapping Units.

Class I soils have few limitations that restrict their use (no subclasses).
- Unit I–1.—Deep, nearly level, well drained and somewhat poorly drained soils. Permeability is moderate or moderately slow, and the available water capacity is high.

Class II soils have moderate limitations that reduce the choice of plants or require moderate conservation practices.
- Subclass IIe soils are subject to moderate erosion unless protected.
  - Unit IIe–1.—Deep, gently sloping, moderately well drained soils on terraces. Permeability is moderate, and the available water capacity is high.
  - Unit IIe–5.—Deep, gently sloping, moderately well drained and somewhat poorly drained soils on uplands. Permeability is slow or very slow, and the available water capacity is high or moderate.
- Subclass IIw soils are moderately limited because of excess water.
  - Unit IIw–1.—Deep, nearly level, moderately well drained and somewhat poorly drained soils on bottom land. Permeability is moderate or moderately slow, and the available water capacity is high or very high.
  - Unit IIw–2.—Deep, nearly level, poorly drained and somewhat poorly drained soils on bottom land, uplands, and terraces. Permeability is moderately slow to very slow, and the available water capacity is moderate or high.
- Subclass IIs soils are moderately limited because of droughtiness.
  - Unit IIs–1.—Deep, nearly level, somewhat excessively drained soils on bottom land. Permeability is moderately rapid, and the available water capacity is moderate.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.
- Subclass IIIe soils are subject to severe erosion if they are cultivated and not protected.
  - Unit IIIe–1.—Deep, moderately sloping, well drained and moderately well drained soils on uplands. Permeability is moderate, and the available water capacity is high.
  - Unit IIIe–4.—Deep, moderately sloping, moderately well drained soils on uplands. Permeability is slow, and the available water capacity is moderate.
  - Unit IIIe–5.—Deep, gently sloping and moderately sloping, moderately well drained and somewhat poorly drained soils on uplands and terraces. Permeability is moderately slow or very slow, and the available water capacity is moderate.
- Subclass IIIw soils are severely limited for cultivation by excess water.
  - Unit IIIw–2.—Deep, nearly level, poorly drained soils on uplands and terraces. Permeability is slow or very slow, and the available water capacity is moderate or high.
  - Unit IIIw–14.—Deep, nearly level or depressional, very poorly drained soils on bottom land. Permeability is very slow, and the available water capacity is moderate.
- Subclass IIIs soils are severely limited because of droughtiness, a stony surface layer, or both.
  - Unit IIIs–1.—Deep, nearly level, somewhat excessively drained soils on bottom land. Permeability is moderately rapid or rapid, and the available water capacity is moderate or low.

Class IV soils have very severe limitations that reduce

the choice of plants, require very careful management, or both.

Subclass IVe soils are subject to very severe erosion if cultivated and not protected.

Unit IVe–1.—Deep, moderately sloping or strongly sloping, well drained and moderately well drained soils on uplands. Permeability is moderate, and the available water capacity is high.

Unit IVe–4.—Deep, strongly sloping, moderately well drained soils on uplands. Permeability is slow, and the available water capacity is moderate.

Unit IVe–8.—Deep, moderately sloping, moderately well drained, severely eroded soils on uplands. Permeability is slow or moderately slow, and the available water capacity is low.

Unit IVe–11.—Moderately deep, strongly sloping, moderately well drained soils on uplands. Permeability is slow, and the available water capacity is moderate.

Class V soils are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture or range, woodland or wildlife habitat. (None in survey area.)

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife habitat.

Subclass VIe soils are severely limited, chiefly by risk of erosion, unless protective cover is maintained.

Unit VIe–1.—Deep, steep, well drained and moderately well drained soils on uplands. Permeability is moderate, and the available water capacity is high.

Unit VIe–4.—Deep, moderately steep to steep, well drained soils on uplands. Permeability is moderately slow, and the available water capacity is high.

Subclass VIs soils are severely limited by droughtiness, stoniness, or both.

Unit VIs–8.—Shallow, moderately sloping, somewhat excessively drained soils on uplands. Permeability is moderately slow, and the available water capacity is very low.

Unit VIs–9.—Deep, strongly sloping, well drained soils on uplands. Permeability is moderate, and the available water capacity is low.

Class VII soils have very severe limitations that make them unsuited to cultivation and restrict their use largely to range, woodland, or wildlife food and cover.

Subclass VIIs soils are very severely limited by droughtiness, steepness, and stoniness.

Unit VIIs–8.—Shallow and moderately deep, steep and very steep, well drained and somewhat excessively drained soils on uplands. Permeability is slow or moderately slow, and the available water capacity is low or very low.

Unit VIIs–9.—Deep, steep and very steep, well drained, stony soils on uplands. Permeability is moderate, and the available water capacity is low.

Class VIII soils and landforms have limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife, and sources of sand and gravel.

Subclass VIIIs soils are very severely limited by droughtiness and gravel or sand content.

Unit VIIIs–1.—Deep, nearly level, excessively drained soils in or adjacent to stream channels. Permeability is rapid, and the available water capacity is very low.

Predicted Yields

Table 2 lists for each soil in Montgomery and Warren Counties the predicted average yields per acre of principal crops. All available sources of yield information were used to make these estimates. They are based on the observations of the soil scientists that made the survey along with information obtained from local farmers, professional agronomists, public and private agencies, demonstration plots, and research data.

Management practices, weather conditions, plant diseases, and insect manifestations vary from year to year and from place to place. Differences in any of these factors, especially the droughts during the summer months, cause great fluctuations in crop yields. Crop damage can also be heavy locally as a result of wind, hail, torrential downpours of rain, or flooding.

Data in table 2 are based on an improved combination of management practices used by some of the farmers in the county. A systematic cropping plan, consistent with the capability of the soils, is followed. Sloping areas on uplands are terraced, and most areas where slopes are more than 2 percent are farmed on the contour. Adequate drainage is installed as needed. Suited high yielding varieties are planted. Lime and fertilizer are regularly applied according to soil tests for maximum yields. Considerable attention is given to new methods of weed control and crop residue management. All farm operations are timely.

The yield predictions in table 2 are approximate figures only and are intended to serve only as guides. Many users consider the comparative yields between soils to be of more value than the actual yields. These relationships are likely to remain constant over a period of years.

Woodland Management and Productivity [3]

In 1972 about 229,500 acres, or 37 percent of Montgomery and Warren Counties (*4*), remained in woodland. The wooded tracts are mostly in relatively small private holdings. Timber production, recreation, and wildlife are the main uses.

The principal forest type is upland oak consisting of white oak, black oak, northern red oak, post oak, and hickory. This type occurs mainly in the Goss-Gasconade-Chilhowie unit, the Keswick-Lindley unit, and the Hatton-Keswick-Marion unit. (See General Soil Map.) Bottom land hardwoods consisting of east-

[3] By GARY R. NORDSTROM, forester, Soil Conservation Service.

TABLE 2.—*Predicted average yields per acre of principal crops*

[Absence of yield indicates that the crop is not ordinarily grown on the soil]

Soil	Corn	Soybeans	Winter wheat	Grain sorghum	Grass-legume hay	Grass-legume pasture
	Bu	*Bu*	*Bu*	*Bu*	*Tons*	*AUM* [1]
Armster loam, 5 to 9 percent slopes, eroded	62	23	28	58	2.7	5.4
Armster clay loam, 5 to 9 percent slopes, severely eroded	52	18	22	50	2.5	5.0
Auxvasse silt loam	70	25	28	63	3.2	6.4
Blake silty clay loam	105	40	45	90	5.0	
Blake-Haynie-Waldron complex	95	35	40	83	4.3	
Booker clay	55	25	28	60	2.5	
Calwoods silt loam, 1 to 5 percent slopes	75	28	32	65	3.5	7.0
Calwoods silty clay loam, 1 to 5 percent slopes, eroded	60	20	25	52	3.0	6.0
Cedargap silt loam	75	28	35	65	3.3	6.6
Cedargap cherty silt loam	50	18	28	47	3.0	6.0
Cedargap clay loam, loamy variant	106	40	44	90	4.6	9.2
Chariton silt loam	75	28	30	65	3.2	6.4
Chilhowie, Gasconade, and Crider soils, 14 to 35 percent slopes						4.2
Coland clay loam	110	42	40	90	4.4	7.6
Crider silt loam, 5 to 9 percent slopes	84	31	35	65	3.7	7.4
Crider silt loam, 9 to 14 percent slopes, eroded	74	28	32	60	3.4	6.8
Dockery silt loam	95	40	30	80	4.5	9.0
Gasconade stony silty clay loam, 5 to 9 percent slopes						3.0
Gasconade-Rock outcrop complex, 14 to 50 percent slopes						2.0
Goss very cherty silt loam, 5 to 14 percent slopes						3.0
Goss soils, 14 to 45 percent slopes						4.2
Hatton silt loam, 2 to 9 percent slopes	68	24	32	60	3.4	6.8
Haynie very fine sandy loam	96	36	42	85	3.6	
Hodge loamy fine sand	38	14	20	44	1.7	
Holstein loam, 5 to 9 percent slopes, eroded	79	30	33	62	3.5	7.0
Holstein loam, 9 to 14 percent slopes, eroded	70	25	29	56	3.2	6.4
Holstein-Rock outcrop complex, 14 to 35 percent slopes						3.2
Keswick silt loam, 5 to 9 percent slopes, eroded	58	24	30	58	2.2	4.0
Keswick silt loam, 9 to 14 percent slopes	52	20	26	52	2.2	4.0
Keswick clay loam, 5 to 9 percent slopes, severely eroded	44	17	21	48	1.8	3.5
Lindley loam, 14 to 35 percent slopes						2.0
Marion silt loam	60	24	25	55	3.0	6.0
Menfro silt loam, 5 to 9 percent slopes, eroded	84	31	35	65	3.7	7.4
Menfro silt loam, 9 to 14 percent slopes, eroded	74	28	32	60	3.4	6.8

TABLE 2.—*Predicted average yields per acre of principal crops*—Continued

Soil	Corn	Soybeans	Winter wheat	Grain sorghum	Grass-legume hay	Grass-legume pasture
	Bu	*Bu*	*Bu*	*Bu*	*Tons*	*AUM* [1]
Menfro silt loam, 14 to 20 percent slopes	63		28	52	3.0	6.0
Menfro silt loam, 20 to 35 percent slopes						5.4
Mexico silt loam, 1 to 5 percent slopes	80	30	33	67	3.5	7.0
Mexico silty clay loam, 1 to 5 percent slopes, eroded	60	21	25	52	3.0	6.0
Modale silt loam	98	38	40	85	4.0	7.5
Moniteau silt loam	80	30	28	65	3.0	6.0
Nodaway silt loam	90	40	28	78		6.5
Putnam silt loam	75	28	30	65	3.2	6.4
Riverwash						
Sampsel silty clay loam, 5 to 9 percent slopes, eroded	65	23	26	57	2.5	5.0
Sharon silt loam	84	32	25	75	3.5	7.0
Snead silty clay loam, 9 to 14 percent slopes	55	21	25	50	2.7	5.1
Twomile silt loam	65	23	28	60	2.7	5.0
Waldron silty clay	92	35	38	80	3.8	
Weller silt loam, 2 to 5 percent slopes	80	30	30	65	3.5	6.7
Weller silt loam, 5 to 9 percent slopes, eroded	70	24	28	62	3.0	5.6
Winfield silt loam, 2 to 5 percent slopes	95	36	40	85	4.4	8.8
Winfield silt loam, 5 to 9 percent slopes, eroded	90	34	37	82	4.1	8.2
Winfield silt loam, 9 to 14 percent slopes, eroded	80	29	32	75	3.7	7.4
Winfield silt loam, 14 to 20 percent slopes	70		30	65	3.3	6.6
Winfield silt loam, 20 to 35 percent slopes						6.0

[1] AUM is the number of animal units carried per acre multiplied by the number of months the pasture is grazed during a season.

ern cottonwood, American sycamore, and silver maple occur in the Blake-Haynie-Booker unit.

The potential productivity of the soils for trees is moderate to moderately high for the upland hardwoods and high to very high for the bottom land species.

Table 3 is useful in planning use of soils for wood crops. Those soils suitable for wood crops are listed alphabetically by soil series and map symbol, and the woodland group for each soil is given. All soils in the same woodland group require the same general kinds of woodland management and have about the same potential productivity.

The first part of the 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 *w* indicates excessive water in or on 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; *r*, steep slopes. The letter *o* indicates no significant limitations or restrictions. If a soil has more than one limitation, priority in placing the soil into a limitation class is in the order in which the letters are listed above.

The third part of the symbol, a number, indicates the degree of hazard or limitation and general suitability of the soils for certain kinds of trees.

The numeral *1* indicates soils that have no or only slight limitations and are best suited to conifer species.

The numeral *2* indicates soils that have one or more moderate limitations and are best suited to conifer species.

The numeral *3* indicates soils that have one or more severe limitations and are best suited to conifer species.

TABLE 3.—*Woodland management and productivity*

Soil name and map symbol	Woodland group	Management concerns: Erosion hazard	Management concerns: Equipment limitations	Management concerns: Seedling mortality	Management concerns: Windthrow hazard	Management concerns: Plant competition	Potential productivity: Important trees	Potential productivity: Site index	Trees to plant
Blake: Bk	2o5	Slight	Slight	Slight	Slight	Slight.	Eastern cottonwood	100	Eastern cottonwood, green ash, pin oak.
Booker: Bo	4w6	Slight	Severe	Severe	Severe	Severe.	Eastern cottonwood	85	Eastern cottonwood, pin oak, green ash, sweetgum, silver maple.
Calwoods: CaB, CbB2	4c5	Slight	Slight	Moderate	Slight	Slight.	White oak Black oak	55 ---	Pin oak, green ash, sweetgum.
Cedargap: Cd, Ce	3f6	Slight	Slight	Moderate	Slight	Slight.	Black oak Black walnut American sycamore	66 --- ---	Green ash, American sycamore, black walnut, pin oak.
Chilhowie: CnF	4c9	Moderate	Severe	Moderate	Moderate	Slight.	White oak Northern red oak Green ash Black gum	53 55 --- ---	Pin oak, green ash, shortleaf pine.
Crider: CrC, CrD2	3o4	Slight	Slight	Slight	Slight	Slight.	White oak Black oak Northern red oak	64 66 ---	Green ash, black walnut.
Dockery: Do	3o4	Slight	Slight	Slight	Slight	Slight.	Pin oak	76	Pin oak, pecan, eastern cottonwood.
Gasconade:									
GaC	5d8	Slight	Moderate	Moderate	Moderate	Slight.	Black oak Northern red oak	47 48	Shortleaf pine, eastern redcedar.
GdF	5d9	Moderate	Severe	Severe	Moderate	Slight.	Black oak Northern red oak	47 48	Shortleaf pine, eastern redcedar.
Goss:									
GoD	5f8	Slight	Moderate	Slight	Slight	Slight.	White oak Black oak Northern red oak Black walnut	45 49 52 ---	Green ash, shortleaf pine.
GoF	5f9	Slight	Severe	Moderate	Slight	Slight.	White oak Black oak Northern red oak Black walnut	45 49 52 ---	Green ash, shortleaf pine.
Hatton: HcB	4c5	Slight	Slight	Moderate	Slight	Slight.	White oak Black oak Green ash	54 59 ---	Green ash.
Haynie: He	1o5	Slight	Slight	Slight	Slight	Moderate.	Eastern cottonwood American sycamore Black walnut Green ash	115 --- --- ---	Eastern cottonwood, black walnut, American sycamore.

Hodge: Hg	3s5	Slight	Slight	Moderate	Slight	Slight.	Eastern cottonwood American sycamore	90 ----	Eastern cottonwood, American sycamore.
Holstein: HoC2, HoD2	4o7	Slight	Slight	Slight	Slight	Slight.	White oak Black oak Green ash Black cherry	58 63 ---- ----	Shortleaf pine, green ash, black walnut.
Holstein-Rock outcrop complex: HrE.	4r8	Moderate	Moderate	Moderate	Slight	Slight.	White oak Black oak Green ash Black cherry	58 63 ---- ----	Shortleaf pine, green ash, black walnut.
Keswick: KeC2, KeD, KsC3.	4c5	Slight	Slight	Moderate	Moderate	Slight.	White oak Northern red oak Pin oak Black oak	58 ---- ---- ----	Green ash, pin oak, sweetgum, black walnut.
Lindley: LnE	4r5	Moderate	Moderate	Moderate	Slight	Slight.	White oak Black oak Northern red oak Black walnut	60 63 ---- ----	Green ash, sweetgum, black walnut.[1]
Marion: Ma	5w6	Slight	Severe	Moderate	Moderate	Severe.	Pin oak White oak Black oak Northern red oak	45 50 50 ----	Green ash, sweetgum, silver maple.
Menfro: MeC2, MeD2	1o7	Slight	Slight	Slight	Slight	Slight.	White oak Northern red oak Black oak Black cherry	---- 89 87 ----	Shortleaf pine, green ash, black walnut, sweetgum, silver maple.
MeE, MeF	1r8	Moderate	Moderate	Moderate	Slight	Slight.	White oak Red oak Black oak Black cherry	---- 89 87 ----	Shortleaf pine, green ash, sweetgum, black walnut, silver maple.
Nodaway: Nd	2o7	Slight	Slight	Slight	Slight	Slight.	White oak Black walnut Eastern cottonwood	80 ---- ----	Eastern cottonwood, pin oak, black walnut, pecan, silver maple, eastern white pine.
Sharon: Sh	2o4	Slight	Slight	Slight	Slight	Moderate.	White oak Black walnut	80 ----	Black walnut, pin oak, pecan, eastern cottonwood, silver maple.
Snead: SnD	4c5	Slight	Moderate	Moderate	Slight	Slight.	White oak	55	Green ash, black walnut, pin oak.
Twomile: Tm	3w6	Slight	Severe	Moderate	Moderate	Severe.	Pin oak	76	Green ash, American sycamore, silver maple, pin oak.
Waldron: Wa	1c6	Slight	Moderate	Severe	Slight	Slight.	Eastern cottonwood Pin oak American sycamore	113 ---- ----	Eastern cottonwood, pin oak, American sycamore, pecan, silver maple.

TABLE 3.—*Woodland management and productivity*—Continued

Soil name and map symbol	Wood-land group	Management concerns					Potential productivity		Trees to plant
		Erosion hazard	Equipment limitations	Seedling mortality	Windthrow hazard	Plant compe-tition	Important trees	Site index	
Winfield:									
WnB, WnC2, WnD2	3o7	Slight	Slight	Slight	Slight	Slight.	White oak	65	Shortleaf pine, green ash, black walnut, sweetgum.
WnE, WnF	3r8	Moderate	Moderate	Moderate	Slight	Moderate.	White oak	65	Shortleaf pine, green ash, black walnut.

[1] Confine to cool slopes, coves, benches, and slope bases.

The numeral *4* indicates soils that have no or only slight limitations and are best suited to deciduous species.

The numeral *5* indicates soils that have one or more moderate limitations and are best suited to deciduous species.

The numeral *6* indicates soils that have one or more severe limitations and are best suited to deciduous species.

The numeral *7* indicates soils that have no or only slight limitations and are best suited to either conifer or deciduous species.

The numeral *8* indicates soils that have one or more moderate limitations and are best suited to either conifer or deciduous species.

The numeral *9* indicates soils that have one or more severe limitations and are best suited to either conifer or deciduous species.

In table 3 the soils are also rated for a number of factors to be considered in management. The ratings of slight, moderate, and severe are used to indicate the degree of major soil limitations.

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 some 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 equipment; *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 that the soil affects expected mortality of planted tree seedlings when plant competition is not a limiting factor. The ratings are for seedlings from good planting stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality of the planted seedlings is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Considered in the ratings of windthrow hazard are characteristics of the soil that affect the development of tree roots and the ability of soil to hold trees firmly. A rating of *slight* indicates that trees in wooded areas are not expected to be blown down by commonly occurring winds; *moderate*, that some trees are blown down during periods of excessive soil wetness and strong winds; and *severe*, that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

Ratings of plant competition indicate the degree to which undesirable plants are expected to invade or grow if openings are made in the tree canopy. The invading plants compete with native plants or planted seedlings by impeding or preventing their growth. 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* means that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed for the control of undesirable plants.

The potential productivity of merchantable 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. The site index for upland oak (*7*) species is the height reached in 50 years. The site index for eastern cottonwood (*3*) is the height reached in 30 years.

Use of Soils for Trees and Shrubs for Environmental Improvement [4]

This section gives information about some of the trees, shrubs, and other vegetative cover used in landscaping sites for homes, schools, industry, and recreational areas. In planning, consideration should be given to wind protection, cover for critical areas, screening of unsightly areas, wildlife food and cover, and the general beauty of neighborhoods.

Trees and shrubs of different species vary widely in suitability to different soils and to site conditions. The soils in the county are placed in seven tree and shrub groups mainly on the basis of the amount of wetness from a seasonal high water table and from the available moisture capacity.

Each group of soils in a specific group has similar suitability for tree and shrub plantings. The soils in a tree and shrub suitability group can be identified by referring to the "Guide to Mapping Units" at the back of this survey.

Table 4 lists uses for specific plants on soils in the seven tree and shrub groupings. This listing is a good basis for planning the use of trees and shrubs for environmental improvement. In this table a listing is also made of some trees that grow naturally on each of the seven soil groups that may be retained when developing an area for more intensive use for people. The plants in table 4 are only a partial listing of those suited to soils in the survey area. Many plants serve a dual purpose of landscaping and of providing food and cover for wildlife. If more detail is needed and pertinent landscaping plans are desired, landowners and others should contact local landscape specialists.

No ratings were made for Blake-Haynie-Waldron complex, Holstein-Rock outcrop complex, and Riverwash.

Critical areas are those where the soils are highly erodible or severely eroded and thus are sediment producing—areas, for example, where there are dams, dikes, levees, cuts, fills, and denuded or gullied soils. In these areas it is difficult to establish vegetation using the usual seeding or planting methods.

Use of the Soils for Wildlife [5]

The survey area consists of flat and rolling prairie

[4] GARY R. NORDSTROM, forester, Soil Conservation Service, helped prepare this section.

[5] EDWARD A. GASKINS, biologist, Soil Conservation Service, helped prepare this section.

TABLE 4.—*Suitability of the soil for trees and*

Tree and shrub group	Trees to retain at home and park sites	Plantings for beauty and shade
Group 1: Deep, somewhat excessively drained to moderately well drained, nearly level to very steep soils; low to moderate available water capacity. AmC2, ArC3, Cd, Ce, GoD, GoF, HcB, Hq, KeC2, KeD, KsC3, WeB, WeC2.	White oak, northern red oak, black oak, black walnut, pin oak.	Alternate-leaf dogwood, American hornbeam, Amur honeysuckle, Amur maple, Amur privet, "Arnot" bristly locust, autumn-olive, black oak, bur oak, Carolina laurelcherry, coralberry, crabapple, cutleaf staghorn sumac, eastern hophornbeam, eastern redbud, English yew, fragrant sumac, hackberry, hawthorn, Japanese yew, mallow ninebark, Nanking cherry, Norway maple, oriental arborvitae, pawpaw, persimmon, red pine, scarlet oak, shadblow serviceberry, Siberian elm, silky dogwood, spreading cotoneaster, sugar maple, Tartarian honeysuckle, white ash, white oak, winged euonymous, yellow-poplar.
Group 2: Moderately deep, well drained and moderately well drained, strongly sloping to steep soils; low to moderate available water capacity. CnF SnD.	White oak, northern red oak, green ash.	American cranberry bush, American hornbeam, American sycamore, Amur honeysuckle, Amur maple, "Arnot" bristly locust, autumn-olive, black oak, bur oak, Carolina laurelcherry, coralberry, cornelian cherry dogwood, crabapple, eastern hophornbeam, eastern redbud, English yew, flowering dogwood, fragrant sumac, hackberry, hawthorn, Japanese yew, lilac, mallow ninebark, mockorange, Nanking cherry, Norway maple, oriental arborvitae, pawpaw, pecan, persimmon, red pine, rose-of-sharon, scarlet oak, shadblow serviceberry, Siberian elm, silky dogwood, spreading cotoneaster, sugar maple, Tartarian honeysuckle, white ash, white oak, winged euonymous, yellow-poplar.
Group 3: Very shallow and shallow, somewhat excessively drained, moderately sloping to very steep soils; very low available water capacity; limestone bedrock within 20 inches of the surface. GaC, GdF.	Black oak, northern red oak, eastern redcedar.	American hornbeam, Amur honeysuckle, Amur maple, Amur privet, "Arnot" bristly locust, autumn-olive, bur oak, coralberry, crabapple, eastern hophornbeam, hawthorn, lilac, mallow ninebark, mockorange, oriental arborvitae, shadblow serviceberry, Siberian elm, silky dogwood, Tartarian honeysuckle, winged euonymous.
Group 4: Deep, well drained and moderately well drained, moderately sloping to steep soils, high available water capacity. CrC, CrD2, HoC2, HoD2, LnE, MeC2, MeD2, MeE, MeF, WnC2, WnD2, WnE, WnF.	White oak, northern red oak, black oak, black cherry, black walnut.	Alternate-leaf dogwood, American hornbeam, American sycamore, Amur honeysuckle, Amur maple, Amur privet, "Arnot" bristly locust, autumn-olive, black cherry, black locust, black oak, black walnut, bur oak, Chinese elm, coralberry, Cornelian cherry dogwood, crabapple, eastern cottonwood, eastern hophornbeam, eastern redbud, eastern white pine, English yew, flowering dogwood, fragrant sumac, green ash, hackberry, hawthorn, Japanese yew, lilac, Lombardy poplar, mallow ninebark, mockorange, Nanking cherry, Norway maple, Ohio buckeye, oriental arborvitae, pawpaw, pecan, persimmon, pin oak, pussy willow, red-osier dogwood, red pine, rose-of-sharon, sassafras, scarlet oak, shadblow serviceberry, Siberian elm, silky dogwood, silver buffaloberry, silver maple, spreading cotoneaster, sugar maple, white ash, white oak, winged euonymous, yellow-poplar.

shrubs used for environmental improvement

Plantings to attract songbirds and wildlife	Plantings for critical areas	Plantings for windbreaks, screens, and sound barriers
Alternate-leaf dogwood, American hazel, American plum, Amur honeysuckle, Amur privet, "Arnot" bristly locust, autumn-olive, boxelder, bur oak, Carolina laurelcherry, coralberry, crabapple, eastern hophornbeam, eastern redcedar, English yew, fragrant sumac, Japanese yew, multiflora rose, Nanking cherry, oriental arborvitae, pawpaw, persimmon, red pine, shadblow serviceberry, shrub lespedeza, silky dogwood, spreading cotoneaster, Tartarian honeysuckle, winged euonymous.	American hazel, Amur honeysuckle, "Arnot" bristly locust, autumn-olive, coralberry, cutleaf staghorn sumac, eastern redcedar, English yew, fragrant sumac, Japanese yew, mallow ninebark, multiflora rose, shrub lespedeza, Tartarian honeysuckle.	American plum, Amur honeysuckle, Amur maple, Amur privet, autumn-olive, boxelder, crabapple, eastern redcedar, hackberry, hawthorn, lilac, mallow ninebark, multiflora rose, Nanking cherry, oriental arborvitae, osage-orange, red pine, Siberian elm, Tartarian honeysuckle, winged euonymous.
American cranberry bush, American hazel, American plum, Amur honeysuckle, "Arnot" bristly locust, autumn-olive, boxelder, bur oak, Carolina laurelberry, coralberry, cornelian cherry dogwood, crabapple, eastern hophornbeam, eastern redcedar, English yew, flowering dogwood, fragrant sumac, Japanese yew, multiflora rose, Nanking cherry, oriental arborvitae, pawpaw, pecan, persimmon, red pine, shadblow serviceberry, shrub lespedeza, silky dogwood, spreading cotoneaster, Tartarian honeysuckle, winged euonymous.	American hazel, Amur honeysuckle, "Arnot" bristly locust, autumn-olive, coralberry, eastern redcedar, English yew, fragrant sumac, Japanese yew, mallow ninebark, multiflora rose, rose, shrub lespedeza, Tartarian honeysuckle.	American plum, Amur honeysuckle, Amur maple, autumn-olive, boxelder, crabapple, eastern redcedar, hackberry, hawthorn, lilac, mallow ninebark, mockorange, multiflora rose, Nanking cherry, oriental arborvitae, osage-orange, red pine, rose-of-sharon, Siberian elm, Tartarian honeysuckle, winged euonymous.
American plum, Amur honeysuckle, Amur privet, "Arnot" bristly locust, autumn-olive, bur oak, coralberry, crabapple, eastern hophornbeam, eastern redcedar, multiflora rose, oriental arborvitae, silky dogwood, Tartarian honeysuckle, winged euonymous.	Amur honeysuckle, "Arnot" bristly locust, autumn-olive, coralberry, eastern redcedar, mallow ninebark, multiflora rose, shrub lespedeza, Tartarian honeysuckle.	American plum, Amur honeysuckle, Amur privet, autumn-olive, boxelder, crabapple, eastern redcedar, hawthorn, lilac, mallow ninebark, mockorange, multiflora rose, oriental arborvitae, Tartarian honeysuckle, winged euonymous.
Alternate-leaf dogwood, American hazel, American plum, Amur honeysuckle, Amur privet, "Arnot" bristly locust, autumn-olive, black cherry, black walnut, bur oak, Chinese elm, coralberry, cornelian cherry dogwood, crabapple, eastern hophornbeam, eastern redcedar, eastern white pine, English yew, flowering dogwood, fragrant sumac, Japanese yew, multiflora rose, Nanking cherry, oriental arborvitae, pawpaw, pecan, persimmon, pin oak, pussy willow, red-osier dogwood, red pine, sassafras, shadblow serviceberry, shrub lespedeza, silky dogwood, silver buffaloberry, spreading cotoneaster, Tartarian honeysuckle, winged euonymous.	American hazel, Amur honeysuckle, "Arnot" bristly locust, autumn-olive, black locust, coralberry, eastern redcedar, English yew, European alder, fragrant sumac, Japanese yew, multiflora rose, pussy willow, red-osier dogwood, shrub lespedeza, silver buffaloberry, Tartarian honeysuckle.	American plum, Amur honeysuckle, Amur maple, Amur privet, autumn-olive, black willow, Chinese elm, crabapple, eastern cottonwood, eastern redcedar, eastern white pine, green ash, hackberry, hawthorn, lilac, Lombardy poplar, mallow ninebark, medium purple willow, mockorange, multiflora rose, Nanking cherry, oriental arborvitae, osage-orange, pin oak, red-osier dogwood, red pine, rose-of-sharon, Siberian elm, silver buffaloberry, Tartarian honeysuckle, winged euonymous.

TABLE 4.—*Suitability of the soil for trees and shrubs*

Tree and shrub group	Trees to retain at home and park sites	Plantings for beauty and shade
Group 5: Deep, well drained and moderately well drained, nearly level to gently sloping soils; high to very high available water capacity; water table below a depth of 4 feet most of the year. Cf, He, Nd, Sh, WnB.	White oak, black walnut, northern red oak, black cherry.	Alternate-leaf dogwood, American sycamore, Amur honeysuckle, Amur privet, "Arnot" bristly locust, black oak, bur oak, Chinese elm, coralberry, cornelian cherry dogwood, crab-apple, eastern cottonwood, eastern hophorn-beam, eastern redbud, eastern white pine, English yew, flowering dogwood, fragrant sumac, green ash, hackberry, hawthorn, Japanese yew, lilac, Lombardy poplar, mallow ninebark, Nanking cherry, Norway maple, Ohio buckeye, oriental arborvitae, pawpaw, pecan, persimmon, pin oak, pussy willow, red-osier dogwood, red pine, rose-of-sharon, sassafras, scarlet oak, shadblow serviceberry, Siberian elm, silky dogwood, silver buffalo-berry, silver maple, spreading cotoneaster, sugar maple, Tartarian honeysuckle, white ash, white oak, winged euonymous, yellow-poplar.
Group 6: Deep, somewhat poorly drained, nearly level to moderately sloping soils; moderate to high available water capacity; seasonal high water table. Bk, CaB, CbB2, Do, MoB, MpB2, Ms, SaC2, Wa.	White oak, black oak, pin oak.	Alternate-leaf dogwood, American cranberry bush, Amur honeysuckle, Amur privet, "Arnot" bristly locust, black oak, bur oak, Chinese elm, coralberry, eastern hophorn-beam, green ash, mallow ninebark, northern catalpa, Ohio buckeye, oriental arborvitae, pecan, persimmon, pin oak, pussy willow, red-osier dogwood, red pine, Russian-olive, silky dogwood, silver maple, sweetgum, Tar-tarian honeysuckle, white oak, willow oak.
Group 7: Deep, poorly drained and very poorly drained, nearly level soils; moderate to high available water capacity; seasonal high water table. Au, Bo, Ch, Co, Ma, Mu, Pt, Tm.	Pin oak, white oak, black oak, northern red oak.	Alternate-leaf dogwood, American cranberry bush, Amur honeysuckle, Amur privet, "Arnot" bristly locust, black oak, bur oak, Chinese elm, coralberry, eastern hophorn-beam, green ash, mallow ninebark, northern catalpa, Ohio buckeye, oriental arborvitae, pin oak, pussy willow, red-osier dogwood, red pine, Russian-olive, silky dogwood, sweetgum, Tartarian honeysuckle, white oak, willow oak.

intersected by the breaks of the Missouri River tributaries. The northern glaciated plateau breaks away on the south into the Missouri River bottoms. The counties are a part of the transition zone between the prairie and the Ozarks border. This region, with its fairly rich and varied land types, provides a variety and profusion of edge growth that makes excellent game cover (*6*).

The Mexico-Armster-Putnam unit (See General Soil Map) is the main area of habitat for open land wildlife in the survey area. This soil unit supports medium populations of rabbits, quail, and deer and a high population of doves. Squirrel populations fluctuate between low and medium levels, depending on the amount and type of woodland habitat. Turkey numbers are low.

The Goss-Gasconade-Chilhowie unit, the Keswick-Lindley unit, and the Hatton-Keswick-Marion unit provide the vast majority of habitat for woodland wildlife. These wooded areas contain low populations of rabbits, quail, and doves; high deer and squirrel populations; and a medium turkey population. A successful stocking of ruffed grouse has been established and while populations are low at present, they are expected to increase during the coming years. The wild turkey, long extinct in the survey area, has been restored by a live trapping and release program conducted by the Missouri Department of Conservation.

The Winfield-Menfro unit, known as the "River Hills area," supports both open land and woodland wildlife. The area supports low to medium populations of all the species listed above with the exception of ruffed grouse.

The limited wetland wildlife areas occur along the Missouri River in the Blake-Haynie-Booker and Nodaway-Moniteau-Dockery units. Waterfowl populations are low in Montgomery and Warren Counties, and those waterfowl that are present use the river and its tributary systems.

The fishery resource is limited to certain areas within the two counties. Major streams include the West Fork of the Cuivre River and the Loutre in Montgomery County and the lower reaches of Lost Creek, Massas Creek, and Carrette Creek in southern

used for environmental improvement—Continued

Plantings to attract songbirds and wildlife	Plantings for critical areas	Plantings for windbreaks, screens, and sound barriers
American hazel, Amur honeysuckle, Amur privet, "Arnot" bristly locust, bur oak, Chinese elm, coralberry, cornelian cherry dogwood, crabapple, eastern hophornbeam, eastern redcedar, eastern white pine, English yew, flowering dogwood, fragrant sumac, Japanese yew, multiflora rose, Nanking cherry, oriental arborvitae, pawpaw, pecan, persimmon, pin oak, pussy willow, red-osier dogwood, red pine, sassafras, shadblow serviceberry, shrub lespedeza, silky dogwood, silver buffaloberry, spreading cotoneaster, Tartarian honeysuckle, winged euonymous.	Alternate-leaf dogwood, American hazel, Amur honeysuckle, Amur privet, "Arnot" bristly locust, coralberry, eastern redcedar, English yew, European alder, fragrant sumac, Japanese yew, mallow ninebark, multiflora rose, pussy willow, red-osier dogwood, silver buffaloberry, Tartarian honeysuckle.	Amur honeysuckle, Amur privet, black willow, Chinese elm, crabapple, eastern cottonwood, eastern redcedar, eastern white pine, green ash, hackberry, hawthorn, lilac, Lombardy poplar, mallow ninebark, medium purple willow, multiflora rose, Nanking cherry, oriental arborvitae, osage-orange, pin oak, red-osier dogwood, red pine, rose-of-sharon, Siberian elm, silver buffaloberry, Tartarian honeysuckle, winged euonymous.
American cranberry bush, Amur honeysuckle, Amur privet, "Arnot" bristly locust, bur oak, Chinese elm, coralberry, eastern hophornbeam, eastern redcedar, gray dogwood, mallow ninebark, multiflora rose, oriental arborvitae, pecan, persimmon, pin oak, pussy willow, red-osier dogwood, red pine, Russian-olive, shrub lespedeza, silky dogwood, Tartarian honeysuckle, willow oak.	Alternate-leaf dogwood, Amur honeysuckle, "Arnot" bristly locust, coralberry, eastern redcedar, European alter, gray dogwood, mallow ninebark, multiflora rose, pussy willow, red-osier dogwood, shrub lespedeza, Tartarian honeysuckle.	Amur honeysuckle, Amur privet, black willow, Chinese elm, eastern redcedar, gray dogwood, green ash, mallow ninebark, medium purple willow, multiflora rose, northern catalpa, oriental arborvitae, pin oak, red pine, Russian-olive, Tartarian honeysuckle.
American cranberry bush, Amur honeysuckle, Amur privet, "Arnot" bristly locust, bur oak, Chinese elm, coralberry, eastern hophornbeam, eastern redcedar, gray dogwood, multiflora rose, oriental arborvitae, pussy willow, red pine, Russian-olive, shrub lespedeza, silky dogwood, Tartarian honeysuckle, willow oak.	Alternate-leaf dogwood, Amur honeysuckle, "Arnot" bristly locust, coralberry, eastern redcedar, European alder, gray dogwood, mallow ninebark, multiflora rose, pussy willow, red-osier dogwood, shrub lespedeza, Tartarian honeysuckle.	Amur honeysuckle, Amur privet, black willow, Chinese elm, eastern redcedar, gray dogwood, green ash, mallow ninebark, medium purple willow, multiflora rose, northern catalpa, oriental arborvitae, pin oak, red pine, Russian-olive, Tartarian honeysuckle.

Warren County. The Missouri River provides fishing opportunities along the southern border of both counties. Wellsville Lake and the Marshall Diggs Wildlife Area in Montgomery County offer the only public lake fishing. Major stream fishes include catfish, carp, bass, buffalo, and crappie. Ponds and lakes are generally stocked with largemouth bass, channel catfish, and bluegill.

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the development of water impoundments. The kind and abundance of wildlife that populate an area depends largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, inadequate, or inaccessible, wildlife either is scarce or does not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by properly managing the existing plant cover, and by fostering the natural establishment of desirable plants.

In table 5 the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat. This information can be used to plan the use of parks, wildlife refuges, nature study areas, and other developments for wildlife; select soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat; determine the intensity of management needed for each element of the habitat; and determine areas that are suitable for acquisition to manage for wildlife.

The potential of the soil is rated *good, fair, poor,* or *very poor.* A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderate intensity of management and fairly frequent attention are required for satisfactory results. A rating of *poor* means that the limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, im-

TABLE 5.—*Suitability of the soils for elements of wildlife habitat and for kinds of wildlife*

Soil series and map symbols	Grain and seed crops	Grasses and legumes	Wild herbaceous upland plants	Hardwood woody plants	Coniferous woody plants	Shrubs	Wetland food and cover plants	Shallow water developments	Open land wildlife habitat	Woodland wildlife habitat	Wetland wildlife habitat
Armster: AmC2, ArC3	Fair	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Auxvasse: Au	Fair	Fair	Fair	Fair	Fair	Fair	Good	Fair	Fair	Fair	Fair.
Blake: Bk, Bm. For Haynie and Waldron parts of Bm, see their respective series.	Good	Good	Good	Good	Good	Good	Good	Fair	Good	Good	Fair.
Booker: Bo	Poor	Poor	Fair	Poor	Poor	Poor	Poor	Good	Poor	Poor	Fair.
Calwoods: CaB, CbB2	Fair	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Cedargap:											
Cd, Ce	Fair	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Cf	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Chariton: Ch	Fair	Fair	Fair	Fair	Fair	Fair	Good	Fair	Fair	Fair	Fair.
Chilhowie: CnF. For Gasconade and Crider parts, see their respective series.	Very poor.	Fair	Fair	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
Coland: Co	Good	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
Crider:											
CrC	Fair	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
CrD2	Fair	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Dockery: Do	Good	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
Gasconade: GaC, GdF. Rock outcrop part of GdF is too variable to be rated.	Very poor.	Poor	Poor	Poor	Very poor.	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
Goss:											
GoD	Poor	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
GoF	Very poor.	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
Hatton: HcB	Fair	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.

Haynie: He	Poor	Fair	Fair	Fair	Poor	Fair	Poor	Poor	Fair	Fair	Poor.
Hodge: Hg	Poor	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Holstein: HoC2, HoD2, HrE. Rock outcrop part of HrE is too variable to be rated.	Fair	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Keswick: KeC2, KeD, KsC3.	Fair	Good	Fair	Good	Fair	Good	Poor	Poor	Fair	Good	Poor.
Lindley: LnE	Very poor.	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Marion: Ma	Fair	Fair	Fair	Fair	Fair	Fair	Good	Fair	Fair	Fair	Fair.
Menfro:											
MeC2, MeD2	Fair	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
MeE	Poor	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
MeF	Very poor.	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Mexico: MoB, MpB2	Fair	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Modale: Ms	Good	Good	Good	Good	Fair	Good	Poor	Poor	Good	Good	Poor.
Moniteau: Mu	Fair	Fair	Fair	Fair	Fair	Fair	Good	Fair	Fair	Fair	Fair.
Nodaway: Nd	Good	Good	Good	Good	Fair	Good	Fair	Poor	Good	Good	Fair.
Putnam: Pt	Fair	Fair	Fair	Fair	Fair	Fair	Good	Fair	Fair	Fair	Fair.
Riverwash: Rv. Too variable to be rated.											
Sampsel: SaC2	Fair	Good	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Sharon: Sh	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Snead: SnD	Fair	Good	Fair	Fair	Fair	Fair	Poor	Very poor.	Fair	Fair	Very poor.
Twomile: Tm	Fair	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
Waldron: Wa	Fair	Fair	Poor	Good	Good	Good	Poor	Fair	Fair	Fair	Poor.
Weller:											
WeB	Good	Good	Fair	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
WeC2	Fair	Fair	Fair	Fair	Fair	Fair	Poor	Poor	Fair	Fair	Poor.

TABLE 5.—*Suitability of the soils for elements of wildlife habitat and for kinds of wildlife*—Continued

Soil series and map symbols	Grain and seed crops	Grasses and legumes	Wild herbaceous upland plants	Hardwood woody plants	Coniferous woody plants	Shrubs	Wetland food and cover plants	Shallow water developments	Open land wildlife habitat	Woodland wildlife habitat	Wetland wildlife habitat
Winfield:											
WnB	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
WnC2, WnD2	Fair	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
WnE	Poor	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
WnF	Very poor.	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.

proved, or maintained in most places, but management is difficult and requires intensive effort. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of wildlife are very severe and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

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

Grain and seed crops are seed-producing annuals used by wildlife. Examples are corn, sorghum, wheat, oats, barley, millet, buckwheat, cowpeas, soybeans, and sunflowers. The major properties 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.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Examples are fescue, bluegrass, lovegrass, switchgrass, bromegrass, timothy, orchardgrass, clover, alfalfa, trefoil, and crownvetch. Major properties 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 moisture are also considerations.

Wild herbaceous upland plants are native or naturally established herbaceous grasses and forbs, including weeds, that provide food and cover for wildlife. Examples are bluestem, indiangrass, goldenrod, beggarweed, pokeweed, foxtail, croton, switchgrass, partridgepea, and fescue. Major properties 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 moisture are also considerations.

Hardwood woody plants provide cover for wildlife and produce nuts or other fruit, buds, catkins, twigs, bark, or foliage that wildlife eat. Examples of native plants are oak, poplar, cherry, sweetgum, apple, hawthorn, dogwood, persimmon, sassafras, hickory, black walnut, and blackhaw. Major properties that affect growth of hardwood trees are depth of the root zone, available water capacity, and wetness.

Coniferous woody plants are cone bearing trees, shrubs, or ground cover that furnish habitat or supply food in the form of browse, seeds, or fruitlike cones. Examples are pine, spruce, hemlock, fir, yew, cedar, and juniper. Major soil properties that affect the growth of coniferous plants are depth of the root zone, available water capacity, and wetness.

Shrubs are busy woody plants that produce fruits, buds, twigs, bark, or foliage used as food, or that provide cover and shade for wildlife species. Examples are sumac, hazelnut, wild plum, buttonbush, and certain dogwoods. Examples of fruit producing shrubs that are commercially available and suitable for planting on soils rated good are autumn-olive, Amur honeysuckle, Russian-olive, and hawthorn. Major properties that affect the growth of shrubs are depth of the root zone, available water capacity, and wetness.

Wetland food and cover plants are annual and perennial wild herbaceous plants that grow on moist or wet sites, exclusive of submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Examples of wetland plants are smartweed, wild millet, rushes, sedges, cutgrass, wildrice, buttonbush, and cattail. Major properties affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness.

Shallow water developments are bodies of surface water that have an average depth of less than 5 feet and are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control devices in marshes or streams. Examples are muskrat marshes, waterfowl feeding areas, wildlife watering development, beaver ponds, and other wildlife ponds. Major soil properties affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. The availability of a dependable water supply is important if water areas are to be developed.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Open land habitat consists of cropland, pasture, meadow, 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 kinds of wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, killdeer, cottontail rabbit, red fox, woodchuck, and mourning dove.

Woodland habitat consists of hardwoods or conifers or a mixture of both, with associated grasses, legumes, and wild herbaceous plants. Examples of wildlife attracted to this habitat are wild turkey, ruffed grouse, woodcock, thrushes, vireos, woodpeckers, tree squirrels. grey fox, raccoon, deer, and black bear.

Wetland habitat consists of water-tolerant plants in open, marshy, or swampy shallow water areas. Examples of wildlife attracted to this habitat are ducks, geese, herons, shore birds, rails, kingfishers, muskrat, mink, and beaver.

Use of the Soils for Recreational Development [6]

The proximity of Montgomery and Warren Counties to the major metropolitan area of St. Louis adds greatly to the recreation potential of these areas. Interstate 70 makes much of the counties' land area available to the urban resident within one hour's drive of St. Louis.

The Statewide Comprehensive Outdoor Recreation Plan (SCORP) (*8*) shows 10,569 acres of existing recreational development in Montgomery County and 4,338 acres in Warren County. The report shows a minimum need to increase horse trails, playfields, fishing areas, swimming areas, foot trails, and winter sports areas in the two counties. A total of 6,386 acres of state owned lands are open to the public for various forms of outdoor recreation. These include two state forests, three wildlife areas, and one state park.

The NACD Nationwide Outdoor Recreation Inventory (*5*) shows nine private income producing recreation enterprises in Montgomery County and 24 in

[6] EDWARD A. GASKINS, biologist, Soil Conservation Service, helped prepare this section.

Warren County. These areas range from fishing lakes to transient campgrounds and include approximately 1,200 acres of land.

The 1972 Appraisal of Recreation Potential (*12*) for the Boonslick Regional Planning Area (Warren, Montgomery, and Lincoln Counties) provides the following information on the potential for private development of eleven recreational enterprises. Those having a high potential are vacation cabins, cottages, and homes; hunting areas; and water sports areas. Those rated as having a medium potential are camping, picnic, and sports areas; fishing waters; golf courses; natural, scenic, and historic areas; shooting preserves; and vacation farms. Riding stables have a low potential.

The soils of the survey area are rated in table 6 according to limitations that affect their suitability for camp areas, picnic areas, playgrounds, and paths and trails. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the material in the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewer lines or a capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in various degrees, for recreational use by the duration of flooding and the season when it occurs. Onsite assessment of height, duration, and frequency of flooding is essential in planning recreational facilities.

In table 6 the limitations of soils are rated as slight, moderate, or severe. *Slight* means that the soil properties are generally favorable and that the limitations are minor and easily overcome. *Moderate* means that the 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 6 can be supplemented by additional information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields and for dwellings without basements and for local roads and streets, all given in table 8.

Camp areas require such site preparation as shaping and leveling 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 for this use have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall steadily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing camping sites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as 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 will 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 not wet or subject to flooding during the season of use. The surface is free of stones or boulders, is firm after rain, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth of the soil over rock should be sufficient to allow necessary grading.

The design and layout of paths and trails for walking, horseback riding, and bicycling should require little or no cutting and filling. The best soils for this use are those that are not wet, are firm after rain, are not dusty when dry, and are not subject to flooding more than once during the period of use. They should have moderate slopes and have few or no stones or boulders on the surface.

Engineering Uses of the Soils

This section is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among properties of soils highly important in engineering are permeability, strength, compaction characteristics, drainage, shrink-swell potential, grain size, plasticity, and reaction. Also important are depth to the water table, depth to bedrock, and soil slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built, for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 7 and 8, which show, respectively, several estimated soil properties significant to engineering and interpretations for various engineering uses (*9*).

This information, along with the soil map and other parts of this publication, can be used to make interpretations in addition to those given in tables 7 and 8, and it also can be used to make other useful maps.

TABLE 6.—*Limitations of the soils for certain recreational developments*

Soil series and map symbols	Picnic areas	Playgrounds	Camp areas	Paths and trails
Armster:				
AmC2	Slight	Severe: slope	Moderate: moderately slow permeability.	Severe: slope.
ArC3	Moderate: too clayey	Severe: slope	Moderate: too clayey	Moderate: too clayey.
Auxvasse: Au	Severe: wet	Severe: very slow permeability.	Severe: very slow permeability.	Severe: wet.
Blake: Bk, Bm For Haynie and Waldron parts of Bm, see their respective series.	Moderate: wet; floods; too clayey.	Severe if commonly flooded. Moderate if protected from flooding; wet; too clayey.	Severe if commonly flooded. Moderate if protected from flooding; wet; too clayey.	Moderate: too clayey.
Booker: Bo	Severe: wet, floods; too clayey.	Severe: wet, floods; very slow permeability.	Severe: floods; wet; very slow permeability.	Severe: wet; too clayey.
Calwoods:				
CaB	Moderate: wet	Moderate: very slow permeability; wet.	Moderate: very slow permeability; wet.	Moderate: wet.
CbB2	Moderate: wet; too clayey.	Moderate: very slow permeability; wet; too clayey.	Moderate: very slow permeability; too clayey.	Moderate: wet; too clayey.
Cedargap:				
Cd	Slight	Moderate: floods	Moderate: floods	Moderate: small stones.
Ce	Moderate: small stones.	Severe: small stones	Moderate: floods; small stones.	Moderate: small stones.
Cf [1]	Moderate: too clayey; floods.	Moderate: too clayey; floods.	Moderate: too clayey	Moderate: too clayey.
Chariton: Ch	Severe: wet	Severe: slow permeability; wet.	Severe: slow permeability; wet; floods.	Severe: wet.
Chilhowie: CnF	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Coland: Co	Severe: floods; wet	Severe: floods; wet	Severe: floods; wet; moderately slow permeability.	Severe: floods; wet.
Crider:				
CrC	Slight where slopes are 5 to 9 percent.	Severe: slope	Slight	Slight.
CrD2	Moderate where slopes are 9 to 14 percent.	Moderate: wetness; floods.	Severe: wetness; floods.	Slight.
Dockery: Do	Moderate: wetness; floods.	Moderate: wetness; floods.	Severe: wetness; floods.	Slight.
Gasconade: GaC, GdF Rock outcrop part of GdF is too variable to be rated.	Severe: large stones	Severe: depth to rock; large stones.	Severe: large stones	Severe: large stones.
Goss:				
GoD	Moderate where slopes are 5 to 14 percent: small stones.	Severe: slope; small stones.	Moderate where slopes are 5 to 14 percent: small stones.	Moderate where slopes are 5 to 14 percent: small stones.
GoF	Severe where slopes are 14 to 45 percent.	Severe: slope; small stones.	Severe where slopes are 14 to 45 percent.	Severe where slopes are 14 to 45 percent.
Hatton: HcB	Slight	Severe: slope	Moderate: slow permeability.	Slight.
Haynie: He	Moderate: floods	Moderate: floods	Severe: floods	Slight.

TABLE 6.—*Limitations of the soils for certain recreational developments*—Continued

Soil series and map symbols	Picnic areas	Playgrounds	Camp areas	Paths and trails
Hodge: Hg	Moderate: too sandy; soil blowing.	Severe: floods; too sandy; soil blowing.	Severe: floods; too sandy; soil blowing.	Moderate: too sandy; soil blowing.
Holstein:				
HoC2	Slight where slopes are 5 to 9 percent.	Severe: slope	Slight where slopes are 5 to 9 percent.	Slight.
HoD2	Moderate where slopes are 9 to 14 percent.	Severe: slope	Moderate where slopes are 9 to 14 percent.	Slight.
HrE Rock outcrop part is too variable to be rated.	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
Keswick:				
KeC2	Moderate where slopes are 5 to 9 percent: wetness.	Severe: slope	Moderate where slopes are 5 to 9 percent: slow permeability; wetness.	Slight.
KeD	Moderate where slopes are 9 to 14 percent: wetness.	Severe: slope	Moderate where slopes are 9 to 14 percent: slow permeability; wetness.	Slight.
KsC3	Moderate where slopes are 5 to 9 percent: wetness.	Severe: slope	Moderate where slopes are 5 to 9 percent: slow permeability; wetness.	Moderate: too clayey.
Lindley: LnE	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
Marion: Ma	Severe: wetness	Severe: very slow permeability; wetness.	Severe: very slow permeability; wetness.	Severe: wetness.
Menfro:				
MeC2, MeD2	Slight where slopes are 5 to 9 percent; moderate where 9 to 14 percent.	Severe: slope	Slight where slopes are 5 to 9 percent; moderate where 9 to 14 percent.	Slight where slopes are 5 to 14 percent.
MeE, MeF	Severe where slopes are 14 to 35 percent.	Severe: slope	Severe where slopes are 14 to 35 percent.	Moderate where slopes are 14 to 35 percent.
Mexico: MoB, MpB2	Moderate: wetness	Severe: very slow permeability.	Severe: very slow permeability.	Moderate: wetness.
Modale: Ms	Moderate: wetness; floods.	Severe: slow permeability; floods.	Severe: floods	Moderate: wetness; floods.
Moniteau: Mu	Severe: wetness	Severe: wetness	Severe: wetness; floods.	Severe: wetness.
Nodaway: Nd	Severe: floods	Severe: floods	Severe: floods	Moderate: floods.
Putnam: Pt	Severe: wetness	Severe: very slow permeability; wetness.	Severe: very slow permeability; wetness.	Severe: wetness.
Riverwash: Rv. Too variable to be rated.				
Sampsel: SaC2	Moderate: wetness; too clayey.	Severe: slope	Moderate: slow permeability; wetness; too clayey.	Moderate: wetness; too clayey.
Sharon: Sh	Moderate: floods	Severe: floods	Severe: floods	Moderate: floods.

TABLE 6.—*Limitations of the soils for certain recreational developments*—Continued

Soil series and map symbols	Picnic areas	Playgrounds	Camp areas	Paths and trails
Snead: SnD	Moderate: wetness; too clayey.	Severe: slope	Moderate: slope; slow permeability; too clayey.	Moderate: too clayey.
Twomile: Tm	Severe: wetness	Severe: wetness	Severe: wetness; floods.	Severe: wetness.
Waldron: Wa	Severe: too clayey	Severe: too clayey	Severe: floods; wetness.	Severe: too clayey.
Weller:				
WeB	Moderate: wetness	Moderate where slopes are 2 to 4 percent: slow permeability; wetness.	Moderate: wetness; slow permeability.	Slight.
WeC2	Moderate: wetness	Severe where slopes are 5 to 9 percent.	Moderate: wetness; slow permeability.	Slight.
Winfield:				
WnB	Slight where slopes are 2 to 9 percent.	Moderate where slopes are 2 to 5 percent.	Slight where slopes are 2 to 9 percent.	Slight where slopes are 2 to 14 percent.
WnC2	Slight where slopes are 2 to 9 percent.	Severe where slopes are 5 to 35 percent.	Slight where slopes are 2 to 9 percent.	Slight where slopes are 2 to 14 percent.
WnD2	Moderate where slopes are 9 to 14 percent.	Severe where slopes are 5 to 35 percent.	Moderate where slopes are 9 to 14 percent.	Slight where slopes are 2 to 14 percent.
WnE, WnF	Severe where slopes are 14 to 35 percent.	Severe where slopes are 14 to 35 percent.	Severe where slopes are 14 to 35 percent.	Moderate where slopes are 14 to 35 percent.

[1] Cedargap clay loam, loamy variant.

This information, however, does not eliminate need for further investigations at sites selected for engineering works, especially works that involve heavy loads or that require excavations to a depth of more than 6 feet. Also, inspection of sites, especially the small ones, is needed because many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have special meanings to soil scientists that are not known to all engineers. The Glossary defines many of these terms commonly used in soil science.

Engineering soil classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system (*2*) used by the SCS engineers, Department of Defense, and others, and the AASHTO system (*1*) adopted by the American Association of State Highway and Transportation Officials.

The Unified system is used to classify soils according to engineering uses for building materials or for the support of structures other than highways. Soils are classified according to particle size distribution, plasticity index, liquid limit, and organic matter content. Soils are grouped into 15 classes. There are eight classes of coarse-grained soils that are subdivided on the basis of gravel and sand content. These are identified as GW, GP, GM, GC, SW, SP, SM, and SC. Six classes of fine-grained soils are subdivided on the basis of the plasticity index. Nonplastic classes are ML, MH, OL, and OH; plastic classes are CL and CH. There is one class of highly organic soils, Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example CL–ML.

The AASHTO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system a soil is placed in one of seven basic groups ranging from A–1 through A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A–1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A–7, are clay soils that have low strength when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A–1, A–2, and A–7 groups are divided as follows: A–1–a, A–1–b, A–2–4, A–2–5, A–2–6, A–2–7, A–7–5, and A–7–6. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest. The estimated classification, without group index numbers, is given in table 7 for all soils mapped in the survey area.

USDA texture (*10*) is determined by the relative proportions of sand, silt, and clay in soil material that is less than 2.0 millimeters in diameter. "Sand," "silt,"

TABLE 7.—*Estimated soil properties*

[Absence of data indicates that no estimate was made. The symbol > means more than; the symbol < means less than. An asterisk mapping units may have different properties and limitations, and for this reason the reader

Soil series and map symbols	Depth to— Bedrock	Depth to— Seasonal water table	Depth from surface	USDA texture	Classification Unified	Classification AASHTO	Coarse fraction greater than 3 inches
	Ft	*Ft*	*In*				*Pct*
Armster: AmC2, ArC3	>6	2½–4	0–6	Loam and clay loam	CL	A-6	0
			6–52	Clay loam and clay	CL, CH	A-7	0
			52–60	Clay loam	CL	A-6, A-7	0
Auxvasse: Au	>6	1–2	0–15	Silt loam	CL–ML, CL	A-4, A-6	0
			15–40	Silty clay	CH	A-7	0
			40–60	Silty clay loam	CL	A-6, A-7	0
*Blake: Bk, Bm	>6	2–4	0–30	Silty clay loam	CL	A-7	0
For Haynie and Waldron parts of Bm, see their respective series.			30–35	Silty clay	CL, CH	A-7	0
			35–60	Stratified very fine sandy loam and loamy very fine sand.	ML, CL–ML	A-4	0
Booker: Bo	>6	0–1	0–60	Clay	CH	A-7	0
Calwoods: CaB, CbB2	>6	1–2½	0–8	Silty loam and silty clay loam.	CL–ML, CL	A-4	0
			8–12	Silty clay loam	CL	A-6, A-7	0
			12–33	Silty clay and clay	CH	A-7	0
			33–40	Silty clay loam	CL	A-6, A-7	0
			40–60	Silty clay loam	CL	A-6, A-7	0
Cedargap:							
Ce	>6	>6	0–12	Cherty silt loam	SM, GM	A-1, A-2, A-4	2–15
			12–62	Very cherty clay loam, very cherty clay.	GC	A-1, A-2-6, A-6	5–20
Cd	>6	>6	0–12	Silt loam	ML	A-4	0–5
			12–62	Very cherty clay loam.	GC	A-1, A-2-6, A-6	5–20
Cf[a]	>6	>6	0–32	Clay loam	CL	A-6	0
			32–60	Clay loam	CL	A-6	0–5
Chariton: Ch	>6	1–2	0–12	Silt loam	CL–ML, CL	A-4, A-6	0
			12–15	Silty clay loam	CL	A-6, A-7	0
			15–42	Silty clay	CH	A-7	0
			42–68	Clay loam	CL, SC	A-6	0
Chilhowie: CnF	2–3	4	0–3	Silty clay loam	CH, MH	A-7	0–50
For Gasconade and Crider parts, see their respective series.			3–19	Silty clay and clay	CH, MH	A-7	0–15
			19–28	Very cobbly clay	CH, GC	A-7, A-2-7	10–30
			28	Unweathered bedrock.			
Coland: Co	>6	1–3	0–60	Clay loam	CL, CH	A-7	0
Crider: CrC, CrD2	>6		0–9	Silt loam	ML, CL	A-4, A-6	0
			9–41	Silty clay loam	ML, CL	A-4, A-6, A-7	0
			41–60	Silty clay	CL, CH	A-6, A-7	0–5
Dockery: Do	>6	1–3	0–60	Stratified silt loam and silty clay loam.	CL–ML, CL	A-4, A-6, A-7	0
Gasconade: GaC, GdF	10–20	>6	0–6	Stony silty clay loam	CL	A-6	20–70
Rock outcrop part of GdF is too variable to be rated.			6–13	Channery silty clay	GC	A-2-7	20–70
			13	Unweathered bedrock.			

significant to engineering

in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in such should follow carefully the instructions for referring to another series in this table]

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
						In/hr	*In/in of soil*	*pH*			
95–100	80–95	75–90	55–80	20–35	11–20	0.6–2.0	0.17–0.20	5.6–6.0	Moderate	Moderate	Moderate.
95–100	80–95	70–90	55–80	45–60	26–35	0.2–0.6	0.10–0.18	4.5–5.6	High	High	Moderate.
95–100	80–95	70–90	55–80	30–45	15–25	0.2–0.6	0.10–0.15	6.1–7.3	Moderate	High	Low.
100	100	90–100	85–100	25–35	5–15	0.6–2.0	0.22–0.24	5.1–6.0	Low	High	Moderate.
100	100	95–100	90–100	50–65	30–40	<0.06	0.09–0.11	4.5–5.5	High	High	High.
100	100	90–100	90–96	35–45	20–25	0.2–0.6	0.18–0.20	4.5–5.0	Moderate	High	High.
100	100	90–100	85–95	41–50	20–30	0.2–2.0	0.20–0.22	7.4–8.4	High	High	Low.
100	100	95–100	90–100	45–65	30–45	0.2–0.6	0.11–0.13	7.4–7.8	High	High	Low.
100	100	65–90	50–85	<20	[1] NP–8	2.0–6.0	0.15–0.19	7.9–8.4	Low	High	Low.
100	100	100	95–100	50–75	35–55	<0.06	0.09–0.11	6.1–7.3	Very high	High	Low.
100	100	95–100	90–98	25–32	5–10	0.6–2.0	0.22–0.24	4.5–6.0	Low	Moderate	Moderate.
100	100	95–100	90–99	35–50	23–35	0.2–0.6	0.18–0.20	4.5–5.0	Moderate	Moderate	High.
100	100	97–100	95–100	55–70	30–45	<0.06	0.11–0.13	4.5–5.0	High	High	High.
100	100	95–100	95–100	35–50	25–35	<0.06	0.14–0.18	5.1–5.5	High	High	Moderate.
100	100	95–100	90–100	30–45	15–25	<0.06	0.18–0.20	5.6–6.0	Moderate	High	Moderate.
40–85	30–75	20–60	15–50	25–35	3–9	2.0–6.0	0.11–0.18	6.6–7.3	Low	Low	Low.
25–50	20–50	15–45	15–40	30–40	15–25	2.0–6.0	0.04–0.10	6.6–7.3	Low	Low	Low.
90–100	85–95	75–95	70–95	25–35	3–9	0.6–2.0	0.22–0.24	6.6–7.3	Low	Low	Low.
25–50	20–50	15–45	15–40	30–40	15–25	2.0–6.0	0.04–0.10	6.6–7.3	Low	Low	Low.
95–100	95–100	65–85	60–75	30–40	10–20	0.6–2.0	0.17–0.19	6.1–6.5	Moderate	Moderate	Low.
90–100	85–100	55–85	51–75	30–40	10–20	0.6–2.0	0.12–0.14	6.6–7.3	Moderate	Moderate	Low.
100	100	90–100	85–100	25–35	5–15	0.6–2.0	0.22–0.24	6.1–7.3	Low	High	Low.
100	100	95–100	90–99	30–45	15–25	0.2–0.6	0.18–0.20	5.6–6.0	Moderate	High	Moderate.
100	100	95–100	90–100	55–70	35–45	0.06–0.2	0.11–0.13	5.6–6.5	High	High	Moderate.
100	100	80–95	36–65	25–35	10–20	0.6–2.0	0.15–0.17	6.6–7.3	Moderate	High	Low.
90–100	60–100	60–100	55–90	50–65	15–30	0.2–2.0	0.14–0.18	6.6–7.8	Moderate	High	Low.
75–100	65–100	60–100	55–90	50–65	20–35	0.06–0.2	0.10–0.15	6.6–7.8	Moderate	High	Low.
45–80	35–70	30–70	25–70	50–60	20–35	0.06–0.2	0.02–0.05	6.6–7.8	Moderate	High	Low.
100	100	95–100	70–90	45–55	20–30	0.2–0.6	0.15–0.19	6.1–7.3	High	High	Low.
100	95–100	90–100	85–100	25–35	3–15	0.6–2.0	0.19–0.23	6.1–6.5	Low	Moderate	Low.
100	95–100	90–100	85–100	30–45	8–25	0.6–2.0	0.18–0.20	5.1–6.0	Low	Moderate	Moderate.
85–100	75–100	70–100	60–100	35–65	15–40	0.6–2.0	0.10–0.12	5.6–6.0	Moderate	Moderate	Moderate.
100	100	90–100	70–95	25–45	5–20	0.2–0.6	0.20–0.24	6.6–7.3	Moderate	Moderate	Low.
70–85	70–85	60–75	55–65	30–40	15–25	0.6–2.0	0.10–0.12	6.6–7.3	Moderate	High	Low.
40–50	40–50	30–40	20–35	55–65	35–45	0.2–0.6	0.05–0.07	6.6–7.3	Moderate	High	Low.

TABLE 7.—*Estimated soil properties*

Soil series and map symbols	Depth to— Bedrock	Depth to— Seasonal water table	Depth from surface	USDA texture	Classification: Unified	Classification: AASHTO	Coarse fraction greater than 3 inches
	Ft	*Ft*	*In*				*Pct*
Goss: GoD GoF	>6	>6	0–23	Very cherty silt loam	GM, GC	A-2	10–40
			23–61	Very cherty clay	GC	A-7	10–45
			61–65	Weathered chert and shale.			
Hatton: HcB	>6	2–3	0–13	Silt loam	CL–ML, CL	A-4, A-6	0
			13–32	Silty clay loam and silty clay.	CL, CH	A-7	0
			32–45	Silt loam	CL	A-6	0
			45–60	Loam, silt loam	CL	A-6, A-7	0
Haynie: He	>6	>6	0–60	Very fine sandy loam	ML, CL	A-4, A-6	0
Hodge: Hg	>6	>6	0–45	Loamy fine sand	SM	A-2, A-4	0
			45–55	Fine sandy loam, very fine sandy loam.	SM, SM–SC, SC	A-4	0
			55–60	Fine sand	SM	A-2, A-4	0
Holstein: HoC2, HoD2, HrE. Rock outcrop part of HrE is too variable to be rated.	>6	>6	0–5	Loam	CL–ML, CL	A-4, A-6	0–10
			5–13	Clay loam	CL	A-4, A-6	0–5
			13–46	Clay loam	CL	A-6	0–5
			46–65	Sandy clay loam	SC, CL	A-4, A-6	0–5
Keswick: KeC2, KeD, KsC3	>6	1–3	0–16	Silt loam and clay loam.	CL, CL–ML	A-6, A-4	0
			16–52	Clay	CH, MH	A-7	0
			52–60	Clay loam	CL, SC	A-6	0
Lindley: LnE	>6	6	0–4	Loam	CL–ML, CL	A-4, A-6	0
			4–45	Clay loam	CL	A-6, A-7	0
			45–60	Clay loam	CL	A-6	0
Marion: Ma	>6	1–2	0–13	Silt loam	ML, CL	A-4, A-6	0
			13–36	Silty clay	CH	A-7	0
			36–66	Silty clay loam	CL	A-6, A-7	0
Menfro: MeC2, MeD2, MeE, MeF.	>6	>6	0–11	Silt loam	CL	A-6	0
			11–57	Silty clay loam	CL	A-6, A-7	0
			57–72	Silt loam	CL–ML, CL	A-4, A-6	0
Mexico: MoB, MpB2	>6	1–2	0–9	Silt loam and silty clay loam.	CL–ML, CL	A-4, A-6	0
			9–14	Silty clay loam	CL, CH	A-7	0
			14–25	Silty clay	CH	A-7	0
			25–43	Silty clay loam	CL	A-6, A-7	0
			43–80	Clay loam	CL, CH	A-7	0
Modale: Ms	>6	1–3	0–30	Silt loam	CL	A-4, A-6	0
			30–60	Silty clay	CH	A-7	0
Moniteau: Mu	>6	1–2	0–20	Silt loam	CL–ML, CL	A-4, A-6	0
			20–65	Silty clay loam	CL	A-6, A-7	0
Nodaway: Nd	>6	>6	0–60	Silt loam	CL, CL–ML	A-4, A-6	0
Putnam: Pt	>6	½–1½	0–15	Silt loam	CL–ML, CL	A-4, A-6	0
			15–44	Silty clay	CH	A-7	0
			44–60	Silty clay loam	CL, CH	A-7	0
Riverwash: Rv. Too variable to be rated.							
Sampsell: SaC2	5–7	1½–3	0–6	Silty clay loam	CL	A-6, A-7	0
			6–60	Clay	CH	A-7	0

significant to engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
						In/hr	*In/in of soil*	*pH*			
40–60	35–55	30–50	25–35	20–30	2–8	2.0–6.0	0.06–0.10	5.1–6.0	Low	Low	Moderate.
45–70	40–65	40–50	35–45	50–70	30–40	0.6–2.0	0.04–0.09	5.0–6.0	Moderate	Low	Moderate.
100	100	92–100	80–98	25–40	5–15	0.6–2.0	0.22–0.24	4.5–5.5	Low	High	Moderate.
100	100	95–100	90–100	40–60	25–35	0.06–0.2	0.11–0.18	4.5–5.0	Moderate	High	High.
100	85–95	80–90	75–85	25–40	10–20	0.06–0.2	0.10–0.13	4.5–5.5	Low	High	Moderate.
95–100	80–95	70–90	60–85	30–45	15–25	0.06–0.2	0.14–0.18	5.6–6.0	Moderate	High	Moderate.
100	100	85–100	70–100	30–40	5–15	0.6–2.0	0.21–0.23	7.4–7.8	Low	Low	Low.
100	100	60–85	25–45	--------	NP	>6.0	0.07–0.12	7.4–7.8	Very low	Low	Low.
100	100	70–90	40–50	<25	NP–5	>6.0	0.13–0.15	7.4–7.8	Very low	Low	Low.
100	100	60–85	25–45	--------	NP	>6.0	0.06–0.10	7.4–7.8	Very low	Low	Low.
90–100	85–100	70–90	55–75	20–30	5–15	0.6–2.0	0.20–0.22	5.6–6.5	Low	Low	Moderate.
95–100	90–100	80–95	60–80	25–35	8–15	0.6–2.0	0.17–0.19	5.1–6.0	Low	Low	Moderate.
95–100	90–98	80–95	60–80	30–40	11–20	0.6–2.0	0.15–0.17	4.5–6.0	Moderate	Moderate	Moderate.
95–100	85–98	75–90	36–55	25–35	8–15	0.6–2.0	0.15–0.17	4.5–6.0	Low	Low	Moderate.
95–100	80–100	75–90	60–80	20–30	5–15	0.6–2.0	0.14–0.18	4.5–6.0	Moderate	High	Moderate.
95–100	80–100	70–90	55–80	50–60	20–30	0.06–0.2	0.11–0.15	4.5–5.5	High	High	Moderate.
95–100	80–100	65–85	40–70	35–40	15–25	0.2–0.6	0.12–0.16	5.6–6.0	Moderate	High	Moderate.
95–100	90–100	85–95	50–65	15–30	5–15	0.6–2.0	0.16–0.18	5.1–6.0	Low	Moderate	Moderate.
95–100	90–100	85–95	55–75	30–45	15–25	0.2–0.6	0.14–0.18	4.5–6.5	Moderate	Moderate	Moderate.
95–100	90–100	85–95	50–70	30–40	15–25	0.2–0.6	0.12–0.16	7.4–7.8	Moderate	Moderate	Low.
100	100	90–100	90–100	30–40	5–15	0.6–2.0	0.22–0.24	4.5–6.0	Low	High	Moderate.
100	100	95–100	90–100	50–65	30–40	<0.06	0.11–0.13	4.5–5.0	High	High	High.
100	100	95–100	85–95	35–45	20–25	<0.06	0.15–0.17	4.5–5.0	Moderate	High	High.
100	100	95–100	92–100	25–35	11–20	0.6–2.0	0.22–0.24	5.6–6.5	Low	Low	Low.
100	100	95–100	95–100	36–45	20–25	0.6–2.0	0.18–0.20	5.1–6.5	Moderate	Low	Moderate.
100	100	95–100	92–100	25–35	5–15	0.6–2.0	0.20–0.22	6.1–6.5	Low	Low	Low.
100	100	95–100	90–98	26–40	5–20	0.6–2.0	0.22–0.24	5.6–7.5	Low	Moderate	Moderate.
100	100	95–100	92–100	45–60	30–38	0.06–0.2	0.18–0.20	5.1–5.5	High	Moderate	Moderate.
100	100	97–100	95–100	55–75	32–48	<0.06	0.10–0.12	5.1–6.0	Very high	High	Moderate.
100	100	95–100	92–100	35–50	25–35	<0.06	0.12–0.14	6.1–6.5	High	High	Low.
95–100	95–100	80–95	70–100	40–70	25–40	<0.06	0.10–0.12	6.6–7.3	High	High	Low.
100	100	95–100	70–90	25–40	8–18	0.6–2.0	0.21–0.23	6.6–7.8	Moderate	Moderate	Low.
100	100	95–100	95–100	65–85	40–60	0.06–0.2	0.11–0.13	7.4–7.8	High	High	Low.
100	100	90–100	85–100	25–35	5–15	0.2–0.6	0.21–0.23	4.5–7.3	Low	High	Moderate.
100	100	85–100	80–95	30–45	15–25	0.06–0.2	0.18–0.20	4.5–5.5	Moderate	High	High.
100	95–100	95–100	90–100	25–35	5–15	0.6–2.0	0.20–0.23	6.6–7.3	Moderate	Moderate	Low.
100	100	92–100	85–98	25–40	5–20	0.6–2.0	0.22–0.24	5.1–6.5	Low	High	Moderate.
100	100	95–100	92–99	65–75	38–48	<0.06	0.09–0.11	4.5–5.5	High	High	High.
100	100	95–100	92–99	45–60	30–38	<0.06	0.12–0.16	5.6–6.0	High	High	Moderate.
100	100	95–100	90–99	35–50	15–25	0.2–0.6	0.21–0.24	6.1–7.3	Moderate	Moderate	Low.
100	100	97–100	95–100	52–75	35–45	0.06–0.2	0.11–0.13	6.1–7.8	High	High	Low.

TABLE 7.—*Estimated soil properties*

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification		Coarse fraction greater than 3 inches
	Bedrock	Seasonal water table			Unified	AASHTO	
	Ft	*Ft*	*In*				*Pct*
Sharon: Sh	>6	>4	0–60	Silt loam	ML, CL	A–4	0
Snead: SnD	2–4	2–3	0–12	Silty clay loam	CL	A–6, A–7	0–10
			12–24	Silty clay	CH	A–7	0–10
			24–60	Weathered bedrock.			
Twomile: Tm	>6	1–2	0–24	Silt loam	CL–ML, CL	A–4, A–6	0
			24–33	Silt loam	CL–ML, CL	A–4	0
			33–62	Silty clay loam	CL	A–6, A–7	0
			62–72	Clay loam	CL	A–6	0
Waldron: Wa	>6	1–3	0–7	Silty clay	CL, CH	A–7	0
			7–60	Stratified silty clay and silty clay loam.	CL, CH	A–6, A–7	0
Weller: WeB, WeC2	>6	2–4	0–8	Silt loam	ML, CL	A–6, A–4	0
			8–50	Silty clay loam and silty clay.	CH	A–7	0
			50–60	Silty clay loam	CH, CL	A–7	0
Winfield: WnB WnC2, WnD2, WnE, WnF.	>6	>4	0–6	Silt loam	CL	A–6	0
			6–30	Silty clay loam	CL	A–6, A–7	0
			30–43	Silty clay loam	CL	A–6, A–7	0
			43–62	Silty clay loam	CL, CL–ML	A–4, A–6	0

[1] NP = nonplastic.
[2] Cedargap clay loam, loamy variant.

"clay," and some of the other terms used in the USDA textural classification are defined in the Glossary. Stones, cobbles, and gravel are used as textural modifiers where present in the soil.

Soil properties significant to engineering

Several estimated soil properties significant to engineering are given in table 7. These estimates are made by layers of representative soil profiles having significantly different soil properties. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties. Following are explanations of some of the columns in table 7.

Depth to bedrock is the distance from the surface of the soil to a rock layer within the depth of observation.

Depth to seasonal high water table is the distance from the surface of the soil to the highest level that ground water reaches in the soil in most years.

Soil texture is described in table 7 in the standard terms used by the Department of Agriculture (*10*). These terms are based on the percentages of sand, silt, and clay in the less than 2 millimeter fraction of the soil. "Loam," for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, as for example, "gravelly loamy sand." "Sand," "silt," "clay," and some of the other terms used in USDA textural classification are defined in the Glossary of this soil survey.

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the water content of a clayey soil, from which the particles coarser than 0.42 millimeter have been removed, is increased from a dry state, the material changes from a semisolid to a plastic. If the moisture content is further increased, the material changes from a plastic to a liquid. The plastic limit is the moisture content at which the soil material changes from a semisolid to a plastic; the liquid limit is the moisture content at which it changes from a plastic to a liquid. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of water content within which a soil material is plastic. Liquid limit and plasticity index are estimated in table 7.

Permeability, as used here, is an estimate of the rate at which saturated soil transmits water in a vertical direction under a unit head of pressure. It is estimated on the basis of those soil characteristics observed in the field, particularly structure, porosity, and texture. Lateral seepage or such transient soil features as plowpans and surface crusts are not considered.

Available water capacity is an estimate of the capacity of soils to hold water for use by most plants. It is defined here as the difference between the amount

significant to engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
						In/hr	*In/in of soil*	*pH*			
100	100	80–95	75–95	24–31	2–10	0.6–2.0	0.22–0.24	4.5–6.0	Low	Low	High.
90–100	90–100	90–100	80–95	35–50	15–25	0.2–0.6	0.21–0.23	6.1–6.5	Moderate	Moderate	Low.
90–100	90–100	90–100	80–100	52–75	35–45	0.06–0.2	0.09–0.13	6.6–8.4	High	High	Low.
100	100	95–100	90–100	25–40	5–15	0.6–2.0	0.22–0.24	4.5–6.0	Low	High	Moderate.
100	100	95–100	90–100	25–30	5–10	0.2–0.6	0.10–0.13	4.5–5.0	Low	High	Moderate.
100	95–100	90–100	85–95	30–45	15–20	0.06–0.2	0.08–0.10	4.5–5.0	Moderate	High	Moderate.
100	95–100	90–100	70–90	30–40	10–20	0.2–0.6	0.12–0.16	5.1–5.5	Moderate	High	Moderate.
100	100	95–100	95–100	45–60	30–40	0.06–0.2	0.12–0.14	7.4–7.8	High	High	Low.
100	100	95–100	90–100	35–65	20–40	0.06–0.2	0.10–0.18	7.4–7.8	High	High	Low.
100	100	100	95–100	30–40	5–15	0.6–2.0	0.22–0.24	5.6–6.0	Low	High	Moderate.
100	100	100	95–100	50–65	30–40	0.06–0.2	0.12–0.18	4.5–5.5	High	High	Moderate.
100	100	100	95–100	45–55	20–30	0.2–0.6	0.18–0.20	5.1–5.5	High	High	Moderate.
100	100	95–100	92–100	25–40	11–20	0.6–2.0	0.22–0.24	6.1–6.5	Low	Moderate	Low.
100	100	95–100	95–100	35–45	20–25	0.6–2.0	0.18–0.20	5.1–5.5	Moderate	Moderate	Moderate.
95–98	95–98	90–98	90–96	35–45	20–25	0.6–2.0	0.15–0.17	5.1–5.5	Moderate	Low	Moderate.
85–98	85–98	80–96	75–94	25–35	5–15	0.6–2.0	0.14–0.16	5.1–5.5	Low	Low	Moderate.

of water in the soil at field capacity and the amount at the wilting point of most plants.

Reaction refers to the acidity or alkalinity of a soil, expressed in pH values for a stated soil-solution mixture. The pH value and terms used to describe soil reaction are explained in the Glossary.

Shrink-swell potential refers to the relative change in volume to be expected of soil material as moisture content changes; that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. The extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils can damage building foundations, roads, and other structures. Soils having a *high* shrink-swell potential are the most hazardous.

Corrosivity, as used in table 7, pertains to potential soil-induced chemical action that dissolves or weakens steel or concrete. Rate of corrosion of steel is related to soil properties such as drainage, texture, total acidity, and electrical conductivity of the soil material. Installations of steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations entirely in one kind of soil or in one soil horizon. Corrosivity for concrete is influenced mainly by the content of sodium or magnesium sulfate, but also by soil texture and acidity. A corrosivity rating of *low* means that there is a low probability of soil induced corrosion damage, and a corrosivity rating of *moderate* means there is a moderate probability. A rating of *high* means that there is such a high probability of damage that protective measures for steel and more resistant concrete should be used to reduce damage.

Engineering interpretations of soils

The estimated interpretations in table 8 are based on the engineering properties of soils shown in table 7, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of Montgomery and Warren Counties. In table 8 ratings are used to summarize limitation or suitability of the soils for all listed purposes other than for drainage of cropland and pasture, irrigation, ponds and reservoirs, embankments, and terraces and diversions. For these particular uses, table 8 lists those soil features not to be overlooked in planning, installation, and maintenance.

Soil limitations are indicated by the ratings *slight, moderate*, and *severe*. *Slight* means soil properties are generally favorable for the rated use, or in other words, limitations that are minor and easily overcome. *Moderate* means that some soil properties are unfavorable, but the problem can be overcome or modified by special planning and design. *Severe* means soil properties are so unfavorable and so difficult to correct or overcome as to require major soil reclamation, special designs, or intensive maintenance.

Soil suitability is rated by the terms good, fair, and

TABLE 8.—*Interpretations of*

[An asterisk in the first column indicates at least one mapping unit in this series is made up of two or more kinds of soil. The the instructions for referring to

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill	Local roads and streets
Armster: AmC2, ArC3	Severe: moderately slow permeability.	Moderate: slope.	Moderate: too clayey; wetness.	Severe: shrink-swell; low strength.	Moderate: too clayey.	Severe: shrink-swell; low strength.
Auxvasse: Au	Severe: wetness; very slow permeability.	Slight where protected from flooding; Severe where subject to rare flooding: floods, wetness.	Severe: wetness.	Severe: wetness; shrink-swell; floods.	Severe: wetness.	Severe: wetness; shrink-swell.
*Blake: Bk, Bm. For Haynie and Waldron parts of Bm, see their respective series.	Severe: wetness; floods.	Severe: wetness; seepage; floods.	Severe: wetness; floods.	Severe: floods.	Severe: wetness; seepage; floods.	Severe: low strength; floods; frost action.
Booker: Bo	Severe: very slow permeability; floods; wetness.	Slight where protected from flooding; Severe where subject to common flooding: floods, wetness.	Severe: wetness; floods; too clayey.	Severe: wetness; floods; shrink-swell.	Severe: floods; wetness; too clayey.	Severe: wetness; floods; shrink-swell.
Calwoods: CaB, CbB2	Severe: very slow permeability; wetness.	Moderate: slope.	Severe: wetness.	Severe: shrink-swell.	Moderate: wetness; too clayey.	Severe: shrink-swell; frost action.
Cedargap: Cd, Ce	Severe: floods.	Severe: floods; seepage.	Severe: floods.	Severe: floods.	Severe: floods; seepage.	Severe: floods.
Cf[1]	Moderate: floods.	Severe: floods; seepage.	Moderate: floods.	Severe: floods.	Moderate: floods; seepage.	Moderate: floods.
Chariton: Ch	Severe: wetness; slow permeability.	Slight where protected from flooding; Severe where subject to rare flooding; floods, wetness.	Severe: wetness.	Severe: wetness; shrink-swell.	Severe: wetness.	Severe: wetness; frost action; shrink-swell.
*Chilhowie: CnF. For Gasconde and Crider parts, see their respective series.	Severe: slope; slow permeability; depth to rock.	Severe: slope; depth to rock.	Severe: slope.	Severe: slope.	Severe: slope; depth to rock.	Severe: slope.

engineering properties

soils in such mapping units may have different properties and limitations and for this reason the reader should follow carefully another series of this table]

Suitability as a source of—		Soil features affecting—				
Road fill	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions
Poor: shrink-swell; low strength.	Poor: thin layer; area reclaim.	Slope	Shrink-swell; erodes easily.	Not needed	Slope; moderately slow permeability; erodes easily.	Moderately slow permeability; erodes easily; complex slopes.
Poor: wetness; shrink-swell.	Poor: wetness.	Favorable	Compressible; low strength; piping.	Very slow permeability.	Very slow permeability; wetness.	Very slow permeability; wetness.
Poor: low strength; frost action.	Fair: too clayey.	Slope	Low strength; piping.	Frost action; floods.	Floods; wetness	Not needed.
Poor: wetness; shrink-swell; low strength.	Poor: wetness; too clayey.	Favorable	Shrink-swell; compressible; low strength.	Floods; very slow permeability; wetness.	Slow intake; wetness; floods.	Not needed.
Poor: shrink-swell; frost action.	Fair: thin layer.	Favorable	Shrink-swell	Not needed	Slow intake; wetness; slope.	Very slow permeability; wetness.
Fair: frost action.	Fair: silt loam; small stones. Poor: cherty silt loam and cherty loam; small stones.	Seepage	Seepage; piping	Not needed	Droughty; seepage; floods.	Not needed.
Fair: shrink-swell.	Fair: too clayey.	Seepage	Seepage	Not needed	Floods	Not needed.
Poor: wetness; shrink-swell.	Poor: wetness.	Favorable	Compressible; low strength; piping.	Slow permeability; wetness.	Slow permeability; wetness.	Slow permeability; wetness.
Poor: slope	Poor: slope; too clayey.	Depth to rock	Thin layer; hard to pack.	Not needed	Rooting depth; droughty.	Depth to rock; slope.

TABLE 8.—*Interpretations of*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill	Local roads and streets
Coland: Co	Severe: floods; wetness.	Severe: floods; wetness.	Severe: floods; wetness.	Severe: floods; wetness; frost action.	Severe: floods; wetness.	Severe: floods; wetness; frost action.
Crider: CrC, CrD2	Slight where slopes are 5 to 9 percent; moderate where 9 to 14 percent.	Moderate where slopes are 5 to 9 percent: seepage. Severe where slopes are 9 to 14 percent.	Slight where slopes are 5 to 9 percent; moderate where 9 to 14 percent.	Severe: frost action; low strength.	Slight	Severe: frost action; low strength.
Dockery: Do	Severe: wetness; floods.	Moderate where protected from flooding: seepage. Severe where subject to flooding: floods, wetness.	Severe: wetness; floods.	Severe: wetness; floods; low strength.	Moderate where protected from flooding: wetness. Severe where subject to occasional flooding: floods.	Severe: frost action; floods; low strength.
*Gasconade: GaC, GdF. Rock outcrop part of GdF is too variable to be rated.	Severe: depth to rock; large stones.	Severe: depth to rock; seepage.	Severe: depth to rock; large stones.	Severe: depth to rock; large stones.	Severe: depth to rock; large stones; seepage.	Severe: depth to rock; large stones.
Goss: GoD, GoF	Moderate where slopes are 5 to 14 percent; severe where 14 to 45 percent.	Severe: seepage.	Moderate where slopes are 5 to 14 percent, severe where 14 to 45 percent.	Moderate where slopes are 5 to 14 percent: frost action. Severe where slopes are 14 to 45 percent.	Slight where slopes are 5 to 14 percent, severe where 14 to 45 percent.	Moderate where slopes are 5 to 14 percent: shrink-swell; frost action. Severe where slopes are 14 to 45 percent.
Hatton: HcB	Severe: slow permeability.	Moderate: slope.	Moderate: wetness.	Moderate: shrink-swell; wetness; low strength.	Moderate: too clayey.	Severe: low strength.
Haynie: He	Severe: floods.	Moderate where protected from flooding: seepage. Severe where flooding is common.	Slight where protected from flooding. Severe where flooding is common.	Severe: floods.	Severe: floods.	Severe: floods; frost action.
Hodge: Hg	Severe: floods.	Severe: floods; seepage.	Severe: floods; cutbanks cave.	Severe: floods.	Severe: floods; seepage.	Slight where protected from flooding. Severe where subject to flooding.
*Holstein: HoC2, HoD2, HrE. Rock outcrop part of HrE is too variable to be rated.	Moderate: moderate permeability.	Moderate where slopes are 5 to 9 percent: seepage. Severe where slopes are 9 to 14 percent.	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: too clayey.	Moderate: shrink-swell.

engineering properties—Continued

Suitability as a source of—		Soil features affecting—				
Road fill	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions
Poor: low strength; excess humus; frost action.	Good	Seepage; slope	Compressible; low strength.	Floods; wetness.	Wetness; floods.	Not needed.
Poor: frost action; low strength.	Good where slopes are 5 to 9 percent; fair where 9 to 14 percent.	Slope; seepage	Low strength; compressible; hard to pack.	Not needed	Erodes easily; slope.	Slope.
Poor: frost action; low strength.	Good	Seepage	Compressible; low strength; piping.	Floods; wetness.	Floods; wetness.	Not needed.
Poor: thin layer; large stones; area reclaim.	Poor: thin layer; large stones; area reclaim.	Depth to rock; seepage.	Large stones; thin layer; seepage.	Not needed	Droughty; seepage; rooting depth.	Depth to rock; large stones; slope.
Fair where slopes are 5 to 14 percent: frost action; shrink-swell. Poor where slopes are 14 to 45 percent.	Poor: small stones; thin layer.	Slope; seepage	Compressible; hard to pack.	Not needed	Complex slopes; droughty; stones.	Complex slopes; stones.
Poor: low strength.	Fair: thin layer.	Slope	Low strength; shrink-swell; compressible.	Not needed	Slope; erodes easily; slow permeability.	Slope; erodes easily.
Poor: frost action.	Good	Slope	Low strength; piping; erodes easily.	Not needed	Floods; excess lime.	Not needed.
Good	Poor: too sandy.	Seepage	Piping; unstable fill.	Not needed	Droughty; fast intake; soil blowing.	Not needed.
Fair: shrink-swell.	Poor: thin layer.	Seepage; slope	Compressible; piping.	Not needed	Slope; erodes easily.	Slope; erodes easily.

TABLE 8.—*Interpretations of*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill	Local roads and streets
Keswick: KeC2, KeD, KcC3.	Severe where slopes are 9 to 14 percent: slow permeability.	Severe where slopes are 9 to 14 percent: wetness.	Severe: wetness.	Severe: shrink-swell; wetness; low strength.	Severe: wetness.	Severe: low strength; shrink-swell; frost action.
Lindley: LnE	Severe: moderately slow permeability.	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Marion: Ma	Severe: wetness; very slow permeability.	Slight	Severe: wetness.	Severe: wetness; shrink-swell.	Severe: wetness.	Severe: wetness; shrink-swell.
Menfro: MeC2, MeD2, MeE, MeF.	Slight where slopes are 5 to 9 percent; moderate where 9 to 14 percent; severe where 14 to 35 percent.	Moderate where slopes are 5 to 9 percent: seepage. Severe where slopes are 9 to 35 percent.	Slight where slopes are 5 to 9 percent; moderate where 9 to 14 percent; severe where 14 to 35 percent.	Moderate where slopes are 5 to 14 percent: shrink-swell. Severe where slopes are 14 to 35 percent.	Moderate where slopes are 5 to 20 percent: too clayey. Severe where slopes are 20 to 35 percent.	Moderate where slopes are 5 to 14 percent: shrink-swell. Severe where slopes are 14 to 35 percent.
Mexico: MoB, MpB2	Severe: very slow permeability; wetness.	Moderate: slope.	Severe: wetness.	Severe: shrink-swell.	Moderate: wetness; too clayey.	Severe: shrink-swell; frost action.
Modale: Ms	Severe: slow permeability.	Severe: wetness; floods.	Severe: wetness; floods; too clayey.	Severe: shrink-swell; low strength; too clayey.	Severe: wetness; floods.	Severe: floods; shrink-swell; low strength.
Moniteau: Mu	Severe: floods; wetness; slow permeability.	Slight where protected from flooding. Severe where subject to occasional flooding: floods, wetness.	Severe: wetness; floods.	Severe: wetness; floods.	Severe: wetness; floods.	Severe: wetness; floods; frost action.
Nodaway: Nd	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods; frost action.
Putman: Pt	Severe: wetness; very slow permeability.	Slight	Severe: wetness.	Severe: wetness ; shrink-swell.	Severe: wetness.	Severe: wetness; shrink-swell.
Riverwash: Rv. Too variable to be rated.						
Sampsel: SaC2	Severe: slow permeability; wetness.	Moderate: slope.	Severe: too clayey; wetness.	Severe: shrink-swell; frost action.	Severe: too clayey.	Severe: shrink-swell; frost action.
Sharon: Sh	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods; frost action.

engineering properties—Continued

Suitability as a source of—		Soil features affecting—				
Road fill	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions
Poor: low strength.	Poor: area reclaim.	Slope	Shrink-swell; erodes easily; low strength.	Slow permeability.	Erodes easily; slope.	Slow permeability.
Fair: frost action; shrink-swell.	Poor: slope	Slope	Favorable	Not needed	Slope	Slope; moderately slow permeability.
Poor: wetness; shrink-swell.	Poor: wetness.	Favorable	Compressible; low strength; piping.	Very slow permeability; wetness.	Very slow permeability; wetness.	Not needed.
Fair: shrink-swell.	Fair: thin layer.	Seepage; slope	Compressible; low strength.	Not needed	Slope; erodes easily.	Erodes easily; slope.
Poor: shrink-swell; frost action.	Fair: thin layer.	Favorable	Shrink-swell	Not needed	Slow intake; wetness; slope.	Very slow permeability; wetness.
Poor: low strength; shrink-swell; frost action.	Good	Favorable	Low strength; piping; erodes easily.	Slow permeability; poor outlets; floods.	Wetness; floods; excess lime.	Not needed.
Poor: wetness.	Poor: wetness.	Favorable	Compressible; low strength; piping.	Slow permeability; wetness.	Slow permeability; wetness.	Not needed.
Poor: frost action.	Good	Seepage	Low strength	Floods	Floods	Not needed.
Poor: wetness; shrink-swell.	Poor: wetness.	Favorable	Compressible	Very slow permeability; wetness.	Very slow permeability; wetness; slow intake.	Not needed.
Poor: shrink-swell; frost action.	Fair: thin layer; too clayey.	Depth to rock; slope.	Shrink-swell	Not needed	Slow intake; slow permeability; slope.	Slow permeability; wetness.
Poor: frost action.	Good	Moderate permeability.	Piping; low strength.	Floods	Floods	Not needed.

TABLE 8.—*Interpretations of*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill	Local roads and streets
Snead: SnD	Severe: slow permeability; wetness.	Severe: slope.	Severe: too clayey.	Severe: shrink-swell.	Severe: too clayey.	Severe: shrink-swell; low strength.
Twomile: Tm	Severe: wetness; slow permeability.	Slight where protected from flooding. Severe where flooding is rare: floods; wetness.	Severe: wetness.	Severe: wetness; floods.	Severe: wetness.	Severe: wetness; frost action.
Waldron: Wa	Severe: slow permeability.	Slight where protected from flooding. Severe where flooding is common: floods; wetness.	Severe: wetness; too clayey.	Severe: wetness; floods; shrink-swell.	Severe: floods; wetness; too clayey.	Severe: floods; shrink-swell; low strength.
Weller: WeB, WeC2	Severe: slow permeability.	Moderate where slopes are 2 to 5 percent, severe where 5 to 9 percent.	Moderate: wetness.	Severe: shrink-swell.	Moderate: too clayey.	Severe: shrink-swell.
Winfield: WnB, WnC2, WnD2, WnE, WnF.	Moderate where slopes are 2 to 15 percent: moderate permeability, slope where slopes are 9 to 15 percent. Severe where slopes are 15 to 35 percent.	Moderate where slopes are 2 to 9 percent: seepage. Severe where slopes are 9 to 35 percent.	Moderate where slopes are 2 to 14 percent: wetness. Severe where slopes are 14 to 35 percent.	Moderate where slopes are 2 to 14 percent: shrink-swell. Severe where slopes are 14 to 35 percent.	Moderate where slopes are 2 to 20 percent: too clayey. Severe where slopes are 20 to 35 percent.	Moderate where slopes are 2 to 14 percent: shrink-swell. Severe where slopes are 14 to 35 percent.

[1] Cedargap clay loam, loamy variant.

poor, which have, respectively, meanings approximately parallel to the terms slight, moderate, and severe.

Following are explanations of some of the columns in table 8.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material between depths of 18 inches and 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope is a soil property that affects difficulty of layout and construction and also the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Sewage lagoons are normally shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor and sides, or embankments, of compacted soil material. The assumption is made that the embankment is compacted to medium density and the pond is protected from flooding. Properties are considered that affect the pond floor and the embankment. Those that affect the pond floor are permeability, organic matter content, and slope; and if the floor needs to be leveled, depth to bedrock becomes important. The soil properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified Soil Classification and the amounts of stones, if any, that influence the ease of excavation and compaction of the embankment material.

Shallow excavations are those that require digging or trenching to a depth of less than 6 feet, as for example, excavations for pipelines, sewer lines, phone

engineering properties—Continued

Suitability as a source of—		Soil features affecting—				
Road fill	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions
Poor: shrink-swell.	Poor: too clayey.	Depth to rock; slope.	Compressible; thin layer; shrink-swell.	Not needed	Slope; rooting depth.	Depth to rock; erodes easily; slow permeability.
Poor: wetness.	Poor: wetness.	Favorable	Compressible; low strength; piping.	Slow permeability; wetness.	Slow permeability; wetness.	Not needed.
Severe: shrink-swell; low strength.	Poor: too clayey; thin layer.	Favorable	Shrink-swell; compressible; low strength.	Floods; slow permeability; wetness.	Slow intake; wetness; floods.	Not needed.
Poor: shrink-swell.	Fair: area reclaim; thin layer.	Favorable	Compressible; low strength; shrink-swell.	Not needed	Erodes easily; slow intake.	Favorable.
Fair: shrink-swell.	Fair where slopes are 2 to 14 percent: thin layer. Poor where slopes are 14 to 35 percent.	Slope; seepage	Compressible; low strength.	Not needed	Slope; erodes easily.	Slope; erodes easily.

and power transmission lines, basements, open ditches, and cemeteries. Desirable soil properties are good workability, moderate resistance to sloughing, gentle slopes, absence of rock outcrops or big stones, and freedom from flooding or a high water table.

Dwellings, as rated in table 8, are not more than three stories high and are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to capacity to support load and resist settlement under load, and those that relate to ease of excavation. Soil properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

Sanitary landfill is a method of disposing of refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated, the ratings in table 8 apply only to a depth of about 6 feet, and therefore limitation ratings of *slight* or *moderate* may not be valid if trenches are to be much deeper than that. For some soils, reliable predictions can be made to a depth of 10 to 15 feet, but regardless, every site should be investigated before it is selected.

Local roads and streets, as rated in table 8, have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base consisting of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete.

These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep.

Soil properties that most affect design and construction of roads and streets are load supporting capacity and stability of the subgrade, and the workability and quantity of cut and fill material available. The AASHTO and Unified classifications of the soil material, and also the shrink-swell potential, indicate traffic supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect ease of excavation and amount of cut and fill needed to reach an even grade.

Road fill is soil material used in embankments for roads. The suitability ratings reflect the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage and the relative ease of excavating the material at borrow areas.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as for preparing a seedbed; natural fertility of the material, or its response to plants when fertilizer is applied; and absence of substances toxic to plants. Texture of the soil material and its content of stone fragments are characteristics that affect suitability, but also considered in the ratings is damage that results at the area from which topsoil is taken.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to their permeability and depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material resistant to seepage and piping and of favorable stability, shrink-swell potential, shear strength, and compactibility. Presence of stones or organic material in a soil are among factors that are unfavorable.

Drainage of cropland and pasture is affected by such soil properties as permeability, texture, and structure; depth to claypan, rock, or other layers that influence rate of water movement; depth to the water table; slope; stability in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage.

Irrigation of a soil is affected by such features as slope, susceptibility to stream overflow, water erosion, or soil blowing; soil texture; content of stones; accumulation of salts and alkali; depth of root zone; rate of water intake at the surface; permeability of soil layers below the surface layer and in fragipans or other layers that restrict movement of water; amount of water held available to plants; and need for drainage or depth to water table or bedrock.

Terraces and diversions are embankments or ridges constructed across the slope to intercept runoff so that it soaks into the soil or flows slowly to a prepared outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; permeability; and resistance to water erosion, soil slipping, and soil blowing. A soil suitable for these structures provides outlets for runoff and is not difficult to vegetate.

Formation and Classification of the Soils

This section tells how the factors of soil formation have affected the development of soils in Montgomery and Warren Counties. It also explains the system of soil classification and places the soil series in some of the higher categories of this classification.

Factors of Soil Formation

Soil is produced by soil-forming processes acting on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material, the climate under which the soil material has accumulated and existed since accumulation, the plant and animal life on and in the soil, the relief, or lay of the land, and the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it 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 profile. Generally, a long time is required for the development 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 development are unknown.

Parent material

Parent material is the unconsolidated mass from which a soil is formed. The formation or the deposition of this material is the first step in the development of a soil profile. The characteristics of the material determine the limits of chemical and mineralogical composition of the soil. In Montgomery and Warren Counties, four principal kinds of parent material, alone or in combinations of two or more, have contributed to the formation of the soils. These four kinds are residual material weathered from bedrock, glacial or ice-deposited material, loess or wind-deposited material, and alluvial or water deposited material. Of lesser importance is colluvium, which was transported short distances downslope by the action of water and gravity.

Residual material, or residuum, has weathered from limestone, sandstone, and shale. Limestone derived parent material in the two counties are divided into two broad groups for the purposes of the soil survey.

Residuum from cherty limestone and thinly interbedded shale is the parent material of Goss soils. Gasconade and Chilhowie soils formed in material weathered from relatively chert free limestone formations and interbedded shale. Sampsel and Snead soils formed in shale residuum. Sandstone residuum, mixed with colluvium weathered and transported from limestone and shale upslope, provided the parent material of Holstein soils.

Glacial parent material, composed of clay, silt, sand, gravel, stones, and a few boulders, was transported by ice action. Much of the material in the glacial till mass was moved long distances, but some of it is of fairly local origin. Armster, Keswick, and Lindley soils formed in glacial till.

Loess, a silty material transported by wind, is the most extensive of the parent material in the survey area. The principal source is believed to have been the flood plain of the Missouri River following the retreat of the last glacier. Deepest deposits of loess are on the hills bordering this flood plain, where they formed the parent material of Menfro and Winfield soils. Further from the source, the windborne deposits were shallower and contained more clay. In the prairie region of the two counties, this material was deposited in a poorly drained setting. Here they formed the parent material of Mexico and Putnam soils. On narrow ridgetops, loessial deposits were thin. Hatton soils formed in loess and the underlying glacial materials in this setting.

The parent material of all the bottom land in Montgomery and Warren Counties is alluvium. Reflecting the diverse origins and the varying speeds of flowing water, this material ranges greatly in texture and in chemical and mineralogical composition. Bottom land along small tributary streams is limited to local uplands for a source of alluvium parent material. The Missouri River flood plain soils have as a source of their parent material the vast drainage system of the "Big Muddy." Abundantly supplied with unweathered minerals, Haynie and Blake soils, for example, are very fertile and neutral in reaction. In contrast Sharon soils, which formed in material washed largely from acid glacial deposits along small streams are infertile and acid in reaction.

Climate

Climate has been an important factor in the formation of the soils of Montgomery and Warren Counties. The effect of rainfall and temperature on soil formation continues to the present. As a result of climate in past ages, soil forming material was deposited by ice and wind. Since that time climate has affected the soils that formed in these and other materials. The rate of geologic erosion varies with the climate, and the shape and character of the land forms that make up an area are influenced accordingly. Changes in the relative abundance and species composition of plant and animal life are directed by climatic change. Present climatic conditions favor the growth of trees at the expense of prairie grasses. The prairie region in the two counties may be a relic of a more arid climatic cycle, but the reason for its persistence until the time of settlement is not well understood.

Higher temperatures and rainfall encourage rapid chemical change and physical disintegration. Calcium carbonate and other soluble salts are removed by leaching and then fertility declines. Nearly all the upland soils in Montgomery and Warren Counties show these climatic effects.

Prominent layers of any kind in a soil, if the soil is other than one that formed in alluvium, indicate that chemical weathering has been intense. Examples are the claypans and bleached subsurface layers in Putnam, Mexico, and Marion soils and the fragipan in Hatton soils.

The influence of regional climate on soil formation is modified in many places by local conditions. For example, shallow Gasconade soils intermingled with Rock outcrop form on steep, south-facing slopes under the influence of a microclimate that is warmer and less humid than the opposite north-facing slopes where the deeper Chilhowie soils formed.

Climate, then, has greatly influenced the nature and degree of weathering in the soils of the two counties. Native vegetation, however, has more than likely had other influences as well.

Plant and animal life

In addition to the mineral matter provided by parent material, another important component is organic matter. Plants, animals, insects, bacteria, and fungi are important in the formation of soils, and their more or less decomposed residue makes up the organic fraction. Humus, or stable organic matter, is the part within this fraction that is resistant to further decomposition. It is black or brown in color and colloidal in nature. It has a capacity to hold and deliver water and nutrients to plants that exceeds that of clay, its inorganic counterpart. The presence of organic matter favorably affects granulation and tilth and greatly influences soil color, especially that of the surface layer. Exceptions to this are recent alluvial soils. Their color is that of the parent material in which they formed. The nitrogen supply, and to an extent the natural fertility of a soil, are directly related to its organic matter content.

In the category of plant and animal life, the kind of native vegetation (prairie grasses versus forest trees) is the factor that has most profoundly influenced soil formation in Montgomery and Warren Counties. Prairie grasses and deciduous trees have marked differences in rooting habits, life span, and mineral composition, and there are significant differences in the micro-organisms and animals associated with each.

Organic matter additions to soils under forest are mostly in the form of leaves, twigs, and logs which decompose at the soil surface. These materials tend to be acid in reaction. This results in forest soils developing a very thin, dark colored surface layer and a leached subsurface layer.

In contrast, organic matter additions to soils under prairie grasses are largely caused by the yearly death and decay of annual and biennial plants. Plant tops decompose at the surface, but a large share of this material is in the soil in the form of roots at various depths. The materials thus added tend to be richer in mineral composition than forest residue. As a result, soils that formed under prairie grasses have a much

thicker, dark colored surface layer and tend to be less acid than their forest counterparts that formed in similar parent material.

In slightly more than one-third of the survey area, the soils formed under prairie grasses. Mexico, Armster, and Putnam are the most important of these soils. Each of these series has what can be considered its counterpart in which the soils formed under forest trees with other factors being approximately equal. Thus, Mexico and Hatton soils both formed in loess and the underlying glacial sediment in areas where slopes are gentle. Armster and Keswick soils both formed in glacial material in areas where slopes are similar. Putnam and Marion soils also have similar settings. The factors of time and climate were equal or nearly so in each case. In each of these paired examples, the marked differences in the soils are caused by differences in native vegetation; that is, prairie grasses versus forest trees. Goss, Menfro, and Winfield soils are examples of upland soils that formed under forest and have no counterparts that formed under prairie in the survey area.

Micro-organisms, especially bacteria and fungi, play an important role in soil formation. They reduce raw and partly decomposed organic matter to humus, releasing plant nutrients in the process. Nodule bacteria fix atmospheric nitrogen, essential to organic matter buildup.

Earthworms, insects, and burrowing animals have a favorable effect on tilth, fertility, and internal drainage.

The activities of man have, in a remarkably short time, had a profound effect on soil formation processes in Montgomery and Warren Counties. The American Indian lived as a part of the natural ecosystem without significantly altering it. Alteration began with the first settlement and has continued at an accelerating pace. The prairie grasses have yielded to the plow. Nearly all the bottom lands and many upland areas have been cleared and are farmed. Huge machines till the soil and harvest the crops. Chemicals are used to fertilize desirable plants and to control unwanted plants, insects, and pests. Improved varieties of grain and forage crops are grown. These changes have helped bring about increased production of food, fiber, and timber products and a higher standard of living. But in terms of sustained productivity, the net effect on soil formation of man's activities has been adverse. Soils in most of the cropland in the two counties are subject to erosion. Accelerated erosion continues to reduce the potential of many soils, but man has the capacity to reverse this trend.

Relief

Relief, or topography, refers to the lay of the land. Relief may be characterized by gradient (degree or percent of slope) and by the length, shape, aspect and uniformity of the slopes that make up a landscape. It is an important factor in determining the pattern and distribution of soils on a landscape because of its influence on drainage, runoff, and erosion.

Relief varies greatly in Montgomery and Warren Counties, ranging from that of the nearly level to moderately sloping prairie region to very steep hillsides and vertical cliffs of the dissected areas. Other things being equal, more water enters the soil in areas of nearly level soils than in areas of more sloping soils. This intensifies leaching, translocation of clay, and other soil forming processes. Over long periods a subsoil high in content of clay forms under a bleached subsurface layer. Putnam and Marion soils show the results of these processes.

At the other extreme are very steep soils. Here runoff is excessive and the rate of soil formation is slowed. Removal of weathering products by geologic erosion almost keeps pace with their accumulation through weathering. Gasconade and Chilhowie soils formed under these conditions.

Time

Time is necessary for the various processes of soil formation to act upon parent material to form soil. The time involved may be very short or very long, and the soils of Montgomery and Warren Counties show a wide range in their ages.

Perhaps the time factor is best understood by considering the extremes. On the one hand we have "instant soils" left behind by flood waters receding from the Missouri River flood plain. These are the youngest soils of the area; indeed, some of them are younger than the people who farm them. Some of the recent Hodge, Haynie, Blake, and Waldron soils on the river side of levees are examples of these young soils.

At the other extreme are soils that formed in loess on nearly level topography at the highest elevations in the survey area. These old timers, Putnam and Marion soils for example, show their advanced age in a number of profile features. The carbonates originally present in their parent material have leached to a great depth, leaving them quite acid throughout. Clay has been concentrated in distinct subsoil horizons, both by formation through weathering and through translocation by percolating water. A bleached subsurface horizon forms by water tables "perched" above an impervious subsoil. All these processes have taken place over a long time period.

Most soils in the area are intermediate between these extremes in age. Moniteau soils on stream terraces are acid in reaction and have a clay enriched subsoil. They formed in the same kind of alluvium as the "young" Nodaway soils on adjacent first bottoms, but in materials which have been in place much longer. Thus, Moniteau soils can be considered "middle aged."

The shallow, steep Gasconade soils afford a somewhat different example. The limestone and shale from which the parent materials form are far older than the oldest soil in the area. But removal of materials by geologic erosion almost keeps pace with accumulation through weathering. Thus, these soils are considered "young."

The age of a soil, as expressed in profile characteristics, is not an absolute function of time, but is rather the result of the interaction of the other factors of soil formation over periods of time. Time, or age, is influenced by topography and climate. It should be remembered that, in any discussion of soil formation, the various factors are separated only for the purpose of study and understanding. No such isolation exists in nature.

Classification of the Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories of classification, such as those used in detailed soil surveys, allow us to organize and apply knowledge about soils in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas such as countries and continents.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Because this system is under continual study, readers interested in developments of the current system should search the latest literature available *(11, 14)*.

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped. The same property or subdivisions of this property may be used in several different categories. In table 9 the soil series of Montgomery and Warren Counties are placed in four categories of the current system. Classes of the current systems are briefly defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The properties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. Three exceptions to this are the Entisols, Histosols, and Vertisols which occur in many different climates.

SUBORDER. Each order is subdivided into suborders using those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders are more narrowly defined than are the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of a water table at a shallow depth, soil climate, the accumulation of clay, iron, or organic carbon in the upper solum, cracking of soils caused by a decrease in soil moisture, and fine stratification.

GREAT GROUP. Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequence of soil horizons and features. The horizons used to make separations are those in which clay, carbonates, and other constituents have accumulated or have been removed; and those that have pans that interfere with growth of roots, movement of water, or both. Some features used are soil acidity, soil climate, soil composition, and color. The names of great groups have three or four syllables and are made by adding a prefix to the name of the suborder.

SUBGROUP. Great groups are subdivided into subgroups, one representing the central (typic) segment of the group, and others called intergrades that have properties of the group and also one or more properties of another great group, suborder, or order. Other subgroups may have soil properties unlike those of any other great group, suborder, or order.

FAMILY. Soil families are separated within a subgroup primarily on the basis of properties important to the growth of plants or to the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, soil depth, and consistence. A family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names for particle size, minerology, temperature regime, or other family differentiae. (See table 9.)

Environmental Factors Affecting Soil Use

The settlement of Montgomery and Warren Counties and later population trends are presented in the first part of this section. This presentation is followed by information on relief and drainage of the county and information on communication, transportation, and industry. A description of educational, cultural, and recreational facilities of the county is presented next, and then a subsection on climate of Montgomery and Warren Counties is provided at the end of the section.

Settlement and Population

Prior to the first settlement, various tribes and bands of Indians occupied what is now Montgomery and Warren Counties. The Missouri, Osage, Sac, and Fox tribes were among those who claimed the survey area as their home and hunting ground.

Prior to the Louisiana Purchase in 1803, the area was under the rule of the Spanish and, subsequently, the French government. In the 1760's the French founded the trading post of Charrette Village at the confluence of Charrette Creek and the Missouri River. No trace of this settlement remains. During Spanish occupation numerous land grants were made, several in what is now Warren County. These claims were respected under succeeding French and United States sovereignty. Most such claims were sold to incoming Americans from the southern states and to families in the St. Louis area who wished to move to the frontier.

The early settlers came mainly from Kentucky, Virginia, and Tennessee, but a few came from states north of the Ohio River. They quickly filed claim to the best land along the streams and lower uplands. In 1808 a group of Kentuckians moved into the area. Daniel Boone, by this time an old man, moved into Warren County with his family. He and his wife lived with their daughter and son-in-law, Flander Callaway, in their home at Marthasville.

The tide of immigration from the south and the Ohio valley was checked by the war of 1812, but it increased thereafter. Germans make up the major foreign immigration.

TABLE 9.—*Classification of soil series*

Series	Family	Subgroup	Order
Armster	Fine, montmorillonitic, mesic	Mollic Hapludalfs	Alfisols.
Auxvasse	Fine, montmorillonitic, mesic	Aeric Albaqualfs	Alfisols.
Blake [1]	Fine-silty, mixed, mesic	Aquic Udifluvents	Entisols.
Booker	Very fine, montmorillonitic, mesic	Vertic Haplaquolls	Mollisols.
Calwoods	Fine, montmorillonitic, mesic	Aeric Ochraqualfs	Alfisols.
Cedargap	Loamy-skeletal, mixed, mesic	Cumulic Hapludolls	Mollisols.
Cedargap, loamy variant	Fine-loamy, mixed, mesic	Typic Hapludolls	Mollisols.
Chariton	Fine, montmorillonitic, mesic	Mollic Albaqualfs	Alfisols.
Chilhowie [2]	Very fine, mixed, mesic	Typic Hapludalfs	Alfisols.
Coland	Fine-loamy, mixed, mesic	Cumulic Haplaquolls	Mollisols.
Crider	Fine-silty, mixed, mesic	Typic Paleudalfs	Alfisols.
Dockery	Fine-silty, mixed, nonacid, mesic	Aquic Udifluvents	Entisols.
Gasconade	Clayey-skeletal, mixed, mesic	Lithic Hapludolls	Mollisols.
Goss	Clayey-skeletal, mixed, mesic	Typic Paleudalfs	Alfisols.
Hatton	Fine, montmorillonitic, mesic	Typic Hapludalfs	Alfisols.
Haynie [3]	Coarse-silty, mixed (calcareous), mesic	Mollic Udifluvents	Entisols.
Hodge	Mixed, mesic	Typic Udipsamments	Entisols.
Holstein	Fine-loamy, mixed, mesic	Typic Paleudalfs	Alfisols.
Keswick	Fine, montmorillonitic, mesic	Aquic Hapludalfs	Alfisols.
Lindley	Fine-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Marion	Fine, montmorillonitic, mesic	Albaquic Hapludalfs	Alfisols.
Menfro	Fine-silty, mixed, mesic	Typic Hapludalfs	Alfisols.
Mexico	Fine, montmorillonitic, mesic	Udollic Ochraqualfs	Alfisols.
Modale [4]	Coarse-silty over clayey, mixed (calcareous), mesic	Aquic Udifluvents	Entisols.
Moniteau	Fine-silty, mixed, mesic	Typic Ochraqualfs	Alfisols.
Nodaway	Fine-silty, mixed (nonacid), mesic	Mollic Udifluvents	Entisols.
Putnam	Fine, montmorillonitic, mesic	Mollic Albaqualfs	Alfisols.
Sampsel [5]	Fine, montmorillonitic, mesic, sloping	Typic Argiaquolls	Mollisols.
Sharon [6]	Coarse-silty, mixed, acid, mesic	Typic Udifluvents	Entisols.
Snead	Fine, mixed, mesic	Aquic Hapludolls	Mollisols.
Twomile	Fine-silty, mixed, mesic	Typic Albaqualfs	Alfisols.
Waldron	Fine, montmorillonitic (calcareous), mesic	Aeric Fluvaquents	Entisols.
Weller	Fine, montmorillonitic, mesic	Aquic Hapludalfs	Alfisols.
Winfield [7]	Fine-silty, mixed, mesic	Typic Hapludalfs	Alfisols.

[1] These soils are taxadjuncts to the Blake series. The depth to materials coarser textured than silty clay loam is greater than the limit for Blake soils, and coarser textured material is between depths of 40 and 60 inches.

[2] These soils are taxadjuncts to the Chilhowie series because of a B horizon that is redder than the one in those soils.

[3] These soils are taxadjuncts to the Haynie series because of a surface horizon that is lighter colored than the one in those soils.

[4] These soils are taxadjuncts to the Modale series because they are browner than Modale soils and lack free carbonates in most of the control section.

[5] These soils are taxadjuncts to the Sampsel series because of a surface horizon that is thinner than the minimum limit and is darker colored.

[6] These soils are taxadjuncts to the Sharon series because they have mottles that have a chroma 2 higher than is allowed in the control section.

[7] These soils are taxadjuncts to the Winfield series because of the chert fragments and sand grains in the lower part of the solum.

Farming soon became the solid economic base of the area. Corn, wheat, hemp, and livestock were major income sources.

As the population grew and the economic base stabilized, formal county government, church, and schools developed. Montgomery County was organized in 1818 and Warren County was carved from it in 1833.

Total population of the two counties reached a peak of about 36,500 in 1900, then gradually decreased to a low of about 19,200 in 1950. An upturn to about 19,850 was evident in the 1960 census. The long and gradual decline in population was due largely to mechanization of farming, as small farms were combined into larger units, and young people migrated to urban areas. The recent upturn is caused by an increase in industrial job opportunities in the area and an increase in the number of people commuting to jobs in the St. Louis area.

Relief and Drainage

The survey area includes several major physiographic regions. The alluvial flood plain of the Missouri parallels its southern boundary. In northward sequence from here are the loess covered "river hills," the steep dissected areas of dominantly residual soils, and the loess covered glacial till plain of the prairie region. Exposed glacial till forms a band of varying thickness around most of the latter region.

Bedrock is covered by loess, glacial till, or both over most of the two counties. It is exposed to soil forming processes only in the steeper areas of the landscape. It spans the geologic sequence from the Pennsylvanian in the northwest, through the Mississippian in the central part, and then to the Ordivician along the southern edge parallel to the Missouri River.

Elevation ranges from 470 feet above sea level on

the Missouri River flood plain in the southeast corner of Warren County to 950 feet in west central Warren County, a variation of 480 feet. Small areas in both counties have an elevation of more than 920 feet within three miles of the Missouri River. Local relief in the dissected areas ranges to as much as 200 feet in one-eighth mile or 340 feet in one-fourth mile. In contrast, many prairie areas show elevation differences of only 20 to 40 feet per one-half mile.

Roughly, the southern half of the survey area drains into the Missouri River, and the northern half into the Mississippi through the Cuivre River watershed. U.S. Highway I–70 is on or near the primary divide between the two major drainage systems.

The major Missouri River tributaries are the Loutre River, Massas Creek, Lost Creek, Charrette Creek, and Wolf Creek. West Fork of Cuivre River, Elkhorn Creek, Coon Creek, Camp Creek, and Indian Camp Creek are the principal Cuivre River tributaries.

Communications, Transportation, and Industry

Weekly newspapers are published in Montgomery City, Wellsville, Marthasville, and Warrenton. Telephone service and electric power are readily available to rural as well as city dwellers. Radio and television reception is good to excellent in the survey area. One radio station, located in Warrenton, broadcasts in the area.

Transportation facilities are good. Interstate I–70 passes through the approximate middle of the survey area east to west. Missouri Highway 54 parallels the Missouri River in a basic east to west path. Crossing the two county area, approximately north to south, are Missouri Highways 19, 47, and 161. The area is served by three railroads—the Burlington Northern, the Missouri-Kansas-Texas, and the Norfolk and Western.

Grain markets are in Bellflower, Jonesburg, McKittrick, Montgomery City, Rhineland, and Wellsville in Montgomery County, and in Marthasville, Treloar, Warrenton, and Wright City in Warren County. Livestock markets are in Montgomery City, in adjoining counties, and in St. Louis.

The two county area has at least 13 manufacturing plants, each of which employs 20 or more persons. These plants employ a total of about 1,300 workers. The principal products are clothing, metal products, furniture, and firebrick.

About 25 percent of the labor force living in the area is employed outside of it, primarily in the St. Louis metropolitan area. The percentage of the labor force in this category is expected to increase significantly in the next decade.

Educational, Cultural, and Recreational Facilities

Four high schools and nine elementary schools are in the area. A junior college is at Union, and several colleges and universities are in the St. Louis area. Although hospitals are not in the immediate survey area, three are just outside of it in Hermann, Troy, and Washington. The area has many churches and several nursing homes.

The survey area has many outdoor recreational facilities. Among these are municipal, commercial, and public areas developed and maintained for recreational purposes. In addition there are several specific leisure areas. These include state forests, state parks, and wildlife areas. Graham Cave State Park has camping sites for the day or weekend visitor, in addition to interesting caverns. Over 3,000 acres are contained in Daniel Boone and Reifsnider State Forests. There are also four wildlife areas. Hunting is permitted in the Danville area, and picnicking, fishing, and hunting are allowed in the Marshall Diggs area. The William Logan and Wellsville areas also have fishing and hunting facilities. The Daniel Boone monument at Marthasville is a popular tourist attraction. Many lakes and ponds offer fishing opportunities. There are many excellent hunting areas and picnic areas for family outings.

Climate [7]

The climate of Montgomery and Warren Counties is quite variable during all seasons. Air from the northern part of the continent frequently invades the counties, while warm and humid air from the Gulf of Mexico is not uncommon. In summer the temperatures are more uniform than in winter. The summer rain is quite variable, depending on the frequency of thundershowers.

The topographic features in the counties do not exert a major influence on the climate. In the hilly regions, however, cooler nighttime minimum temperatures occur on valley floors than along the slopes.

The greatest rainfall occurs in May and June, but there is no sharp seasonal distribution in precipitation. The average precipitation in December, January, and February is 16 percent of the annual total as compared to about 28 percent for March through May, 30 percent for June through August, and 26 percent for the three fall months.

The heaviest daily rainfall occurred in November 1947. It was slightly more than 5.5 inches. Daily precipitation in excess of 2.5 inches has occurred in all months except January, February, and March.

Snowfall has not occurred before early November, and snow as late as April 1 is quite rare. The heaviest snowfall is generally in early March. The maximum depth reported for a thirty-year period was slightly more than 35 inches.

The temperature and precipitation data given in table 10 are from the weather station at Warrenton, Missouri.

Evapotranspiration follows the trend of temperatures through the year, with the highest demand for water occurring in July and August. During June, in four out of 10 years, plants must depend on soil moisture to overcome deficient rainfall. In July and August the atmospheric demand for water is greater than the supply from rainfall in 80 to 85 percent of the years.

Table 11 shows the last date in spring and the first date in fall when specified temperatures can be expected. January is the month with the coolest average temperature, and July is the month with the warmest average temperature. The average maximum temper-

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TABLE 10.—*Temperature and precipitation data*

[All data from Warrenton, Missouri]

Month	Temperature							Precipitation					
						Average number of days		Rainfall		Snow		Aver. No. days with precipitation of—	
	Average daily maximum	Average daily minimum	Monthly average	Record high	Record low	Maximum greater than 90° F	Minimum less than 0° F	Monthly average	Daily maximum	Monthly average	Monthly maximum	More than—	More than—
	°F	°F	°F	°F	°F			In	In	In	In	In	In
January	40.6	21.1	30.8	77.0	−13.0	0.0	2.3	1.67	1.62	4.3	12.0	4.1	0.2
February	45.1	24.4	34.8	80.0	−12.0	.0	0.8	1.88	1.88	4.9	16.0	4.3	.3
March	53.9	31.7	42.8	88.0	−11.0	.0	.2	2.96	1.77	5.7	32.5	6.5	.5
April	68.0	44.3	56.2	92.0	22.0	.3	.0	3.82	2.72	0.2	3.3	7.4	.8
May	77.0	53.3	65.2	94.0	29.0	1.4	.0	4.09	2.62	.0	0.4	7.4	1.0
June	84.9	62.5	73.7	105.0	39.0	7.9	.0	4.60	3.48	.0	.5	7.5	1.4
July	89.2	65.6	77.4	114.0	43.0	14.4	.0	3.76	3.45	.0	.0	5.2	1.3
August	88.3	64.2	76.2	105.0	42.0	13.8	.0	2.92	3.15	.0	.0	4.3	.8
September	81.2	56.4	68.8	105.0	30.0	5.4	.0	3.98	3.70	.0	.0	5.4	1.2
October	71.1	46.6	58.8	97.0	22.0	.4	.0	3.32	5.39	.0	.0	5.6	.8
November	55.1	34.4	44.8	87.0	0.0	.0	.0	2.36	5.51	.9	10.5	4.3	.5
December	43.5	25.1	34.3	75.0	−12.0	.0	1.0	1.94	3.24	4.3	16.1	4.2	.2
Year	66.5	44.1	55.3	114.0	−13.0	43.6	4.3	37.29	5.51	20.3	32.5	66.3	9.0

TABLE 11.—*Probability of last freezing temperature in spring and first in fall*

[All data from Warrenton, Missouri]

	Dates for given probability and temperature				
	16° F or lower	20° F or lower	24° F or lower	28° F or lower	32° F or lower
Spring:					
1 year in 10 later than	March 29	April 4	April 16	April 19	May 3
2 years in 10 later than	March 14	March 20	April 1	April 10	April 24
5 years in 10 later than	March 8	March 14	March 26	April 4	April 18
Fall:					
1 year in 10 earlier than	November 14	November 4	October 25	October 15	October 4
2 years in 10 earlier than	November 23	November 13	November 3	October 24	October 13
5 years in 10 earlier than	November 29	November 19	November 9	October 30	October 19

ature for the day reaches 75° F. by March 15 and remains above this until October 5. The average low temperature for the day reaches 32° by November 25, and the average does not rise above freezing until March 20. An average of more than 20 days during December, January, and February have daily low temperatures below 32°. An average of only 13 days during this three-month period have daily maximum temperatures below freezing. Although minimum temperatures below 50° have occurred in each summer month, the average number of days during either July or August that have temperatures this low is less than 1.

The lowest temperature for a 30-year period was −13° on January 28, 1948. Temperatures below −10° have occurred in March. An average of 5 days per year have temperatures below zero.

Temperatures in excess of 100° have occurred in June, July, August, and September. In both July and August an average of 14 days have temperatures above 90°. Warm temperatures occur in Warrenton in December and January and temperatures in the middle 70's have been reported during these months. Maximum temperatures above 50° occur on an average of 10 days in December, 8 days in January, and 11 days in February.

The hazard of killing freezes begins as early as October 4 in 1 out of 10 years. In spring the chances of temperatures below freezing become remote early in May. In 10 percent of the years, a 32° temperature occurs after April 30.

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Glossary

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

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

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

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

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

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Chert. A very dense, cryptocrystalline, flintlike form of silica that breaks with a splintery fracture. It resists decomposition and generally remains as inert angular fragments in the residual mass. Chert fragments are up to 3 inches in diameter.

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.

Compressible. The soil is relatively soft and decreases excessively in volume when a load is applied.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

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 for 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, as for example in "hillpeats" and "climatic moors."

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Fragipan. A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Habitat. The natural abode of a plant or animal; refers to the kind of environment in which a plant or animal normally lives, as opposed to the range or geographical distribution.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming 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.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks 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 from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II 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.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil has inadequate strength to support loads.

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 single 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.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are very slow (less than 0.06 inch), slow (0.06 to 0.20 inch), moderately slow (0.2 to 0.6 inch), moderate (0.6 to 2.0 inches), moderately rapid (2.0 to 6.0 inches), rapid (6.0 to 20 inches), and very rapid (more than 20 inches).

pH value. (See Reaction, soil). A numerical designation of acidity and alkalinity in soil.

Piping. The soil is susceptible to the formation of tunnels or pipelike cavities by moving water.

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

Reaction, soil. The degree 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		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulates over disintegrating rock.

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground 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.

Second bottom. The first terrace above the normal flood plain of a stream.

Second growth (forestry). Forest that originates naturally after removal of a previous stand by cutting, fire, or other cause. A loosely used term for young stands.

Shrink-swell. The soil expands on wetting and shrinks on drying, which may cause damage to roads, dams, buiding foundations, or other structures.

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.

Soil. A natural, three-dimensional body at the earth's surface that 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 depth. Refers to the depth of the soil profile, including the C horizon, if present, over bedrock or other strongly contrasting nonconforming rock material. In this survey the following classes are used:

Shallow	10 to 20 inches
Moderately deep	20 to 40 inches
Deep	More than 40 inches

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Stratified. Arranged in strata, or layers. The term refers to geologic material. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining 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.

Surface soil. 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."

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 it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by 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, silt loam, 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."

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil (engineering). Presumably a fertile soil or soil material or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

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

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

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.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit read both the description of the mapping unit and that of the soil series to which it belongs. In referring to a capability unit, read the introduction to the section it is in for general information about its management.

Map symbol	Mapping unit	Described on page	Capability unit	Tree and shrub group
AmC2	Armster loam, 5 to 9 percent slopes, eroded	12	IIIe-5	1
ArC3	Armster clay loam, 5 to 9 percent slopes, severely eroded	14	IVe-8	1
Au	Auxvasse silt loam	15	IIIw-2	7
Bk	Blake silty clay loam	16	I-1	6
Bm	Blake-Haynie-Waldron complex	16	IIw-2	-----------
Bo	Booker clay	17	IIIw-14	7
CaB	Calwoods silt loam, 1 to 5 percent slopes	18	IIe-5	6
CbB2	Calwoods silty clay loam, 1 to 5 percent slopes, eroded	18	IIIe-5	6
Cd	Cedargap silt loam	18	IIs-1	1
Ce	Cedargap cherty silt loam	19	IIIs-1	1
Cf	Cedargap clay loam, loamy variant	19	I-1	5
Ch	Chariton silt loam	20	IIw-2	7
CnF	Chilhowie, Gasconade, and Crider soils, 14 to 35 percent slopes	20	VIIs-8	2
Co	Coland clay loam	21	IIw-2	7
CrC	Crider silt loam, 5 to 9 percent slopes	22	IIIe-1	4
CrD2	Crider silt loam, 9 to 14 percent slopes, eroded	22	IVe-1	4
Do	Dockery silt loam	23	IIw-1	6
GaC	Gasconade stony silty clay loam, 5 to 9 percent slopes	23	VIs-8	3
GdF	Gasconade-Rock outcrop complex, 14 to 50 percent slopes	23	VIIs-8	3
GoD	Goss very cherty silt loam, 5 to 14 percent slopes	24	VIs-9	1
GoF	Goss soils, 14 to 45 percent slopes	24	VIIs-9	1
HcB	Hatton silt loam, 2 to 9 percent slopes	25	IIIe-4	1
He	Haynie very fine sandy loam	26	I-1	5
Hg	Hodge loamy fine sand	26	IIIs-1	1
HoC2	Holstein loam, 5 to 9 percent slopes, eroded	27	IIIe-1	4
HoD2	Holstein loam, 9 to 14 percent slopes, eroded	27	IVe-1	4
HrE	Holstein-Rock outcrop complex, 14 to 35 percent slopes	27	VIIs-8	-----------
KeC2	Keswick silt loam, 5 to 9 percent slopes, eroded	28	IIIe-5	1
KeD	Keswick silt loam, 9 to 14 percent slopes	28	IVe-4	1
KsC3	Keswick clay loam, 5 to 9 percent slopes, severely eroded	28	IVe-8	1
LnE	Lindley loam, 14 to 35 percent slopes	29	VIe-4	4
Ma	Marion silt loam	30	IIIw-2	7
MeC2	Menfro silt loam, 5 to 9 percent slopes, eroded	30	IIIe-1	4
MeD2	Menfro silt loam, 9 to 14 percent slopes, eroded	30	IIIe-1	4
MeE	Menfro silt loam, 14 to 20 percent slopes	31	IVe-1	4
MeF	Menfro silt loam, 20 to 35 percent slopes	31	VIe-1	4
MoB	Mexico silt loam, 1 to 5 percent slopes	32	IIe-5	6
MpB2	Mexico silty clay loam, 1 to 5 percent slopes, eroded	32	IIIe-5	6
Ms	Modale silt loam	32	I-1	6
Mu	Moniteau silt loam	33	IIIw-2	7
Nd	Nodaway silt loam	33	IIw-1	5
Pt	Putnam silt loam	35	IIw-2	7
Rv	Riverwash	35	VIIIs-1	-----------
SaC2	Sampsel silty clay loam, 5 to 9 percent slopes, eroded	35	IIIe-5	6
Sh	Sharon silt loam	36	IIw-1	5
SnD	Snead silty clay loam, 9 to 14 percent slopes	36	IVe-11	2
Tm	Twomile silt loam	37	IIIw-2	7
Wa	Waldron silty clay	38	IIw-2	6
WeB	Weller silt loam, 2 to 5 percent slopes	38	IIe-5	1
WeC2	Weller silt loam, 5 to 9 percent slopes, eroded	39	IIIe-5	1
WnB	Winfield silt loam, 2 to 5 percent slopes	39	IIe-1	5
WnC2	Winfield silt loam, 5 to 9 percent slopes, eroded	40	IIIe-1	4
WnD2	Winfield silt loam, 9 to 14 percent slopes, eroded	40	IVe-1	4
WnE	Winfield silt loam, 14 to 20 percent slopes	40	IVe-1	4
WnF	Winfield silt loam, 20 to 35 percent slopes	40	VIe-1	4

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