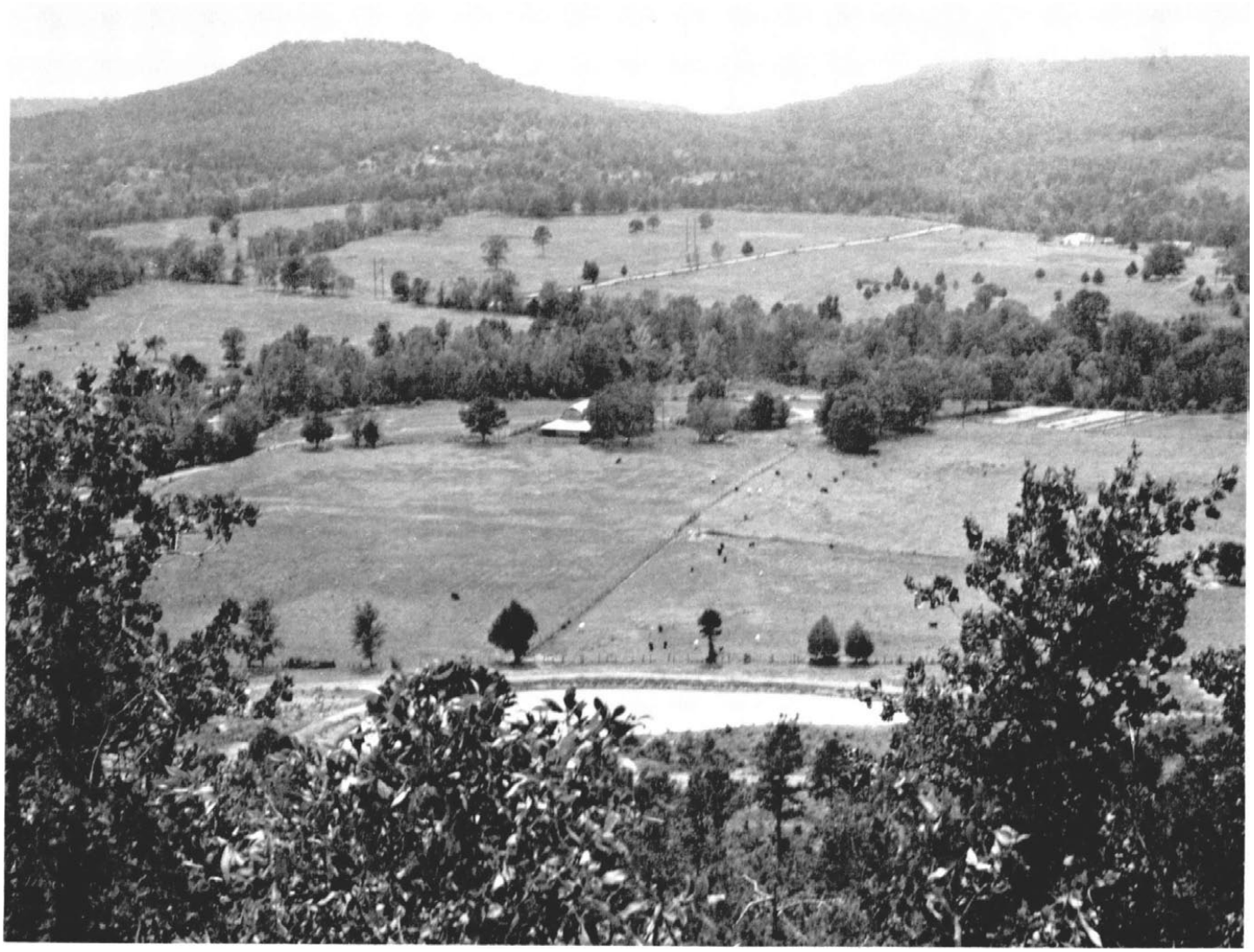
SOIL SURVEY OF

Johnson County, Arkansas



United States Department of Agriculture
Soil Conservation Service and Forest Service
In cooperation with
Arkansas 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 1967–72. Soil names and descriptions were approved in 1973. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1972. This survey was made cooperatively by the Soil Conservation Service, the Forest Service, and the Arkansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Johnson County Conservation District, which includes all of Johnson County.

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 the soils of Johnson County 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 are 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, woodland suitability group, range site, and pasture and hayland group in which each soil has been placed. It shows the page where each soil is described and the pages on which the pasture and hayland group and range site in which the soil has been placed are described.

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 the 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 units, the pasture and hayland groups, the range sites, and the woodland suitability groups.

Foresters and others can refer to the section "Use of the Soils for Woodland;" where the soils of the county are grouped according to their suitability for trees.

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

Ranchers and others can find, under "Use of the Soils for Range," groupings of the soils according to their suitability for range, and also the names of many of the plants that grow on each range site.

Community planners and others can read about soil properties that affect the choice of sites for dwellings, industrial buildings, and for recreation areas in the section "Town and Country Planning" and "Use of the Soils for Recreational Development."

Engineers and builders can find, under "Engineering Uses of the Soils," tables that contain test data, 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 Johnson County 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 "General Nature of the County."

Cover: Pastured valleys of Leadvale, Cane and Taft soils surrounded by wooded hills and mountains of Nella, Enders, and Mountainburg soils.

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SOIL SURVEY OF JOHNSON COUNTY, ARKANSAS

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

JOHNSON COUNTY is in the western part of Arkansas (fig. 1). It is irregularly shaped. It ranges from about 10 to 30 miles in width and is about 27 miles in maximum length. The county is bounded on the north by Madison and Newton Counties, on the east by Pope County, on the south by the Arkansas River, and on the west by Franklin County. According to United States Census reports, the approximate area is 435,200 acres, or 680 square miles. The land area is 430,464 acres.

In 1970, the population was about 13,630. Clarksville, the county seat, is the largest incorporated town in the county and has a population of 4,616. The next largest town is Lamar, which has a population of 589. Most of the people in the county, including more than half of the farmers, work in industries or supporting businesses in the Clarksville area.

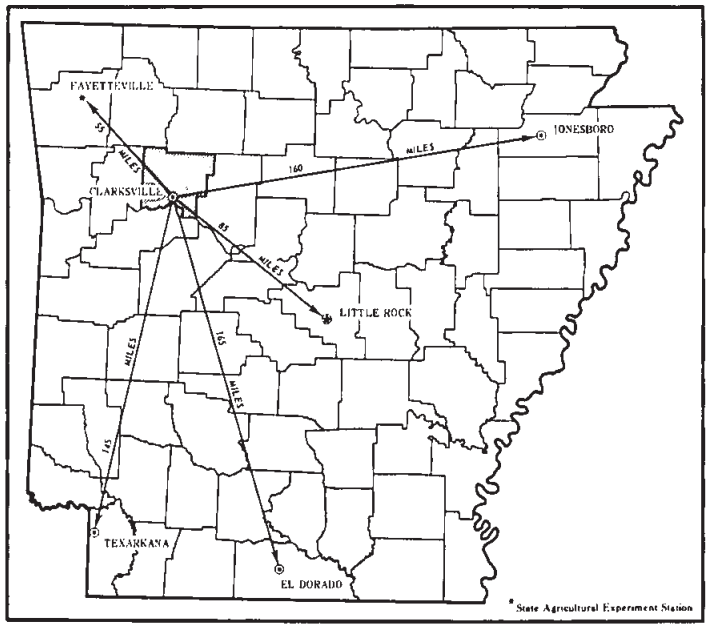

Figure 1.—**Location of Johnson County in Arkansas.**

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Johnson County, 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 the steepness, length, and shape of slopes; the size and speed 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 a 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 town or other geographic feature near the place where a soil of that series was first observed and mapped. Bruno and Sane, 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, Nella gravelly fine sandy loam, 1 to 3 percent slopes, is one of several phases within the Nella 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 photo-

graphs. 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 Johnson County: soil associations and undifferentiated groups.

A soil association is made up of adjacent soils that occur as areas large enough to be shown individually on the soil map but are shown as one unit because the time and effort of delineating them separately cannot be justified. There is a considerable degree of uniformity in pattern and relative extent of the dominant soils, but the soils may differ greatly one from another. If the association includes more than one dominant soil, the name of an association consists of the names of the dominant soils, joined by a hyphen. Leesburg-Enders association, steep, 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. Nella soils, rolling, is an example.

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 land types and are given descriptive names. The Rock outcrop part of Mountainburg-Rock outcrop association, very steep, is an example.

Some mapping units include soils unlike any known series. Such soils are named using nomenclature from a higher level of the soil classification system. In this survey, Udorthents are in this category.

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 their 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.

The Johnson County soil maps in this survey join the soil maps in the published soil survey of Franklin County, Arkansas. The soil boundaries connect, and in most cases the soil names are the same. Exceptions are largely the result of changes in definition of some soil series, or they exist because some soils of adjoining counties were not extensive enough to map in Johnson County.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Johnson County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally 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 association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The soil associations in Johnson County are discussed in the following paragraphs. The terms for texture used in the title for several of the associations apply to the texture of the surface layer. For example, in the title of association 1, the word "loamy" refers to the texture of the surface layer.

1. Nella-Enders-Mountainburg Association

Well drained, gently sloping to very steep, deep and shallow, loamy and stony soils on hills and mountains

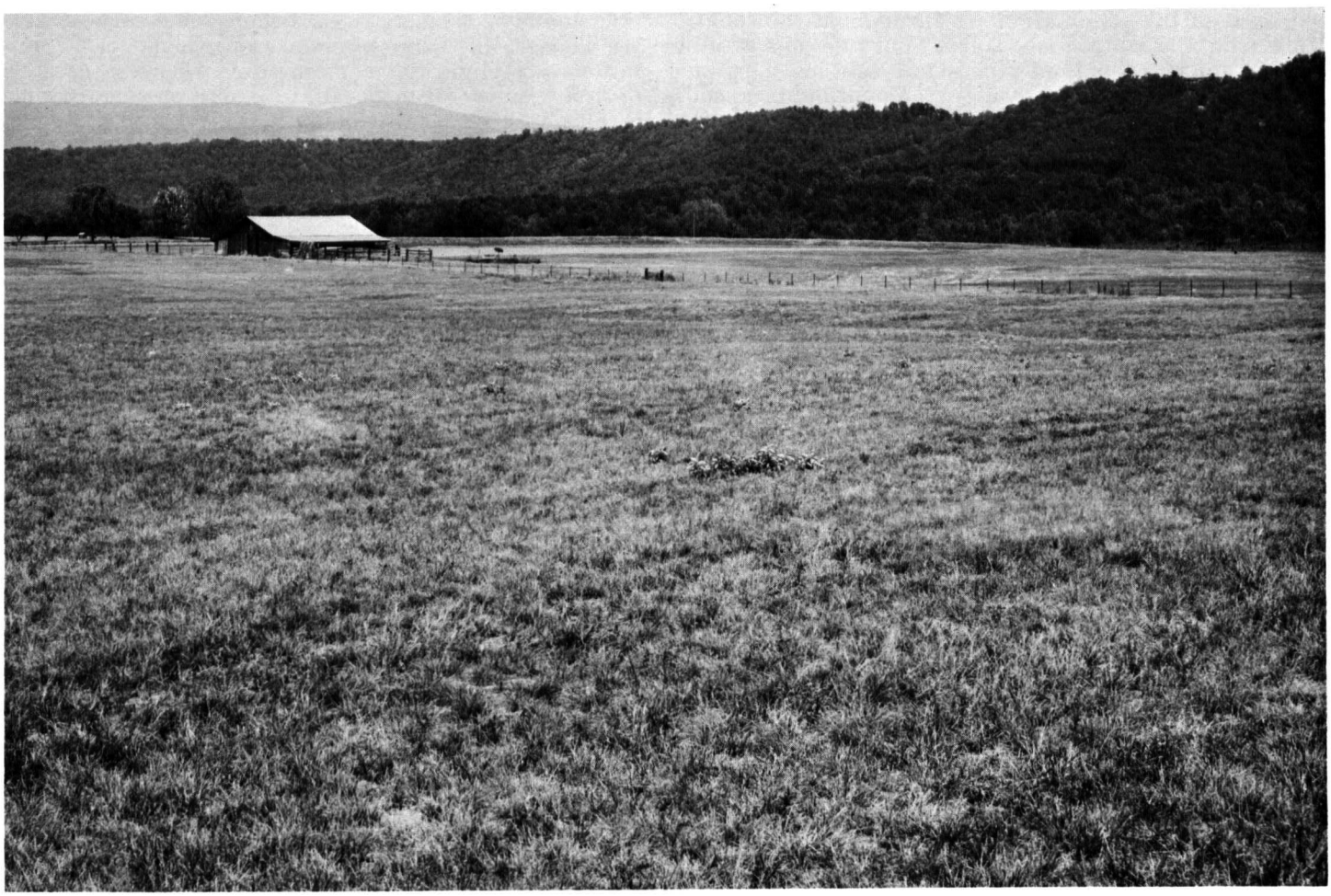

Figure 2.—**Soils of association 1 are in background. (Those in foreground are in association 2.)**

This association is mainly in the northern part of the county on hills and mountains (fig. 2). Nella soils are on toe slopes and benches, and Enders soils are on hillsides and mountainsides. Mountainburg soils are on the tops of hills and mountains and on ledges and benches. Nella soils formed in colluvium derived from acid sandstone and shale. Enders soils formed where the bedrock is acid shale. Mountainburg soils formed where the bedrock is acid sandstone.

This association makes up about 48 percent of the county. Nella soils make up about 45 percent of the association; Enders soils, about 18 percent; and Mountainburg soils, about 16 percent. The remaining 21 percent is Ceda, Leesburg, Linker, and Spadra soils; Rock outcrop; and water areas.

Nella soils are well drained. They have a surface layer of dark brown gravelly fine sandy loam and a subsurface layer of brown gravelly fine sandy loam. The surface layer is stony in some areas. The upper part of the subsoil is reddish brown gravelly sandy clay loam, and the middle part is yellowish red gravelly clay loam. The lower part is red gravelly clay loam.

Enders soils are well drained. They have a surface layer of dark brown fine sandy loam that is gravelly or stony in some areas. The upper part of the subsoil is yellowish red clay loam, and the middle part is yellowish red clay. The lower part is mottled clay, and the underlying material is light gray shaly clay.

Mountainburg soils are well drained. They have a surface layer of dark brown gravelly fine sandy loam. This layer is stony in many areas. The upper part of the subsoil is yellowish red gravelly sandy clay loam, and the lower part is yellowish red gravelly fine sandy loam. In places the subsoil is stony throughout. It is underlain by sandstone bedrock at a depth of 12 to 20 inches.

Generally, soils in this association are unsuited to farming because of slope, depth to bedrock, stony surface layer, or clayey subsoil. Most areas are wooded. Cleared areas are used mainly for pasture. Limitations are severe for most kinds of intensive uses and for septic tank absorption fields because of slope, depth to bedrock, or the slow percolation rate.

2. Linker-Mountainburg Association

Well drained, nearly level to moderately steep, moderately deep and shallow, loamy and stony soils on hills, mountains, and ridges

Areas of this association are throughout the county. Linker and Mountainburg soils are on the tops of hills and mountains, on their side slopes and benches, and on low ridges within valleys. Mountainburg soils formed where the bedrock is harder and more resistant to weathering or where geological erosion has more nearly kept pace with weathering of the bedrock and the parent material is thinner.

This association makes up about 29 percent of the county. Linker soils make up about 50 percent of the association, and Mountainburg soils, about 36 percent. The remaining 14 percent is Cane, Enders, Leadvale, and Nella soils; Rock outcrop; and water areas.

Linker soils are well drained. They have a surface layer of dark brown fine sandy loam. The upper part of the subsoil is yellowish red loam, and the middle part is yellowish red clay loam. The lower part is yellowish red, mottled gravelly clay loam underlain by sandstone bedrock at a depth of 20 to 40 inches.

Mountainburg soils are well drained. They have a surface layer of dark brown gravelly fine sandy loam. This layer is stony in many areas. The upper part of the subsoil is yellowish red gravelly sandy clay loam, and the lower part is yellowish red gravelly fine sandy loam. In places the subsoil is stony throughout. It is underlain by sandstone bedrock at a depth of 12 to 20 inches.

Generally, soils in this association are poorly suited or unsuited to farming because of the stony surface layer, slope, and depth to bedrock. Most areas are used for pasture or are wooded. Limitations are moderate to severe for most intensive uses because of depth to bedrock and slope, but they are severe for septic tank absorption fields.

3. Pickwick-Spadra Association

Well drained, nearly level and gently sloping, deep, loamy soils on stream terraces

This association is on stream terraces along the Mulberry River, Big and Little Piney Creeks, Horsehead Creek, and Spadra Creek. Pickwick soils are on the older, higher terraces. Spadra soils are on the younger, lower terraces adjacent to the streams.

This association makes up about 10 percent of the county. Pickwick soils make up about 36 percent of the association, and Spadra soils, about 30 percent. The remaining 34 percent is Cane, Ceda, Leadvale, Nella, and Taft soils and water areas.

Pickwick soils are well drained. They have a surface layer of dark brown silt loam. The upper part of the subsoil is yellowish red loam, and the middle part is red and dark red silty clay loam. The lower part is dark red, mottled silty clay loam.

Spadra soils are well drained. They have a surface layer of brown fine sandy loam. The upper part of the subsoil is yellowish red sandy clay loam, and the middle part is reddish brown sandy clay loam. The lower part and the underlying material are reddish brown fine sandy loam.

Soils of this association are suited to farming, but erosion needs to be controlled in most areas. Some areas are subject to occasional flooding. The soils are used mainly for pasture, although some large tracts are wooded, and some tracts are in urban areas. Limitations are slight to moderate for intensive uses on Pickwick soils and moderate to severe on Spadra soils because of occasional flooding.

4. Leadvale-Cane-Taft Association

Moderately well drained and somewhat poorly drained, level to gently sloping, deep, loamy soils with fragipans; in broad valleys

This association is in the southern part of the county on old stream terraces in broad valleys between the hills and ridges. The nearly level and gently sloping Leadvale and Cane soils are intermingled on the higher local elevations in the valleys. Taft soils are in the level, low lying areas.

This association makes up about 10 percent of the county. Leadvale soils make up about 35 percent of the association; Cane soils, about 15 percent; and Taft soils, about 9 percent. The remaining 41 percent is Enders, Guthrie, Linker, McKamie, Mountainburg, and Muskogee soils; Udorthents; and water areas.

Leadvale soils are moderately well drained. They have a surface layer of dark brown silt loam. The upper part of the subsoil is yellowish brown, friable silt loam and yellowish brown, mottled, friable silty clay loam. The lower part is a firm, brittle, mottled fragipan of silty clay loam.

Cane soils are moderately well drained. They have a surface layer of brown fine sandy loam. The upper part of the subsoil is yellowish red, friable loam and clay loam, and the middle part is a firm, brittle, mottled fragipan and sandy clay loam. The lower part is mottled, friable sandy clay loam.

Taft soils are somewhat poorly drained. They have a surface layer of dark grayish brown silt loam and a subsurface layer of yellowish brown, mottled silt loam. The upper part of the subsoil is yellowish brown, mottled, friable silt loam, and the middle part is a firm, brittle, mottled fragipan of silty clay loam. The lower part is mottled, firm silty clay.

Soils in this association are suited to farming, but erosion needs to be controlled in most areas. The soils are used mainly for pasture. Limitations are moderate to severe for most intensive uses, but they are severe for septic tank absorption fields because of the slow percolation rates of the soils.

5. Morganfield-Bruno-Roellen Association

Excessively drained to poorly drained, level and nearly level, deep, sandy to clayey soils on the Arkansas River flood plain

This association is in the southwestern part of the county. The soils formed in material deposited by the Arkansas River. Bruno soils formed in sandy sediment on the younger natural levees adjacent to the river. Morganfield soils formed in loamy sediment on the slightly higher elevations of the young natural levees adjacent to the Bruno soils. Roellen soils formed in clayey sediment in slightly depressed back-swamp areas.

This association makes up about 3 percent of the county. Morganfield soils make up about 24 percent of the association; Bruno soils, about 22 percent; Roellen soils, about 18 percent; and the remaining 36 percent is Caspiana and Moreland soils and water areas.

Morganfield soils are well drained. They have a surface layer of dark brown and reddish brown silt loam. The underlying material is reddish brown to dark reddish brown very fine sandy loam and silt loam.

Bruno soils are excessively drained. They have a surface layer of yellowish brown loamy fine sand. The underlying material is light yellowish brown and brown loamy fine sand, loamy very fine sand, and fine sand.

Roellen soils are poorly drained. They have a surface layer of very dark gray clay. The upper part of the subsoil is very dark gray, mottled clay, and the middle part is dark gray, mottled clay. The lower part is dark grayish brown, mottled clay.

Soils in this association, except for Bruno soils, are suited to farming, and most of the acreage is cultivated. Bruno soils are poorly suited to most crops because of the low available water capacity. Roellen soils require surface drainage for efficient farm management. Crops that leave large amounts of residue can be grown year after year.

Limitations are severe for most intensive uses because of a hazard of flooding in areas not protected by levees, soil wetness and high shrink-swell potential in some tracts, and a seasonal high water table in other areas. Except for Roellen soils, limitations are less severe for more extensive nonfarm uses in areas not subject to flooding.

Descriptions of the Soils

In this section the soils of Johnson County 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 are described. 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. Udorthents, for example, do not belong to a soil series; nevertheless, they are listed in alphabetic order along with the soil series.

Preceding the name of each mapping unit is the symbol that identifies the mapping unit on the detailed soil map. Listed at the end of the description of each mapping unit are the capability unit, pasture and hayland group, woodland suitability group, and range site in which the mapping unit has been placed. The page for the description of each pasture and hayland group and range site can be learned by referring to the "Guide to Mapping Units" at the back of this survey

Consecutive capital letters in the map symbol indicate the delineations are much larger and the composition of the units is apt to be more variable than other units in the survey area. Mapping has been controlled well enough, however, for the anticipated use of the areas involved.

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*).[1]

Bruno Series

The Bruno series consists of excessively drained, level and nearly level soils on the younger natural levees along the Arkansas River. These soils formed in stratified sandy sediment carried from the west by the Arkansas River. The native vegetation was hardwood trees.

In a representative profile the surface layer is yellowish brown loamy fine sand about 9 inches thick. The underlying material is light yellowish brown and brown loamy fine sand, loamy very fine sand, and fine sand that extends to a depth of 72 inches or more.

Bruno soils are low in natural fertility. Permeability is rapid, and the available water capacity is low. These soils respond poorly to fertilization.

Bruno soils are fairly well suited to forage crops that are adapted to the local climate. Most areas are in pasture or meadow or are idle. In places these soils are cultivated. Some areas are subject to flooding in winter, but the flooding is occasional and it does not seriously limit the use of the soils for farming. These soils are easy to till and can be cultivated over a wide range of moisture content.

Representative profile of Bruno loamy fine sand in a moist meadow in the SW¼NE¼NW¼ sec. 5, T. 8 N., R. 25 W.:

Ap—0 to 9 inches; yellowish brown (10YR 5/4) loamy fine sand; weak fine granular structure; very friable; many fine roots; few pores; slightly acid; abrupt smooth boundary.

C1—9 to 28 inches; light yellowish brown (10YR 6/4) loamy fine sand; single grained; loose; few fine

[1] Italic numbers in parentheses refer to Literature Cited, p. 77.

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

Soil	Acres	Percent	Soil	Acres	Percent
Bruno loamy fine sand	2,920	0.7	Mountainburg-Enders association, rolling	2,060	.5
Cane fine sandy loam, 1 to 3 percent slopes	1,050	.2	Mountainburg-Enders association, steep	2,840	.6
Cane fine sandy loam, 3 to 8 percent slopes	8,010	1.9	Mountainburg-Enders association, very steep	1,090	.2
Caspiana silt loam	1,640	.4	Mountainburg-Rock outcrop association, very steep	4,000	.9
Ceda cobbly fine sandy loam	5,140	1.2	Muskogee silt loam, 1 to 3 percent slopes	1,720	.4
Enders gravelly fine sandy loam, 5 to 15 percent slopes	3,090	.7	Nella gravelly fine sandy loam, 1 to 3 percent slopes	2,910	.7
Enders-Mountainburg association, rolling	2,370	.5	Nella gravelly fine sandy loam, 3 to 8 percent slopes	5,700	1.3
Enders-Mountainburg association, steep	2,150	.5	Nella gravelly fine sandy loam, 8 to 12 percent slopes	1,630	.4
Guthrie silt loam	2,850	.7	Nella-Enders association, rolling	16,260	3.8
Leadvale silt loam, 1 to 3 percent slopes	11,540	2.7	Nella-Enders association, steep	54,910	12.8
Leadvale silt loam, 3 to 8 percent slopes	4,160	1.0	Nella-Enders association, very steep	11,120	2.6
Leesburg association, rolling	2,920	.7	Nella-Mountainburg association, rolling	13,440	3.1
Leesburg association, steep	2,590	.6	Nella-Mountainburg association, steep	26,700	6.2
Leesburg-Enders association, steep	2,830	.6	Nella-Mountainburg association, very steep	50,210	11.7
Leesburg-Enders association, very steep	8,410	2.0	Nella soils, rolling	4,790	1.1
Linker fine sandy loam, 1 to 3 percent slopes	4,260	1.0	Nella soils, steep	2,980	.7
Linker fine sandy loam, 3 to 8 percent slopes	47,940	11.1	Pickwick silt loam, 1 to 3 percent slopes	5,750	1.3
Linker fine sandy loam, 8 to 12 percent slopes	1,580	.4	Pickwick silt loam, 3 to 8 percent slopes	9,810	2.3
Linker association, rolling	12,730	3.0	Roellen clay	2,360	.5
Linker-Mountainburg association, rolling	2,250	.5	Spadra fine sandy loam, 1 to 3 percent slopes	13,290	3.1
McKamie silt loam, 3 to 8 percent slopes	1,690	.4	Taft silt loam	4,140	1.0
Moreland clay	710	.2	Udorthents	3,050	.7
Morganfield silt loam	3,160	.7	Water [1]	7,024	1.6
Mountainburg gravelly fine sandy loam, 3 to 12 percent slopes	25,950	6.0	Total	430,464	100.0
Mountainburg stony fine sandy loam, 1 to 12 percent slopes	14,480	3.4			
Mountainburg stony fine sandy loam, 12 to 65 percent slopes	6,260	1.4			

[1] Includes only bodies of water of less than 40 acres and streams less than one-eighth mile wide.

roots; few pores; common bedding planes; neutral; gradual smooth boundary.

C2—28 to 45 inches, brown (7.5YR 5/4) loamy very fine sand; single grained; loose; few fine roots; few pores; common bedding planes; netural; abrupt wavy boundary.

C3—45 to 72 inches; light yellowish brown (10YR 6/4) fine sand with thin lenses of brown (7.5YR 5/4) loamy fine sand; single grained; loose; common bedding planes; neutral.

The A horizon is brown or yellowish brown. The C horizon is stratified brown, yellowish brown, or light yellowish brown loamy fine sand, loamy very fine sand, or fine sand. These layers are in different sequences in different profiles. Reaction is slightly acid to neutral throughout the profile.

Bruno soils are associated with Morganfield soils. They are more sandy and more rapidly drained than Morganfield soils.

Br—Bruno loamy fine sand. This level and nearly level soil is on young natural levees along the Arkansas River. Slopes are 0 to 3 percent. Areas range from about 50 to 250 acres in size. Included in mapping are a few areas of Caspiana and Morganfield soils.

This soil is poorly suited to farming. Available water capacity is low, and droughtiness is a severe limitation. Some areas are subject to occasional flooding. The hazard of soil blowing is severe in spring if the soil is left bare. Clean-tilled crops that leave a large amount of residue can be safely grown year after year if management is good.

These soils are used mainly for forage crops. Winter small grains can be grown, but establishing a stand is often difficult. Also, the crop is damaged in places by lack of moisture. Soybeans and other clean-tilled, warm-season crops are poorly suited to but are grown in some areas (fig. 3). Adapted forage plants are bermudagrass, weeping lovegrass, johnsongrass, and crimson clover. Capability unit IIIs–1; pasture and hayland group 3B; woodland suitability group 2s5; not assigned to a range site.

Cane Series

The Cane series consists of moderately well drained, nearly level and gently sloping soils on colluvial foot slopes and old stream terraces in broad valleys. These soils formed in loamy sediment washed from uplands of weathered sandstone and shale. The native vegetation was mainly mixed hardwood trees and some pines.

In a representative profile the surface layer is brown fine sandy loam about 5 inches thick. The subsoil extends to a depth of 72 inches or more. The upper 6 inches is yellowish red, friable loam; the next 9 inches is yellowish red, friable clay loam; and the next 39 inches is a firm, brittle fragipan. The upper 20 inches of the fragipan is yellowish red, mottled clay loam, and the lower 19 inches is mottled sandy clay loam. Mottled, friable sandy clay loam is below the fragipan.

Cane soils are low in natural fertility. Permeability is slow, and the available water capacity is medium. The firm, brittle fragipan in the subsoil restricts the penetration of roots and slows the movement of water through the soil. These soils respond well to fertilization.

Most areas of Cane soils are cleared and were culti-

Figure 3.—**Poor stand of soybeans on Bruno loamy fine sand. (Good stand in background is on Morganfield silt loam.)**

vated in the past, but they are now used as pasture and meadow. They are easy to till and can be cultivated throughout a wide range of moisture content.

Representative profile of Cane fine sandy loam, 3 to 8 percent slopes, in the NE¼NE¼NW¼ sec. 21, T. 9 N., R. 25 W.:

Ap—0 to 5 inches; brown (7.5YR 4/4) fine sandy loam; weak fine granular structure; friable; many fine roots; few pores; medium acid; abrupt smooth boundary.

B1—5 to 11 inches; yellowish red (5YR 4/6) loam; weak fine subangular blocky structure; friable; common fine roots; few pores; strongly acid; clear smooth boundary.

B2t—11 to 20 inches; yellowish red (5YR 5/6) clay loam; moderate fine subangular blocky structure; friable; common patchy clay films on faces of peds; few fine roots; few pores; common fine concretions; strongly acid; gradual smooth boundary.

Bx1—20 to 40 inches; yellowish red (5YR 4/6) clay loam; common medium prominent pale brown (10YR 6/3) mottles; weak prisms that part to moderate medium subangular blocky structure; firm, brittle; common vertical gray (10YR 6/1) silt coatings between prisms; common patchy clay films on faces of peds; few pores; common fine dark-colored concretions; very strongly acid; gradual smooth boundary.

Bx2—40 to 59 inches; mottled light gray (10YR 7/1), yellowish brown (10YR 5/8), and yellowish red (5YR 5/6) sandy clay loam; weak medium subangular blocky structure; firm, brittle; many patchy clay films on faces of peds; common fine dark-colored concretions; very strongly acid; gradual smooth boundary.

B3—59 to 72 inches; mottled light gray (10YR 7/1), strong brown (7.5YR 5/6), and reddish brown (5YR 4/4) sandy clay loam; weak medium subangular blocky structure; friable; common patchy clay films on faces of peds; very strongly acid.

The A horizon ranges from dark grayish brown to brown. The B1 horizon is strong brown or yellowish red. The B2t horizon is strong brown or yellowish red loam, sandy clay loam, or clay loam. Depth to the Bx horizon ranges from 18 to 30 inches. This horizon is loam, clay loam, sandy clay loam, or silty clay loam.

Depth to bedrock is 60 to 96 inches or more. Reaction is medium acid or strongly acid in the A and B1 horizons and strongly acid or very strongly acid below.

Cane soils are associated with Enders, Leadvale, Pickwick, and Taft soils. They have a fragipan, and Enders and Pickwick soils do not. They have a coarser textured B horizon than do Enders soils. Cane soils are redder and contain more sand than Leadvale and Taft soils.

CaB—Cane fine sandy loam, 1 to 3 percent slopes. This nearly level soil is on old stream terraces in broad valleys. Areas range from about 5 to 120 acres in size. Included in mapping are a few small areas of

soils that have a gravelly surface layer and a few areas of Leadvale, Pickwick, and Taft soils.

This soil is suited to farming, but the hazard of erosion is moderate. Clean-tilled crops that leave a large amount of residue can be safely grown year after year if management is good and includes contour cultivation and terracing on long slopes. Sown crops can be grown without attention to row direction.

This soil is used mainly as pasture or meadow. It is suited to such crops as soybeans, grain sorghum, winter small grains, and truck crops. Peaches and grapes are also grown in a few areas. Adapted pasture plants are bahiagrass, bermudagrass, tall fescue, white clover, sericea lespedeza, and annual lespedeza. Capability unit IIe–1; pasture and hayland group 8A; woodland suitability group 3o7; not assigned to a range site.

CaC—Cane fine sandy loam, 3 to 8 percent slopes. This gently sloping soil is on colluvial foot slopes and old stream terraces in broad valleys. Areas range from about 5 to 120 acres in size. It has the profile described as representative for the series. Included in mapping are a few small areas of soils that have slopes of as much as 12 percent and a few small areas of soils that have a gravelly surface layer. Also included are few areas of Enders, Leadvale, and Pickwick soils.

Runoff is medium to rapid, and the hazard of erosion is severe on this soil. However, it is suited to farming. Clean-tilled crops that leave a large amount of residue can be safely grown year after year in the less sloping areas if management is good and includes contour cultivation and terracing. Conservation treatment needs to be intensified as slope increases.

This soil is used mainly as pasture or meadow. Suitable crops are soybeans, grain sorghum, corn, winter small grains, and truck crops. Peaches and grapes are also grown in some areas. Adapted pasture plants are bahiagrass, bermudagrass, tall fescue, white clover, and annual lespedeza. Capability unit IIIe–1; pasture and hayland group 8A; woodland suitability group 3o7; not assigned to a range site.

Caspiana Series

The Caspiana series consists of well drained, level and nearly level soils on older natural levees along the Arkansas River. These soils formed in loamy sediment of mixed origin brought in from the west by the Arkansas River. The native vegetation was hardwood trees.

In a representative profile the surface layer is dark brown silt loam about 10 inches thick. The upper part of the subsoil is dark brown silty clay loam about 20 inches thick, and the lower part is dark brown silt loam about 10 inches thick. The underlying material is brown and reddish brown very fine sandy loam.

Caspiana soils are high in natural fertility. Permeability is moderate, and the available water capacity is high. These soils respond well to fertilization.

Caspiana soils are well suited to cultivated crops. Most of the acreage is cultivated, but a few areas are in alfalfa or improved pasture. Some of these soils are subject to occasional flooding in winter, but this does not seriously limit their use for farming. These soils are easy to till and can be cultivated throughout a wide range of moisture content.

Representative profile of Caspiana silt loam in a moist cultivated area in the SW¼NW¼NW¼ sec. 32, T. 9 N., R. 25 W.:

Ap—0 to 10 inches; dark brown (7.5YR 3/2) silt loam; weak fine granular structure; friable; many fine roots; few pores; slightly acid; abrupt smooth boundary.

B21t—10 to 24 inches; dark brown (7.5YR 3/2) silty clay loam; weak fine subangular blocky structure; friable; common patchy clay films on faces of peds; common fine roots; few fine pores; slightly acid; clear smooth boundary.

B22t—24 to 30 inches; dark brown (7.5YR 4/2) silty clay loam; weak fine subangular blocky structure; friable; common patchy clay films on faces of peds; few fine roots; common pores; slightly acid; clear smooth boundary.

B23t—30 to 40 inches; dark brown (7.5YR 4/2) silt loam; weak fine subangular blocky structure; friable; common patchy clay films on faces of peds; few fine roots; few pores; slightly acid; gradual wavy boundary.

C1—40 to 52 inches; brown (7.5YR 5/4) very fine sandy loam; weak fine subangular blocky structure; friable; few pores; neutral; gradual wavy boundary.

C2—52 to 72 inches; reddish brown (5YR 4/4) very fine sandy loam; weak fine subangular blocky structure; friable; few pores; neutral.

The A horizon is very dark grayish brown to dark brown. Some profiles have a B1 horizon, 5 to 9 inches thick, that is very dark grayish brown or dark brown loam or silt loam. The B2t horizon is very dark grayish brown to dark reddish brown loam, silt loam, or silty clay loam.

The C horizon is dark reddish-brown to brown very fine sandy loam, fine sandy loam, or loam. Reaction is medium acid or slightly acid in the A horizon, medium acid to neutral in the B horizon, and neutral or mildly alkaline in the C horizon.

Caspiana soils are associated with Moreland, Morganfield, and Roellen soils. They are less sandy than Morganfield soils. They contain more silt and less clay than Moreland and Roellen soils, and they are not so gray as Roellen soils.

Cp—Caspiana silt loam. This soil is on natural levees along the Arkansas River. Slope ranges from 0 to 2 percent. Areas range from about 10 to 200 acres in size. Included in mapping are a few areas of Moreland, Morganfield, and Roellen soils and a few small areas of soils that have a lighter colored surface layer.

This soil is well suited to cultivated crops and is easy to till. Clean-tilled crops that leave large amounts of residue can be safely grown year after year if management is good.

Most of the acreage of this soil is used for such row crops as soybeans, cotton, truck crops, and grain sorphum. A few areas are used for alfalfa or improved pasture. This soil is suited to winter small grains, but the crop may be damaged by occasional winter flooding in some areas. Adapted pasture plants are bermudagrass, bahiagrass, tall fescue, and white clover. Capability unit I–1; pasture and hayland group 2A; woodland suitability group 2o4; not assigned to a range site.

Ceda Series

The Ceda series consists of well drained, level and

nearly level soils on flood plains of small streams in narrow valleys. These soils formed in cobbly, loamy sediment washed from uplands of weathered sandstone and shale. The native vegetation was mixed hardwood trees and some pines.

In a representative profile the surface layer is dark brown cobbly fine sandy loam about 10 inches thick. The underlying material extends to a depth of 72 inches or more. The upper 9 inches is brown cobbly fine sandy loam, and below this is dark yellowish brown cobbly fine sandy loam.

Ceda soils are low in natural fertility. Permeability is rapid, and the available water capacity is low.

Ceda soils are not suited to cultivated crops and are poorly suited to improved pasture. They are droughty, and surface cobbles severely restrict the use of farm equipment. These soils are better suited to use as woodland and wildlife habitat. Most of the area is wooded.

Representative profile of Ceda cobbly fine sandy loam in a moist, wooded area in the NE¼SW¼NE¼ sec. 22, T. 12 N., R. 24 W.:

O1—1 inch to 0; hardwood litter and water-deposited debris.
A1—0 to 10 inches; dark brown (10YR 3/3) cobbly fine sandy loam; weak fine granular structure; friable; about 25 percent pebbles and cobbles as much as 5 inches in diameter; many fine and medium roots; many pores; slightly acid; clear smooth boundary.
C1—10 to 19 inches; brown (10YR 4/3) cobbly fine sandy loam; massive; friable; about 40 percent pebbles and cobbles as much as 7 inches in diameter; many medium roots; many pores; strongly acid; clear smooth boundary.
C2—19 to 72 inches; dark yellowish brown (10YR 4/4) cobbly fine sandy loam; massive; friable; about 70 percent cobbles and stones 3 to 14 inches in diameter; few medium roots; many pores; strongly acid.

The A1 horizon is very dark grayish brown to yellowish brown. The C1 horizon is dark brown to yellowish brown loam or fine sandy loam. The C2 horizon is brown to dark yellowish brown fine sandy loam to loamy sand.

The A horizon is 15 to 80 percent coarse fragments, and the C horizon is 35 to 80 percent coarse fragments. Reaction ranges from slightly acid to strongly acid throughout the profile.

Ceda soils are associated with Spadra soils. They have more coarse fragments, more sand, and less clay than Spadra soils. They do not have a B horizon, which is characteristic of Spadra soils.

Cy—Ceda cobbly fine sandy loam. This nearly level soil is along small streams in narrow valleys. Slope is 0 to 2 percent. Areas range from 10 to 50 acres in size. Included in mapping are a few areas of Spadra soils.

This soil is not suited to cultivated crops and is poorly suited to improved pasture. Surface cobbles limit the use of farm equipment, and the soil is droughty. This soil is flooded frequently. It is better suited to woodland or wildlife habitat than it is to other uses. Capability unit VIIs–1; pasture and hayland group 2B; woodland suitability group 3x9; not assigned to range site.

Enders Series

The Enders series consists of well drained, gently sloping to very steep soils on hills, mountains, and ridges. These soils formed in a thin layer of loamy material and the underlying clayey material that has weathered from shale. The native vegetation was hardwood trees or mixed pines and hardwoods.

In a representative profile the surface layer is dark brown fine sandy loam about 6 inches thick. Many stones are in the surface layer. The subsoil extends to a depth of 50 inches. The upper 8 inches is yellowish red clay loam; the next 14 inches is yellowish red clay; the next 10 inches is mottled red, reddish yellow, and pale brown clay; the lower 12 inches is light gray, mottled clay. The underlying material is light gray, mottled shaly clay that extends to a depth of 76 inches or more.

Enders soils are low in natural fertility. The surface layer is thin, and root penetration into the subsoil is restricted. Permeability is very slow, and the available water capacity is high. These soils respond well to fertilization.

Enders soils are not suited to cultivated crops. They are better suited to use as pasture, wildlife habitat, and woodland. In places the soils have been cleared, but most of the areas are wooded. These soils are difficult to stabilize, and this is a concern when the soil material is used in engineering structures.

Representative profile of Enders fine sandy loam in a moist, wooded, stony area of Nella-Enders association, rolling, in the SE¼NE¼SW¼ sec. 29, T. 11 N., R. 22 W.:

O1—½ inch to 0; litter of pine needles and hardwood leaves and twigs.
A1—0 to 6 inches; dark brown (10YR 3/3) fine sandy loam; strong fine granular structure; very friable; about 25 percent sandstone stones; many fine and medium roots; many pores; strongly acid; clear irregular boundary.
B1—6 to 14 inches; yellowish red (5YR 5/6) clay loam; moderate medium subangular blocky structure; friable; about 10 percent sandstone stones; many medium and coarse roots; many pores; very strongly acid; clear wavy boundary.
B21t—14 to 28 inches; yellowish red (5YR 4/8) clay; moderate medium subangular blocky structure; firm; continuous thick clay films in pores and on faces of peds; about 10 percent sandstone stones and 10 percent shale fragments; few medium and coarse roots; common pores; very strongly acid; clear wavy boundary.
B22t—28 to 38 inches; mottled red (2.5YR 4/6), reddish yellow (7.5YR 6/6), and pale brown (10YR 6/3) clay; weak thin platy and moderate fine blocky structure; firm; continous thick clay films on faces of peds; about 25 percent shale fragments and 10 percent sandstone stones; few fine roots; few pores; very strongly acid; clear wavy boundary.
B3—38 to 50 inches; light gray (10YR 7/1) clay; many medium prominent pale brown (10YR 6/3), red (2.5YR 3/6) and dark red (2.5YR 3/6) mottles; weak thin platy structure; firm; continous thick clay films on faces of peds; about 35 percent weathered soft red (2.5YR 5/6) shale fragments; few fine and medium roots; few pores; very strongly acid; clear wavy boundary.
C1—50 to 70 inches; light gray (10YR 6/1) shaly clay; many medium distinct strong brown (7.5YR 5/8) and yellowish red (5YR 4/8) mottles; massive to weak thin platy structure relict of shale beds; firm; about 60 percent soft weathered red (2.5YR 5/6), brown (10YR 5/3), and gray (10YR 5/1) shale fragments; few fine roots; few pores; very strongly acid; clear wavy boundary.
C2—70 to 76 inches; light gray (10YR 6/1) shaly clay;

many medium distinct strong brown (7.5YR 5/8) and yellowish brown (10YR 5/8) and few medium prominent dark red (2.5YR 3/6) mottles; massive to weak thin platy structure relict of shale beds; firm; about 75 percent soft weathered black shale; very strongly acid.

The A1 horizon is very dark grayish brown to dark brown fine sandy loam or gravelly fine sandy loam. Some profiles have an A2 horizon, 3 to 6 inches thick, that is brown or yellowish brown and has the same range of textures as the A1 horizon.

The B1 horizon is reddish brown to strong brown loam, gravelly loam, clay loam, or sandy clay loam. In many profiles the A and B1 horizons are stony. The B21t horizon is yellowish red or red clay loam, clay, or silty clay. The B22t and B3 horizons are silty clay or clay.

The A horizon is 15 to 35 percent sandstone, and the B1 and B21t horizons are as much as 10 percent sandstone. Shale fragments are few to common throughout the profile and make up 10 to 60 percent of the B3 and C horizons. Depth to shale bedrock ranges from about 42 to 96 inches. Reaction is strongly acid or very strongly acid throughout the profile.

Enders soils are associated with Cane, Leadvale, Leesburg, Linker, Mountainburg, and Nella soils. They are more clayey in the B2t horizon than any of the associated soils, and they are underlain by shale rather than by the sandstone of Linker and Mountainburg soils. Enders soils are deeper to bedrock than Linker and Mountainburg soils. They do not have the fragipan characteristic of Cane and Leadvale soils.

EnD—Enders gravelly fine sandy loam, 5 to 15 percent slopes. This gently sloping to moderately steep soil is on crests and toe slopes of ridges and hills. Areas range from about 10 to 100 acres in size. The profile of this soil is similar to the one described as representative for the series except the surface layer is gravelly. Included in mapping are a few areas of Cane, Leadvale, Leesburg, Mountainburg, and Nella soils.

Runoff is rapid on this soil, and the hazard of erosion is severe. Thus, it is not suited to cultivated crops. It is better suited to pasture, wildlife habitat, and woodland than it is to other uses. Adapted pasture plants are bermudagrass, bahiagrass, tall fescue, annual lespedeza, and sericea lespedeza. Capability unit VIe–1; pasture and hayland group 8C; woodland suitability group 4o1; and Clay Break, Shale range site.

EMD—Enders-Mountainburg association, rolling. The soils in this association are on hillsides and mountainsides. Slope ranges from 18 to 20 percent. The individual soils are in areas large enough to map separately, but they were not separated because of poor accessibility and low intensity of use. The soils generally are in a regular pattern and are in about the same relative proportions.

This association is about 50 to 65 percent Enders fine sandy loam that is gravelly or stony in most areas and 25 to 40 percent Mountainburg gravelly or stony fine sandy loam. The rest of the association is small areas of Leesburg, Linker, and Nella soils and Rock outcrop.

Enders soils are on side slopes between sandstone ledges or benches and on foot slopes. Mountainburg soils are on narrow sandstone ledges and benches. Areas range from about 50 to 500 acres in size. Enders soils have a profile similar to the one described as representative for the Enders series except the surface layer is gravelly in some areas. Mountainburg soils have a profile similar to the one described as representative for the Mountainburg series, but in places they are stony throughout their profile.

Runoff is rapid, and the hazard of erosion is very severe on these soils. They are not suited to cultivated crops, and they are poorly suited to pasture. The soils are better suited to wildlife habitat or woodland than to other uses. This association has moderate wood producing potential. A few small areas are used as pasture and range. Surface stones and slopes limit pasture management. Adapted pasture plants are bermudagrass, bahiagrass, tall fescue, annual lespedeza, and sericea lespedeza. Enders soils in Capability unit VIIs–2; pasture and hayland group 8D; woodland suitability group 4x2; and Clay Break, Shale range site. Mountainburg soils in Capability unit VIIs–3; pasture and hayland group 14B; woodland suitability group 5x3; and Sandstone Ridge range site.

EME—Enders-Mountainburg association, steep. The soils in this association are on hillsides and mountainsides. Slope ranges from 20 to 40 percent. The individual soils are in areas large enough to map separately, but they were not separated because of poor accessibility and low intensity of use. The soils generally are in a regular pattern and are in about the same relative proportions.

This association is about 45 to 65 percent Enders fine sandy loam that is gravelly or stony in most areas and 25 to 45 percent Mountainburg gravelly or stony fine sandy loam. The rest of the association is small areas of Leesburg, Linker, and Nella soils and Rock outcrop.

Enders soils are on side slopes between sandstone ledges or benches and on foot slopes. Mountainburg soils are on narrow sandstone ledges and benches. Areas range from about 50 to 500 acres in size. Enders soils have a profile similar to the one described as representative for the Enders series except the surface layer is gravelly in some areas. The Mountainburg soils have a profile similar to the one described as representative for the Mountainburg series, but in places they are stony throughout their profile.

Runoff is very rapid, and the hazard of erosion is very severe on these soils. They are not suited to cultivated crops or improved pasture. The soils are better suited to wildlife habitat or woodland than they are to other uses. This association has a moderate wood producing potential. Enders soils in capability unit VIIs–2; pasture and hayland group 8D; woodland suitability group 4x2; Clay Break, Shale range site. Mountainburg soils in capability unit VIIs–3; pasture and hayland group 14B; woodland suitability group 5x3; and Sandstone Ridge range site.

Guthrie Series

The Guthrie series consists of poorly drained, level to depressional soils mainly on old stream terraces in broad valleys. These soils formed in material washed from acid, loamy upland soils. The native vegetation was hardwood trees.

In a representative profile the surface layer is dark

grayish brown silt loam about 6 inches thick. The subsoil extends to a depth of 72 inches or more. The upper 9 inches is light gray, mottled silt loam, and the next 7 inches is light gray, mottled silty clay loam. Below this is a firm, brittle fragipan. The upper 16 inches is gray, mottled silty clay loam; the next 20 inches is light gray, mottled silty clay loam; and the lower 14 inches is grayish brown, mottled silty clay loam.

Guthrie soils are low in natural fertility. The firm, brittle layer in the subsoil restricts root penetration and slows the movement of water through the soil. Permeability is slow, and the available water capacity is medium. These soils respond well to fertilization.

Guthrie soils are suited to most crops grown in the county if they are drained and well managed. Most areas are used as pasture and meadow. These soils are easy to till, but they are wet for long periods after rains.

Representative profile of Guthrie silt loam in a moist pasture in the SW¼SE¼NE¼ sec. 7, T. 9 N., R. 23 W.:

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silt loam; common fine faint yellowish brown and light gray mottles; weak fine granular structure; friable; many fine roots; few fine pores; strongly acid; abrupt smooth boundary.

B1g—6 to 15 inches; light gray (10YR 6/1) silt loam; common medium distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; common fine roots; common fine pores; few fine concretions; strongly acid; clear smooth boundary.

B2g—15 to 22 inches; light gray (10YR 7/1) silty clay loam; common fine distinct yellowish brown mottles; moderate medium subangular blocky structure; firm; common patchy clay films on faces of peds; few fine roots; few fine pores; common fine concretions; strongly acid; gradual smooth boundary.

Bx1—22 to 38 inches; gray (10YR 5/1) silty clay loam; common fine distinct yellowish brown mottles; strong medium subangular blocky structure; firm; brittle; common patchy clay films and light gray silt coatings on faces of peds; few fine roots; few fine pores; common fine and medium concretions; strongly acid; gradual smooth boundary.

Bx2—38 to 58 inches; light gray (10YR 6/1) silty clay loam; many fine and medium distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; brittle; many patchy clay films on faces of peds; few fine pores; many fine and medium concretions; strongly acid; gradual smooth boundary.

Bx3—58 to 72 inches; grayish brown (10YR 5/2) silty clay loam; common, fine and medium, faint, light gray (10YR 7/2) and many fine and medium distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; brittle; common patchy clay films on faces of peds; few fine pores; common fine and medium concretions; slightly acid.

The Ap or A1 horizon is dark gray to grayish brown. Some profiles have an A2 horizon, 4 to 7 inches thick, that is gray or grayish-brown silt loam.

The B1g horizon is light gray or gray silt loam or silty clay loam. The B2g horizon is light gray to gray silt loam or silty clay loam. Depth to the Bx horizon ranges from 20 to 30 inches.

Some profiles have a C horizon that is gray silty clay or clay at a depth of more than 40 inches. Depth to bedrock ranges from 60 to 84 inches or more.

Reaction is slightly acid to strongly acid in the A horizon, strongly acid or very strongly acid in the B1g through the Bx2 horizons, and slightly acid to strongly acid in the Bx3 and C horizons.

Guthrie soils are associated with Leadvale, Spadra, and Taft soils. They are more poorly drained and grayer in the B horizon than any of the associated soils. Guthrie soils have a fragipan, which is not characteristic of Spadra soils. They have more silt and less sand than Spadra soils.

Ge—Guthrie silt loam. This soil is mainly on old stream terraces in broad valleys. Slope is less than 1 percent. Areas range from about 5 to 200 acres in size. Included in mapping are a few areas of Leadvale, Spadra, and Taft soils.

Runoff is very slow, and excess water is a severe limitation on this soil. The soil is suited to cultivated crops when it is drained and well managed. Farming is delayed several days after rain unless surface drains have been installed. Clean-tilled crops that leave a large amount of residue can be safely grown year after year if management is good and includes adequate drainage.

This soil is used mainly as pasture and meadow. Among the suitable crops are soybeans and grain sorghum. Winter small grains can be grown if surface drainage is adequate. Adapted pasture plants are bermudagrass, bahiagrass, tall fescue, white clover, annual lespedeza, and sericea lespedeza. Capability unit IVw–1; pasture and hayland group 8F; woodland suitability group 2w9; not assigned to a range site.

Leadvale Series

The Leadvale series consists of moderately well drained, nearly level and gently sloping soils on colluvial foot slopes and old stream terraces in broad valleys. These soils formed in loamy sediment washed from uplands of weathered sandstone and shale. The native vegetation was chiefly mixed hardwood trees and some pines.

In a representative profile the surface layer is dark brown silt loam about 5 inches thick. The subsoil extends to a depth of 72 inches or more. The upper 13 inches is yellowish brown, friable silt loam, and the next 5 inches is yellowish brown, mottled, friable silty clay loam. Below this is a mottled yellowish brown and light gray, firm, brittle fragipan of silty clay loam.

Leadvale soils are low in natural fertility. Permeability is moderately slow, and the available water capacity is medium. The firm brittle fragipan restricts root penetration and slows the movement of water through the soil. These soils respond well to fertilization.

Leadvale soils are suited to cultivated crops if erosion is controlled. Most areas are cleared and were cultivated in the past, but they are now used mainly as pasture and meadow. They are easy to till.

Representative profile of Leadvale silt loam, 1 to 3 percent slopes, in a moist pasture in the NW¼NE¼SW¼ sec. 20, T. 9 N., R. 25 W.:

Ap—0 to 5 inches; dark brown (10YR 3/3) silt loam; weak fine subangular blocky structure; friable; many fine roots; few pores; slightly acid; abrupt smooth boundary.

B1—5 to 10 inches; yellowish brown (10YR 5/4) silt loam;

weak fine subangular blocky structure; friable; many fine roots; few pores; medium acid; clear smooth boundary.

B21t—10 to 18 inches; yellowish brown (10YR 5/6) silt loam; weak fine subangular blocky structure; friable; common patchy clay films on faces of peds; common fine roots; few pores; strongly acid; gradual smooth boundary.

B22t—18 to 23 inches; yellowish brown (10YR 5/6) silty clay loam; common fine faint pale brown mottles; moderate fine subangular blocky structure; friable; common patchy clay films on faces of peds; common fine roots; few pores; common fine and medium dark colored concretions; strongly acid; gradual smooth boundary.

Bx1—23 to 49 inches; mottled yellowish brown (10YR 5/8) and light gray (10YR 6/1) silty clay loam; moderate medium subangular blocky structure; firm and brittle; common patchy clay films on faces of peds; few fine roots, mainly in gray bodies; few pores; many fine and medium dark colored concretions and a few small pockets of black concretionary material; strongly acid; gradual smooth boundary.

Bx2—49 to 72 inches; mottled yellowish brown (10YR 5/8 and light gray (10YR 6/1) silty clay loam; moderate medium subangular blocky structure; firm, brittle; common patchy clay films on faces of peds; common large pockets of black concretionary material; strongly acid.

The Ap horizon is dark grayish brown to dark brown. The B1 horizon is brown or yellowish brown. The B2t horizon is silt loam or silty clay loam. Depth to the Bx horizon is 20 to 30 inches.

Depth to bedrock is 60 to 96 inches or more. Reaction is slightly acid to strongly acid in the A horizon, medium acid to very strongly acid in the B1 horizon, and strongly acid or very strongly acid below the B1 horizon.

Leadvale soils are associated with Cane, Enders, Guthrie, Muskogee, Pickwick, Spadra, and Taft soils. They have a fragipan, and Enders, Muskogee, Pickwick, and Spadra soils do not. They are not so red in the B horizon as Cane, Enders, Pickwick, and Spadra soils. They have more silt and less sand than Cane and Spadra soils. They do not have mottling in the upper part of the B horizon, as is characteristic of Taft soils, and they are browner throughout their profile than Guthrie soils. They have less clay in the B horizon than Enders and Muskogee soils.

LeB—Leadvale silt loam, 1 to 3 percent slopes. This soil is on old stream terraces in broad valleys. Areas range from about 10 to 200 acres in size. The profile of this soil is the one described as representative for the series. Included in mapping are a few areas of Cane, Guthrie, Muckogee, Pickwick, Spadra, and Taft soils. Also included are areas with a few low mounds and a few small areas that have slopes of less than 1 percent.

Although the hazard of erosion is moderate, this soil is suited to cultivated crops. Clean-tilled crops that leave a large amount of residue can be safely grown year after year if management is good and includes contour cultivation and terracing on long slopes. Sown crops can be grown without attention to row direction.

This soil is used mainly as pasture or meadow (fig. 4). It is suited to such crops as soybeans, grain sorghum, winter small grains, and truck crops, and these are grown in a few areas. Adapted pasture plants are bahiagrass, bermudagrass, tall fescue, white clover, sericea lespedeza, and annual lespedeza. Capability unit IIe–1; pasture and hayland group 8A; woodland suitability group 3o7; not assigned to a range site.

LeC—Leadvale silt loam, 3 to 8 percent slopes. This gently sloping soil is on foot slopes of hills and on old stream terraces in broad valleys. Areas range from about 10 to 300 acres in size. Included in mapping are a few areas of Cane, Enders, and Pickwick soils. Also included are a few small areas that have slopes of as much as 12 percent.

Runoff is medium, and the hazard of erosion is severe. However, this soil is suited to cultivated crops. Clean-tilled crops that leave a large amount of residue can be safely grown year after year in the less sloping areas if management is good and includes contour cultivation and terracing. Conservation treatment needs to be intensified as slope increases.

This soil is used mainly as pasture or meadow. A small acreage is used for such crops as soybeans, grain sorghum, winter small grains, truck crops, peaches, and grapes. Adapted pasture plants are bahiagrass, bermudagrass, tall fescue, white clover, sericea lespedeza, and annual lespedeza. Capability unit IIIe–1; pasture and hayland group 8A; woodland suitability group 3o7; not assigned to a range site.

Leesburg Series

The Leesburg series consists of well drained, moderately sloping to very steep soils on foot slopes, benches, hillsides, and mountainsides. These soils formed in colluvium derived from acid sandstone and shale. The native vegetation was upland hardwoods mixed with some shortleaf pine trees.

In a representative profile the surface layer is very dark grayish brown gravelly loam about 5 inches thick. The subsoil extends to a depth of 72 inches or more. The upper 5 inches is brown gravelly loam; the next 10 inches is yellowish brown gravelly clay loam; the next 16 inches is strong brown gravelly clay loam; the next 14 inches is strong brown, mottled gravelly clay loam; the lower 22 inches is mottled yellowish red and pale brown gravelly clay loam.

Leesburg soils are moderate in natural fertility. Permeability is moderate, and the available water capacity is medium.

These soils are not suited to cultivated crops, and most of them are poorly suited to pasture because of surface stones and slope. They are better suited to use as woodland and wildlife habitat than they are to other uses. Most areas are wooded.

Representative profile of Leesburg gravelly loam in a wooded area of Leesburg association, rolling, in the SE¼NW¼NW¼ sec. 21, T. 11 N., R. 22 W.:

O1—2 inches to 0; litter of hardwood leaves and twigs.

A1—0 to 5 inches; very dark grayish brown (10YR 3/2) gravelly loam; moderate coarse granular structure; friable; many fine and medium roots; many fine and medium pores; about 15 percent sandstone fragments as much as 3 inches in diameter; strongly acid; clear smooth boundary.

B1—5 to 10 inches; brown (10YR 4/3) gravelly loam; weak fine subangular blocky structure; friable; many fine and medium roots; many fine and medium pores; about 15 percent sandstone fragments as much as 3 inches in diameter; medium acid; gradual smooth boundary.

B21—10 to 20 inches; yellowish brown (10YR 5/6) gravelly clay loam; moderate medium subangular blocky

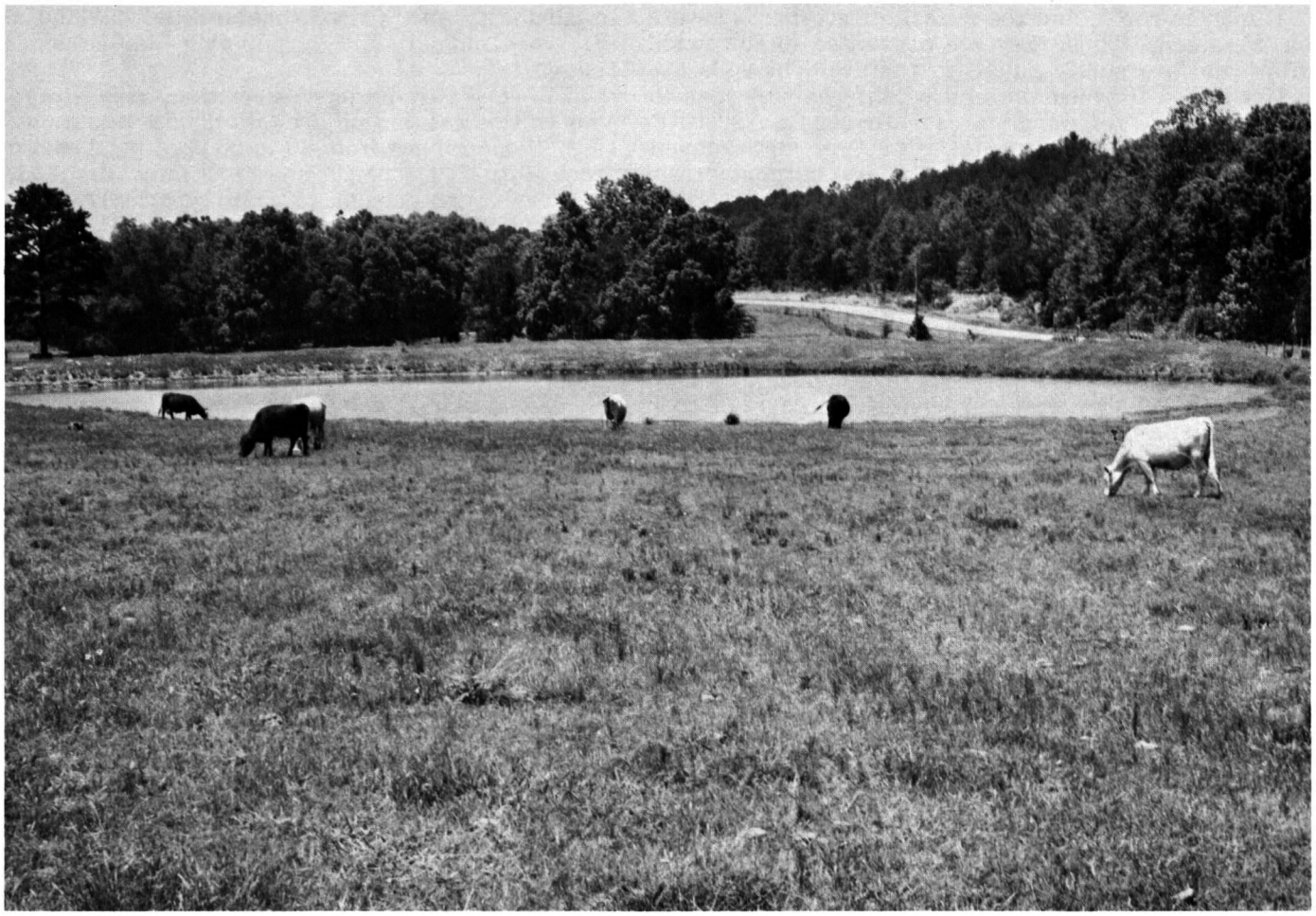

Figure 4.—**Bermudagrass pasture and farm pond on Leadvale silt loam, 1 to 3 percent slopes.**

structure; friable; common patchy clay films on faces of peds; common fine and medium roots; common fine pores; about 15 percent sandstone fragments as much as 3 inches in diameter; strongly acid; gradual smooth boundary.

B22t—20 to 36 inches; strong brown (7.5YR 5/6) gravelly clay loam; moderate medium subangular blocky structure; friable; common patchy clay films on faces of peds; common fine and medium roots; common fine pores; about 15 percent sandstone fragments as much as 3 inches in diameter; strongly acid; gradual wavy boundary.

B23t—36 to 50 inches; strong brown (7.5YR 5/6) gravelly clay loam; common fine faint pale brown mottles; moderate medium subangular blocky structure; friable; common patchy clay films on faces of peds; few fine and medium roots; common fine pores; many fine black concretions; about 40 percent sandstone fragments as much as 6 inches in diameter; very strongly acid; gradual wavy boundary.

B24t—50 to 72 inches; mottled yellowish red (5YR 5/6 and pale brown (10YR 6/3) gravelly clay loam; moderate medium subangular blocky structure; friable; common patchy clay films on faces of peds; few fine roots; few fine pores; many fine black concretions; about 40 percent sandstone fragments as much as 6 inches in diameter; very strongly acid.

The A horizon is brown to very dark grayish brown loam or fine sandy loam that is gravelly or stony. The B1 horizon is brown or dark yellowish brown. The B2t horizon is yellowish brown or strong brown gravelly loam, gravelly clay loam, or gravelly sandy clay loam. Mottling is not present in the B23t and B24t horizons of many profiles.

Content of coarse fragments ranges from 15 to 35 percent of the A horizon; 10 to 25 percent of the B1, B21t, and B22t horizons; and 10 to 50 percent of the B23t and B24t horizons. Depth to bedrock is 72 inches or more. Reaction is medium acid or strongly acid in the A horizon and medium acid to very strongly acid in the B horizon.

Leesburg soils are associated with Enders, Mountainburg, and Nella soils. They have less clay in the B2t horizon than Enders soils. They are deeper to bedrock than Mountainburg soils. They are less red in the B horizon than Nella soils.

LBD—Leesburg association, rolling. These soils are on benches and foot slopes. Slope ranges from 8 to 20 percent. Areas range from 50 to 200 acres in size. The different Leesburg soils are in areas large enough to map separately, but they were not separated because of poor accessibility and low intensity of use.

This association is about 75 to 85 percent Leesburg soils. The rest is small areas of Enders, Mountainburg, and Nella soils and Rock outcrop.

These soils are used for woodland, and management requirements are not greatly different. One of the Leesburg soils has the profile described as representative for the series; others have a similar profile except the surface layer is stony.

Runoff is rapid, and the hazard of erosion is severe on these soils. Thus, they are not suited to cultivated crops and are poorly suited to pasture. The soils are better suited to woodland and wildlife habitat than to other uses. A few small areas are used as pasture. Surface stones and slope make pasture management difficult. Adapted pasture plants are bermudagrass, bahiagrass, tall fescue, annual lespedeza, and sericea lespedeza. Capability unit VIe–2; pasture and hayland group 8B; woodland suitability group 3o7; not assigned to a range site.

LBE—Leesburg association, steep. These soils are on benches and foot slopes. Slope ranges from 20 to 40 percent. Areas are 50 to 200 acres in size. The different Leesburg soils are in areas large enough to map separately, but they were not separated because of poor accessibility and low intensity of use.

This association is about 65 to 95 percent Leesburg soils and 5 to 35 percent Enders, Mountainburg, and Nella soils and Rock outcrop.

These soils are used for woodland, and management requirements are not greatly different. Some of the Leesburg soils have profiles similar to the one described as representative for the series except the surface layer is stony.

Runoff is very rapid, and the hazard of erosion is very severe on these soils. Thus, they are not suited to cultivated crops. These soils are better suited to woodland or wildlife habitat than to other uses. Most areas are forested with upland hardwoods. Capability unit VIIe–1; pasture and hayland group 8B; woodland suitability group 3r8; not assigned to a range site.

LEE—Leesburg-Enders association, steep. The soils in this association are on hillsides and mountainsides. Slope ranges from 20 to 40 percent. Areas range from 50 to 500 acres in size and are generally on northern sides of the mountains. The individual soils are in areas large enough to map separately, but they were not separated because of poor accessibility and low intensity of use. The soils generally are in a regular pattern and in about the same relative proportions.

This association is about 40 to 60 percent Leesburg loam or fine sandy loam that is gravelly or stony and 30 to 50 percent Enders gravelly or stony fine sandy loam. The rest of the association is small areas of Mountainburg and Nella soils and Rock outcrop.

Leesburg soils are on foot slopes, in coves, and on benches. Enders soils are on convex slopes between benches. Some of the Leesburg soils have a profile similar to the one described as representative of the Leesburg series except the surface layer is stony. Some of the Enders soils have a profile similar to the one described as representative of the Enders series except the surface layer is stony or gravelly.

Runoff is rapid, and the hazard of erosion is very severe on these soils. Thus, they are not suited to cultivated crops or pasture. The soils are better suited to woodland or wildlife habitat than they are to other uses. Nearly all of the acreage of this association is forested with upland hardwoods and shortleaf pine trees. Leesburg soils in capability unit VIIe–1; pasture and hayland group 8B; woodland suitability group 3r8; not assigned to a range site. Enders soils in capability unit VIIs–2; pasture and hayland group 8D; woodland suitability group 4x2; Clay Break, Shale range site.

LEF—Leesburg-Enders association, very steep. The soils in this association are on hillsides and mountainsides. Slope ranges from 40 to 65 percent. Areas range from 50 to 500 acres in size. The individual soils are in areas large enough to map separately, but they were not separated because of poor accessibility and low intensity of use. The soils generally are in a regular pattern and are in about the same relative proportions.

This association is about 40 to 60 percent Leesburg gravelly or stony fine sandy loam and 30 to 50 percent Enders gravelly or stony fine sandy loam. The rest of the association is small areas of Mountainburg and Nella soils and Rock outcrop.

The Leesburg soils are on benches, in coves, and on foot slopes. The Enders soils are on convex slopes between benches. Leesburg soils have a profile similar to the one described as representative for the series except the surface layer is stony in most areas.

Runoff is very rapid, and the hazard of erosion is very severe on these soils. Thus, they are not suited to cultivated crops. The soils are better suited to woodland or wildlife habitat than to other uses. Nearly all of the acreage of the association is forested with upland hardwoods and shortleaf pine trees. Leesburg soils in capability unit VIIe–1; pasture and hayland group 8B; woodland suitability group 3r9; not assigned to a range site. Enders soils in capability unit VIIs–2; pasture and hayland group 8D; woodland suitability group 5r3; Clay Break, Shale range site.

Linker Series

The Linker series consists of well drained, nearly level to moderately steep soils on hilltops, hillsides, and benches. These soils formed in loamy material weathered from sandstone. The native vegetation was mixed pine and hardwood trees.

In a representative profile the surface layer is dark brown fine sandy loam about 6 inches thick. The upper part of the subsoil is yellowish red loam about 5 inches thick. The middle part is yellowish red clay loam about 11 inches thick. The lower part of the subsoil is yellowish red, mottled gravelly clay loam that extends to a depth of about 29 inches and is underlain by sandstone bedrock.

Linker soils are low in natural fertility. Permeability is moderate, and the available water capacity is medium. These soils respond well to fertilization.

Most of the less sloping soils are suited to cultivated crops if erosion control treatments are installed. Most of the less sloping soils are cleared and were cultivated in the past but are now used as pasture and meadow. The more sloping soils are generally not suited to cultivated crops and are used as woodland. The surface layer is easy to till, and Linker soils can be cultivated over a wide range of moisture content.

Representative profile of Linker fine sandy loam, 3 to 8 percent slopes, in a moist wooded area in the NE¼NW¼NW¼ sec. 32, T. 11 N., R. 22 W.:

O1—2 inches to 1; loose litter of pine needles, hardwood leaves and twigs.
O2—1 inch to 0; partially decayed organic debris.
Ap—0 to 6 inches; dark brown (10YR 4/3) fine sandy loam; weak medium subangular blocky structure parting to moderate fine granular; friable; about 5 percent sandstone fragments as much as 3 inches in diameter; strongly acid; abrupt smooth boundary.
B1—6 to 11 inches; yellowish red (5YR 5/6) loam; moderate medium subangular blocky structure; friable; about 5 percent sandstone fragments as much as 3 inches in diameter; many fine roots; common pores; very strongly acid; clear wavy boundary.
B21t—11 to 22 inches; yellowish red (5YR 5/6) clay loam; moderate medium subangular blocky structure; friable; common patchy clay films on faces of peds; about 5 percent sandstone fragments as much as 3 inches in diameter; many fine and medium roots; many pores; very strongly acid; clear wavy boundary.
B22t—22 to 29 inches; yellowish red (5YR 4/6) gravelly clay loam; common medium prominent dark red (2.5YR 3/6) and light yellowish brown (10YR 6/4) mottles; moderate fine subangular blocky structure; friable; continuous clay films on faces of peds; about 10 percent sandstone fragments as much as 3 inches in diameter; few fine roots; few pores; very strongly acid; abrupt wavy boundary.
R—29 inches; sandstone bedrock.

The Ap or A1 horizon is very dark grayish brown to dark yellowish brown fine sandy loam or gravelly fine sandy loam. Some profiles have an A2 horizon, 2 to 6 inches thick, that is yellowish brown or brown fine sandy loam or gravelly fine sandy loam. The A horizon is stony in some profiles.

The B1 horizon is brown to yellowish red fine sandy loam, loam, or sandy clay loam. The B2t horizon is yellowish red or red sandy clay loam, clay loam or gravelly clay loam. Some profiles have a B3 horizon, 5 to 10 inches thick, that is yellowish red or red sandy clay loam or clay loam.

Depth to bedrock ranges from 20 to 40 inches. Sandstone fragments range from 0 to 15 percent of the A through B21t horizons and are as much as 20 percent of the B11t horizon. Reaction is medium acid or strongly acid in the A horizon and strongly acid or very strongly acid in the B horizon.

Linker soils are associated with Enders, Mountainburg, and Nella soils. They have more sand and less clay in the B horizon than Enders soils and are deeper to bedrock and have fewer coarse fragments than Mountainburg soils. Linker soils are shallower to bedrock than Nella soils.

LnB—Linker fine sandy loam, 1 to 3 percent slopes. This nearly level soil is on hilltops and benches. Areas range from about 5 to 80 acres in size. Included in mapping are areas of Enders and Mountainburg soils and a few areas of soils that have a gravelly surface layer.

Runoff is medium, and the hazard of erosion is moderate on this soil. This soil is suited to farming. Clean tilled crops that leave a large amount of residue can be safely grown year after year if management is good and includes contour cultivation and terraces on long slopes.

The soil is used mainly as pasture or meadow. Among suitable crops are corn, grain sorghum, soybeans, winter small grains, and truck crops. Such fruit crops as peaches, apples, pears, and grapes are adapted to this soil. Suitable pasture plants are bahiagrass, bermudagrass, white clover, sericea lespedeza, and annual lespedeza. Capability unit IIe–1; pasture and hayland group 8A; woodland suitability group 4o1; Loamy Upland range site.

LnC—Linker fine sandy loam, 3 to 8 percent slopes. This gently sloping soil is on hilltops, hillsides, and benches. Areas range from about 5 to 200 acres in size. This soil has the profile described as representative for the series. Included in mapping are areas of Enders and Mountainburg soils and a few areas of soils that have a gravelly surface layer.

Although runoff is medium and the hazard of erosion is severe, this soil is suited to farming. Clean-tilled crops that leave a large amount of residue can be safely grown year after year in the less sloping areas if management is good and includes contour cultivation and terraces. Conservation practices must be intensified as slope increases.

The soil is used mainly as pasture or meadow. Suitable crops are corn, grain sorghum, soybeans, winter small grains, and truck crops. Fruit crops such as peaches and grapes are grown on this soil (fig. 5). Suitable pasture plants are bahiagrass, bermudagrass, white clover, sericea lespedeza, and annual lespedeza. Capability unit IIIe–1; pasture and hayland group 8A; woodland suitability group 4o1; Loamy Upland range site.

LnD—Linker fine sandy loam, 8 to 12 percent slopes. This moderately sloping soil is on hilltops, hillsides, and benches. Areas range from about 5 to 60 acres in size. Included in mapping are a few areas of soils that have a gravelly surface layer and areas of Enders, Mountainburg, and Nella soils.

Runoff is rapid, and the hazard of erosion is very severe on this soil. Thus, this soil is not suited to clean tilled crops. Sown crops can be grown occasionally in a cropping system that includes close-growing cover most of the time. Special crops such as peaches and grapes can be grown under intensive management. This soil is better suited to pasture, woodland, or wildlife habitat than it is to other uses. Adapted pasture plants are bahiagrass, bermudagrass, white clover, sericea lespedeza, and annual lespedeza. Capability unit IVe–1; pasture and hayland group 8A; woodland suitability group 4o1; Loamy Upland range site.

LKD—Linker association, rolling. This gently sloping to moderately steep soil association is on hilltops, hillsides, and benches. Slopes range from 3 to 15 percent. Areas range from about 50 to 200 acres in size. These soils are mapped together because they are used and managed alike. Poor accessibility and low intensity of anticipated use make separate mapping of the soils impractical. The profiles of the Linker soils in this association are similar to the one described as representative for the series except the surface layer is gravelly or stony in most places.

Linker soils make up about 75 percent of the area, and small tracts of Enders, Mountainburg, and Nella soils make up the rest. Included in mapping are some small areas that have slopes of less than 3 percent and others that have slopes of as much as 20 percent.

Runoff is medium to rapid, and the hazard of erosion is very severe on these soils. Except in more gently sloping areas, this association is not suited to clean-tilled crops. Sown crops can be safely grown occasionally on most of the acreage if the cropping system includes close-growing covers most of the time.

Figure 5.—**Peach orchard on Linker fine sandy loam, 3 to 8 percent slopes.**

The soils of this association are better suited to pasture, woodland, or wildlife habitat than they are to other uses. Adapted pasture plants are bahiagrass, bermudagrass, white clover, sericea lespedeza, and annual lespedeza. Capability unit IVe–1; pasture and hayland group 8A; woodland suitability group 4o1; Loamy Upland range site.

LMD—Linker-Mountainburg association, rolling. The soils in this association are on tops and sides of hills and mountains and on benches. Slope ranges from 8 to 20 percent. The individual soils are in areas large enough to map separately, but they were not separated because of poor accessibility and low intensity of use. The soils generally are in a regular pattern and in about the same relative proportions.

This association is about 50 to 65 percent Linker fine sandy loam that is gravelly or stony in most areas and 25 to 40 percent Mountainburg gravelly or stony fine sandy loam. The rest of the association is small areas of Enders and Nella soils and Rock outcrop.

Mountainburg soils are near the rims of broad hilltops and mountaintops and on benches above Rock outcrop. Linker soils are in irregular areas between the benches and scattered over the hilltops and mountaintops where the bedrock is at a greater depth. Areas range from about 50 to 200 acres in size. Linker soils in this association have a profile similar to the one described as representative for the Linker series except the surface layer is gravelly or stony in most areas. Mountainburg soils in this association have a profile similar to the one described as representative of the Mountainburg series except the surface layer is stony in many areas.

Runoff is rapid, and the hazard of erosion is very severe on these soils. They are not suited to cultivated crops, and they are poorly suited to pasture. The soils are better suited to wildlife habitat or woodland than to other uses. A few small areas are used as pasture and range. Surface stones and slopes limit pasture management. Adapted pasture plants are bahiagrass, bermudagrass, white clover, sericea lespedeza, and annual lespedeza. Linker soils in capability unit VIe–2; pasture and hayland group 8B; woodland suitability group 4o1; Loamy Upland range site. Mountainburg soils in capability unit VIIs–3; pasture and hayland group 14B; woodland suitability group 5x3; Sandstone Ridge range site.

McKamie Series

The McKamie series consists of well drained, gently sloping soils on high terraces along the Arkansas River. These soils formed in loamy and clayey sediment brought in by the Arkansas River from the prairies and mountains to the west. The native vegetation was chiefly mixed hardwood trees and some pines.

In a representative profile the surface layer is dark brown silt loam about 3 inches thick. The subsoil extends to a depth of 72 inches or more. The upper 4 inches is yellowish red silty clay loam; the next 18 inches is red clay; the next 20 inches is mottled yellowish brown, light gray, and red clay; the next 10 inches is yellowish red, mottled clay; and the lower 17 inches is mottled yellowish red and light gray clay loam.

McKamie soils are moderate in natural fertility. Permeability is very slow, and the available water capacity is high. These soils respond well to fertilization.

Most areas are cleared and were cultivated in the past, but they are now used as pasture and meadow. The subsoil shrinks and cracks in prolonged dry periods, and when it is wet it expands and the cracks seal.

Representative profile of McKamie silt loam, 3 to 8 percent slopes, in a moist idle field in the NE¼NW¼SW¼ sec. 18, T. 9 N., R. 23 W.:

Ap—0 to 3 inches; dark brown (10YR 4/3) silt loam; weak fine granular structure; friable; many fine and medium roots; few pores; medium acid; abrupt smooth boundary.

B1—3 to 7 inches; yellowish red (5YR 5/6) silty clay loam; weak fine subangular blocky structure; friable; many fine and medium roots; few pores; strongly acid; gradual smooth boundary.

B21t—7 to 14 inches; red (2.5YR 4/6) clay; moderate medium subangular blocky structure; very firm and very plastic; continuous clay films on faces of peds; common fine and medium roots; few pores; very strongly acid; gradual smooth boundary.

B22t—14 to 25 inches; red (2.5YR 4/6) clay; many fine and medium distinct reddish yellow (5YR 6/6) mottles; moderate medium subangular blocky structure; very firm and very plastic; continuous clay films on faces of peds; very strongly acid; gradual smooth boundary.

B23t—25 to 45 inches; mottled yellowish brown (10YR 5/8), light gray (10YR 7/1), and red (2.5YR 4/8) clay; moderate medium subangular blocky structure; very firm and very plastic; continuous clay films; very strongly acid; gradual smooth boundary.

B24t—45 to 55 inches; yellowish red (5YR 4/8) clay; many coarse prominent light gray (10YR 7/1) and yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; very firm and very plastic; continuous clay films; very strongly acid; gradual smooth boundary.

IIB3—55 to 72 inches; mottled yellowish red (5YR 4/8) and light gray (10YR 7/1) clay loam; weak medium subangular blocky structure; firm; very strongly acid.

The A horizon is dark grayish brown to dark brown. The B1 horizon is strong brown or yellowish-red silt loam or silty clay loam. The B2t horizon is yellowish-red or red clay or silty clay. Many profiles do not have mottling in the B2t horizon. The IIB3 horizon is yellowish-red or red clay loam or sandy clay loam.

Reaction is medium acid or strongly acid in the A and B1 horizons, strongly acid or very strongly acid in the B2t horizon, and very strongly acid to mildly alkaline in the IIB3 horizon.

McKamie soils are associated with Muskogee soils. They are redder and have more clay in the upper part of the B horizon than Muskogee soils.

McC—McKamie silt loam, 3 to 8 percent slopes. This soil is on high terraces along the Arkansas River. Areas range from about 50 to 200 acres in size. Included in mapping are a few eroded areas where the subsoil is exposed and a few areas of Muskogee soils.

Runoff is rapid, and the hazard of erosion is very severe on this soil. It is poorly suited to cultivated crops. Sown crops can safely be grown occasionally in a cropping system that includes close-growing cover most of the time. The soil is better suited to pasture, woodland, and wildlife habitat than it is to other uses. Adapted pasture plants are bahiagrass, bermudagrass, johnsongrass, annual lespedeza, and sericea lespedeza. Capability unit IVe–2; pasture and hayland group 8C; woodland suitability group 3c2; not assigned to a range site.

Moreland Series

The Moreland series consists of somewhat poorly drained, level and nearly level soils in slack-water areas along the Arkansas River. These soils formed in loamy and clayey sediment brought in from the west by the Arkansas River. The native vegetation was hardwood trees.

In a representative profile the surface layer is dark reddish brown clay about 8 inches thick. The subsoil extends to a depth of 72 inches or more. The upper 29 inches is dark reddish brown clay; the next 14 inches is dark reddish brown silty clay loam; and the lower 21 inches is reddish brown clay loam.

Moreland soils are high in natural fertility. Permeability is very slow, and the available water capacity is high. These soils respond well to fertilization.

Moreland soils are well suited to cultivated crops. Most of the acreage is cultivated, but a few areas are in alfalfa or improved pasture. Some of these soils are subject to occasional flooding in winter, but this does not seriously limit their use for farming. Clods form and the soils are difficult to till if they are plowed when too wet. They shrink and crack when dry; when wet, they expand and the cracks seal.

Representative profile of Moreland clay in a moist cultivated area in the NW¼SE¼SE¼ sec. 28, T. 9 N., R. 25 W.:

Ap—0 to 8 inches; dark reddish brown (5YR 3/2) clay; strong fine granular structure; firm; many fine roots; few pores; mildly alkaline; abrupt smooth boundary.

B21—8 to 22 inches; dark reddish brown (5YR 3/3) clay; strong medium subangular blocky structure; firm; common fine roots; few pores; common slickensides; mildly alkaline; calcareous; gradual smooth boundary.

B22—22 to 37 inches; dark reddish brown (5YR 3/2) clay; strong medium subangular blocky structure; firm; few fine roots; few pores; common slickensides; neutral; gradual smooth boundary.

B23—37 to 51 inches; dark reddish brown (5YR 3/2) silty clay loam; strong medium subangular blocky structure; firm; few fine roots; few pores;

common slickensides; neutral; clear wavy boundary.

B3—51 to 72 inches; reddish brown (5YR 4/4) clay loam; moderate medium subangular blocky structure; friable; few fine roots; few pores; neutral.

The A horizon is dark brown or dark reddish brown. The upper 24 to 42 inches of the B horizon is dark brown to dark reddish-brown silty clay or clay. The lower part of the B horizon is dark reddish-brown to reddish-brown silty clay, silty clay loam, or clay loam. Reaction ranges from slightly acid to mildly alkaline throughout the profile. The soil is calcareous in some layers between depths of 8 and 36 inches.

Moreland soils are associated with Caspiana, Morganfield, and Roellen soils. They contain more clay and less sand and silt than Caspiana and Morganfield soils. They are browner below the surface layer and are better drained than Roellen soils.

Md—Moreland clay. This level and nearly level soil is in slack-water areas along the Arkansas River. Slope ranges from 0 to 2 percent. Areas range from about 40 to 200 acres in size. Included in mapping are a few areas of Caspiana, Morganfield, and Roellen soils, and a few small areas of soils that have a silty clay loam surface layer.

This soil is well suited to cultivated crops if it is drained and well managed, but it is difficult to till because of the clay content in the surface layer.

Runoff is slow and the hazard of excess water is moderate. Clean-tilled crops that leave large amounts of residue can be safely grown year after year if management is good and includes adequate surface drainage.

Most of the acreage of this soil is in soybeans and alfalfa, but some tracts are in cotton (fig. 6) and improved pasture. This soil is suited to winter small grains, but the crop may be damaged by occasional winter flooding in some areas. Adapted pasture plants include bermudagrass, bahiagrass, tall fescue, and white clover. Capability unit IIw–1; pasture and hayland group 1A; woodland suitability group 2w6; not assigned to a range site.

Figure 6.—**Typical cottonfield on Moreland clay.**

Morganfield Series

The Morganfield series consists of well drained, level and nearly level soils on natural levees along the Arkansas River. These soils formed in loamy sediment of mixed origin brought in from the west by the Arkansas River. The native vegetation was hardwood trees.

In a representative profile the surface layer is silt loam about 14 inches thick. The upper 7 inches is dark brown, and the lower 7 inches is reddish brown. The underlying material extends to a depth of 72 inches or more. The upper 16 inches is reddish brown very fine sandy loam; the next 11 inches is brown very fine sandy loam; the next 17 inches is dark reddish brown silt loam; and the lower 14 inches is reddish brown very fine sandy loam.

Morganfield soils are high in natural fertility. Permeability is moderate, and the available water capacity is high. These soils respond well to fertilization.

These soils are well suited to cultivated crops. Most of the acreage is cultivated, but a few areas are in alfalfa or improved pasture. Some of these soils are subject to occasional flooding in winter, but this does not seriously limit their use for farming. They are easy to till and can be cultivated throughout a wide range of moisture content.

Representative profile of Morganfield silt loam in a moist meadow in the NW¼NE¼SW¼ sec. 32, T. 9 N., R. 25 W.:

Ap—0 to 7 inches; dark brown (7.5YR 4/4) silt loam; weak fine granular structure; friable; many fine roots; few pores; mildly alkaline; abrupt smooth boundary.

A12—7 to 14 inches; reddish brown (5YR 4/4) silt loam; weak medium granular structure; friable; common fine roots; few pores; few bedding planes; moderately alkaline; gradual smooth boundary.

C1—14 to 30 inches; reddish brown (5YR 4/4) very fine sandy loam; massive; friable; common fine roots; few pores; common bedding planes; moderately alkaline; clear wavy boundary.

C2—30 to 41 inches; brown (7.5YR 4/4) very fine sandy loam; massive; friable; common fine roots; few pores; common bedding planes; mildly alkaline; clear wavy boundary.

Ab—41 to 58 inches; dark reddish brown (5YR 3/3) silt loam; moderate fine granular structure; friable; common fine roots; few pores; moderately alkaline; clear smooth boundary.

IIC—58 to 72 inches; reddish brown (5YR 4/4) very fine sandy loam; massive; friable; few fine roots; few pores; moderately alkaline.

The A horizon is dark brown or reddish brown. The upper 30 to 50 inches of the C horizon is brown or reddish brown silt loam or very fine sandy loam. The lower part of the C horizon is dark reddish brown to brown loamy fine sand to very fine sandy loam. Reaction ranges from slightly acid to moderately alkaline throughout the profile.

Morganfield soils are associated with Bruno, Caspiana, and Moreland soils. They are less sandy than Bruno soils. They are redder and contain less clay than Caspiana soils.

They contain more sand and silt and less clay than Moreland soils.

Mg—Morganfield silt loam. This soil is on natural levees along the Arkansas River. Slope ranges from 0 to 2 percent. Some areas are gently undulating and have alternating swales and low ridges. Areas range from about 40 to 800 acres in size. Included in mapping are a few areas of Bruno, Caspiana, and Moreland soils.

This soil is well suited to cultivated crops (fig. 7) and is easy to till. Clean-tilled crops that leave a large amount of residue can be safely grown year after year if management is good.

Most of the acreage of this soil is used for such row crops as soybeans, truck crops, and grain sorghum. A few areas are in alfalfa or improved pasture. This soil is suited to winter small grains, but the crop may be damaged by occasional winter flooding in some areas. Adapted pasture plants include bermudagrass, bahiagrass, tall fescue, and white clover. Capability unit I–1; pasture and hayland group 2A; woodland suitability group 2o4; not assigned to a range site.

Mountainburg Series

The Mountainburg series consists of well drained, gently sloping to very steep soils on benches and on tops and sides of hills, ridges, and mountains. These soils formed in loamy material weathered from sandstone. The native vegetation is chiefly mixed hardwood trees, pines, and an understory of tall grasses.

In a representative profile the surface layer is dark brown gravelly fine sandy loam about 3 inches thick. The upper part of the subsoil is yellowish red gravelly sandy clay loam about 6 inches thick, and the lower part is yellowish red gravelly fine sandy loam that extends to a depth of about 13 inches. Sandstone bedrock is at a depth of 13 inches.

Mountainburg soils are low in natural fertility. Permeability is moderately rapid, and the available water capacity is low. These soils respond poorly to fertilization.

Mountainburg soils are not suited to clean-tilled crops. The soils are droughty. Furthermore, surface stones and the moderately steep to very steep slopes in some areas severely restrict the use of farm equip-

Figure 7.—**Soybeans on Morganfield silt loam.**

ment. These soils are better suited to pasture or range, woodland, or wildlife habitat than to other uses. Most of the area is woodland and savanna of poor quality. Some of the acreage is in pasture and orchards.

Representative profile of Mountainburg gravelly fine sandy loam, 3 to 12 percent slopes, in a moist wooded area in the NW¼NW¼NW¼ sec. 30, T. 11 N., R. 22 W.:

O1—1 inch to 0; litter of pine needles and hardwood leaves and twigs.

Ap—0 to 3 inches; dark brown (7.5YR 4/4) gravelly fine sandy loam; moderate fine granular structure; very friable; common fine and medium roots; few fine pores; about 15 percent angular sandstone fragments as much as 4 inches in diameter; strongly acid; abrupt smooth boundary.

B21t—3 to 9 inches; yellowish red (5YR 4/6) gravelly sandy clay loam; weak medium subangular blocky structure; friable; common patchy clay films on faces of peds; common fine roots; few pores; about 40 percent angular sandstone fragments as much as 4 inches in diameter; strongly acid; clear wavy boundary.

B22t—9 to 13 inches; yellowish red (5YR 4/6) gravelly fine sandy loam; weak medium subangular blocky structure; friable; common patchy clay films on faces of peds; few fine roots; few pores; about 50 percent angular sandstone fragments as much as 4 inches in diameter; strongly acid; abrupt smooth boundary.

R—13 inches; level-bedded acid sandstone bedrock.

The A1 or Ap horizon ranges from brown to very dark grayish brown gravelly fine sandy loam or stony fine sandy loam. Some profiles have a B1 horizon, 3 to 6 inches thick, that is brown to reddish brown fine sandy loam. The B2t horizon ranges from strong brown to yellowish red gravelly fine sandy loam to gravelly sandy clay loam.

Many profiles are stony throughout. The content of coarse fragments ranges from 15 to 40 percent in the A horizon and from 40 to 65 percent in the B horizon. Depth to bedrock is 12 to 20 inches. Reaction is medium acid or strongly acid in the A horizon and is strongly acid or very strongly acid in the B horizon.

Mountainburg soils are associated with Enders, Leesburg, Linker, and Nella soils. They are shallower over bedrock and have less clay and more coarse fragments in the Bt horizon than any of the associated soils.

MoD—Mountainburg gravelly fine sandy loam, 3 to 12 percent slopes. This soil is on benches, hilltops, mountaintops, and ridges. Areas range from about 10 to 150 acres in size. This soil has the profile described as representative for the series. Included in mapping are a few areas of Enders and Linker soils, Rock outcrop, stony areas, and a few small areas that have slopes of less than 3 percent.

Runoff is medium to rapid, and the hazard of erosion is very severe on this soil. Thus, it is not suited to clean-tilled crops. Sown crops can safely be grown occasionally in a cropping system that includes close-growing cover most of the time. This soil is better suited to pasture, range, or wildlife habitat than it is to other uses. Adapted pasture plants are bermudagrass, bahiagrass, annual lespedeza, and sericea lespedeza. Much of the acreage of this soil is wooded with trees of poor quality. Capability unit IVe–3; pasture and hayland group 14D; woodland suitability group 5d2; Sandstone Ridge range site.

MsD—Mountainburg stony fine sandy loam, 1 to 12 percent slopes. This soil is on benches, hilltops, mountaintops, and ridges. Areas range from about 10 to 120 acres in size. This soil has a profile similar to the one described as representative for the series except the surface layer is stony. Included in mapping are a few areas of Enders and Linker soils and Rock outcrop.

This soil is not suited to cultivated crops, and it is poorly suited to improved pasture. Surface stones and rock outcrops limit the use of farm equipment (fig. 8), and the soil is droughty. Thus, this soil is better suited to range or wildlife habitat than to other uses. Most of this soil is wooded with trees of poor quality. Capability unit VIs–1; pasture and hayland group 14C; woodland suitability group 5x3; Sandstone Ridge range site.

MsF—Mountainburg stony fine sandy loam, 12 to 65 percent slopes. This soil is on hilltops, mountaintops, and ridges. Areas range from about 20 to 240 acres in size. This soil has a profile similar to the one described as representative for the series except the surface layer is stony. Included in mapping are a few small areas of Enders, Linker, and Nella soils and Rock outcrop.

Surface stones, rock outcrops, and slope limit the use of farm equipment, and the soil is droughty. Thus, this soil is not suited to cultivated crops or improved pasture. It is better suited to range or wildlife habitat than it is to other uses. Most of the acreage of this soil is wooded with trees of poor quality. Capability unit VIIs–3; pasture and hayland group 14B; woodland suitability group 5x3; Sandstone Ridge range site.

MED—Mountainburg-Enders association, rolling. The soils in this association are on sides of hills and

Figure 8.—**Typical area of Mountainburg stony fine sandy loam, 1 to 12 percent slopes.**

mountains. Slope ranges from 8 to 20 percent. The individual soils are in areas large enough to map separately, but they were not separated because of poor accessibility and low intensity of use. The soils generally are in a regular pattern and are in about the same relative proportions.

This association is 45 to 60 percent Mountainburg gravelly or stony fine sandy loam and 30 to 45 percent Enders fine sandy loam that is gravelly or stony in most areas. The rest of the association is small areas of Leesburg, Linker, and Nella soils and Rock outcrop.

Mountainburg soils are on narrow sandstone ledges and benches. Enders soils are on slopes between sandstone ledges or benches and on foot slopes. Areas range from about 50 to 200 acres in size. Mountainburg soils have a profile similar to the one described as representative for the Mountainburg series except they are stony in some areas. Enders soils have a profile similar to the one described as representative for the Enders series except the surface layer is gravelly or stony in most places.

Runoff is rapid, and the hazard of erosion is very severe on these soils. They are not suited to cultivated crops, and they are poorly suited to pasture. Surface stones and slopes make pasture management difficult. The soils are better suited to wildlife habitat or woodland than they are to other uses. This association has a low wood producing potential. A few small areas are used as pasture or range. Adapted pasture plants are bermudagrass, annual lespedeza, and sericea lespedeza. Mountainburg soils in capability unit VIIs–3; pasture and hayland group 14B; woodland suitability group 5x3; Sandstone Ridge range site. Enders soils in capability unit VIIs–2; pasture and hayland group 8D; woodland suitability group 4x2; Clay Break, Shale range site.

MEE—Mountainburg-Enders association, steep. The soils in this association are on hillsides and mountainsides. Slope ranges from 20 to 40 percent. The individual soils are in areas large enough to map separately, but they were not separated because of poor accessibility and low intensity of use. The soils generally are in a regular pattern and in about the same relative proportions.

This association is 45 to 65 percent Mountainburg gravelly or stony fine sandy loam and 30 to 45 percent Enders fine sandy loam that is gravelly or stony in most areas. The rest of the association is small areas of Leesburg, Linker, and Nella soils and Rock outcrop.

Mountainburg soils are on narrow sandstone ledges and benches. Enders soils are on side slopes between sandstone ledges or benches and on foot slopes. Areas range from 50 to 500 acres in size. Mountainburg soils have a profile similar to the one described as representative for the Mountainburg series except they are stony in some areas. Enders soils have a profile similar to the one described as representative for the Enders series except the surface layer is gravelly or stony in most areas.

Runoff is very rapid, and the hazard of erosion is very severe on these soils. They are not suited to cultivated crops. The soils are better suited to wildlife habitat or woodland than they are to other uses. This association has a low wood producing potential. Mountainburg soils in capability unit VIIs–3; pasture and hayland group 14B; woodland suitability group 5x3; Sandstone Ridge range site. Enders soils in capability unit VIIs–2; pasture and hayland group 8D; woodland suitability group 4x2; Clay Break, Shale range site.

MEF—Mountainburg-Enders association, very steep. The soils in this association are on hillsides and mountainsides. Slope ranges from 40 to 65 percent. The individual soils are in areas large enough to map separately, but they were not separated because of poor accessibility and low intensity of use. The soils generally are in a regular pattern and in about the same relative proportions.

This association is 50 to 65 percent Mountainburg gravelly or stony fine sandy loam and 30 to 45 percent Enders gravelly or stony fine sandy loam. The rest of the association is small areas of Leesburg, Linker, and Nella soils and Rock outcrop.

Mountainburg soils are on narrow sandstone ledges and benches. Enders soils are on side slopes between sandstone ledges or benches and on foot slopes. Areas range from 60 to 500 acres in size. Mountainburg soils have a profile similar to the one described as representative for the Mountainburg series except they are stony in some areas. Enders soils have a profile similar to the one described as representative for the Enders series except the surface layer is gravelly or stony in most areas.

Runoff is very rapid, and the hazard of erosion is very severe on these soils. They are better suited to wildlife habitat or woodland than they are to other uses. This association has a low wood producing potential. Mountainburg soils in capability unit VIIs–3; pasture and hayland group 14B; woodland suitability group 5x3; Sandstone Ridge range site. Enders soils in capability unit VIIs–2; pasture and hayland group 8D; woodland suitability group 5r3; Clay Break, Shale range site.

MRF—Mountainburg-Rock outcrop association, very steep. This association is on benches and on tops and sides of mountains. Except for near-vertical bluffs, which are in most areas, slope is 20 to 65 percent. The individual soils are in areas large enough to map separately, but they were not separated because of poor accessibility and low intensity of use.

This association is 45 to 70 percent Mountainburg gravelly or stony fine sandy loam, and 25 to 55 percent Rock outcrop. The rest of the association is areas of Enders and Linker soils and a few small areas of loamy, stony, or rocky very shallow soils.

Mountainburg soils are on narrow sandstone ledges and benches. Rock outcrop is along edges of ledges, benches, and mountaintops. Areas range from about 50 to 300 acres in size. Mountainburg soils have a profile similar to the one described as representative for the Mountainburg series except the surface layer is stony in some areas. Rock outcrop consists of areas where sandstone and shale bedrock is exposed.

Runoff is very rapid, and the hazard of erosion is very severe on these soils. They are better suited to

wildlife habitat or woodland than they are to other uses. This association has a very low wood producing potential. Mountainburg soils in capability unit VIIs–3; pasture and hayland group 14B; woodland suitability group 5x3; Sandstone Ridge range site. Rock outcrop not assigned to interpretive groups.

Muskogee Series

The Muskogee series consists of moderately well drained, nearly level soils on high terraces along the Arkansas River. The soils formed in stratified loamy and clayey sediment brought in by the Arkansas River from the prairies and mountains to the west. The native vegetation was chiefly mixed hardwood trees and some pine.

In a representative profile the surface layer is very dark grayish brown, friable silt loam about 4 inches thick. The subsoil extends to a depth of 72 inches or more. The upper 5 inches is yellowish brown silt loam; the next 14 inches is yellowish brown silty clay loam; the next 16 inches is mottled light gray, red, and strong brown clay; and the lower 33 inches is mottled, strong brown and light gray clay.

Muskogee soils are moderate in natural fertility. Permeability is slow, and the available water capacity is high. These soils respond well to fertilization.

Muskogee soils are suited to cultivated crops when erosion is controlled. Most areas are cleared and were cultivated in the past, but they are now used mainly for pasture and meadow. These soils are easy to till.

Representative profile of Muskogee silt loam, 1 to 3 percent slopes, in a moist pasture in the SE¼NE¼NE¼ sec. 20, T. 9 N., R. 24 W.:

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

B1—4 to 9 inches; yellowish brown (10YR 5/4) silt loam; weak fine subangular blocky structure; friable; many fine roots; few pores; very strongly acid; clear smooth boundary.

B21t—9 to 23 inches; yellowish brown (10YR 5/6) silty clay loam; common fine faint strong brown mottles; weak fine subangular blocky structure; friable; common patchy clay films on faces of peds; common fine roots; few pores; very strongly acid; gradual smooth boundary.

B22t—23 to 39 inches; mottled light gray (10YR 7/1), red (2.5YR 4/6), and strong brown (7.5YR 5/6) clay; moderate medium angular blocky structure; firm and plastic; continuous clay films on faces of peds; few fine roots; few pores; common pockets of black concretionary material; very strongly acid; gradual smooth boundary.

B23t—39 to 50 inches; mottled strong brown (7.5YR 5/8) and light gray (10YR 7/1) clay; strong medium angular blocky structure; firm and plastic; continuous clay films on faces of peds; common pockets of black concretionary material; very strongly acid; gradual smooth boundary.

B24t—50 to 72 inches; mottled strong brown (7.5YR 5/8) and light gray (10YR 7/1) clay; moderate medium angular blocky structure; firm and plastic; continuous clay films on faces of peds; common pockets of black concretionary material; very strongly acid.

The Ap horizon ranges from very dark grayish brown to dark brown. Some profiles have an A2 horizon, 3 to 6 inches thick, that is yellowish brown silt loam. The B22t, B23t, and B24t horizons are mottled light gray, strong brown, and red, or they are light gray, yellowish brown, and red silty clay or clay. Reaction is strongly acid or very strongly acid throughout the profile. Depth to bedrock ranges from 60 to 96 inches or more.

Muskogee soils are associated with Leadvale and McKamie soils. They contain more clay in the lower part of the B horizon than Leadvale soils and do not have the fragipan chracteristic of those soils. Muskogee soils contain less clay and more silt and are not so red in the upper part of the B horizon as McKamie soils.

MzB—Muskogee silt loam, 1 to 3 percent slopes. This soil is on high terraces along the Arkansas River. Areas range from about 100 to 1,000 acres in size. Included in mapping are areas of Leadvale and McKamie soils.

Although the hazard of erosion is moderate, this soil is suited to cultivated crops. Clean-tilled crops that leave a large amount of residue can be safely grown year after year if management is good and includes contour cultivation and terracing on long slopes. Sown crops can be grown without attention to row direction.

This soil is used mainly as pasture or meadow. It is suited to such crops as soybeans, grain sorghum, winter small grains, and truck crops. Adapted pasture plants include bahiagrass, bermudagrass, tall fescue, white clover, sericea lespedeza, and annual lespedeza. Capability unit IIe–1; pasture and hayland group 8A; woodland suitability group 3o7; not assigned to a range site.

Nella Series

The Nella series consists of well drained, nearly level to very steep soils on foot slopes, terraces, benches, hillsides, and mountainsides. These soils formed in alluvium and colluvium derived from acid sandstone and shale. The native vegetation was mixed upland hardwoods and shortleaf pine trees.

In a representative profile the surface layer is dark brown gravelly fine sandy loam about 3 inches thick. The subsurface layer is brown gravelly fine sandy loam about 4 inches thick. The subsoil extends to a depth of 72 inches or more. The upper 9 inches is reddish brown gravelly sandy clay loam; the next 13 inches is yellowish red gravelly clay loam; the next 25 inches is red gravelly clay loam; and the lower 18 inches is red gravelly clay loam.

Nella soils are moderate in natural fertility. Permeability is moderate, and the available water capacity is medium. These soils respond well to fertilization, but slopes and surface stones limit their use for crops and pasture in many areas.

Most of the less sloping Nella soils are suited to cultivated crops if erosion is controlled. Most of these areas are cleared and were cultivated in the past but are now used as pasture and meadow. The more sloping soils are generally not suited to cultivated crops, and most areas are used as woodland.

Representative profile of Nella gravely fine sandy loam in a wooded area of Nella-Enders association, steep, in the SW¼NW¼NE¼ sec. 25, T. 11 N., R. 23 W.:

O1—1 inch to 0; litter of hardwood leaves and twigs.

A1—0 to 3 inches; dark brown (10YR 3/3) gravelly fine

sandy loam; weak medium granular structure; very friable; many fine and medium roots; common fine pores; about 30 percent sandstone fragments as much as 3 inches in diameter; medium acid; clear wavy boundary.

A2—3 to 7 inches; brown (10YR 4/3) gravelly fine sandy loam; weak fine subangular blocky structure; friable; many fine and medium roots; common fine pores; about 20 percent sandstone fragments as much as 3 inches in diameter; medium acid; abrupt smooth boundary.

B1—7 to 16 inches; reddish brown (5YR 4/4) gravelly sandy clay loam; weak fine subangular blocky structure; friable; common patchy clay films on faces of peds; common fine roots; common fine pores; about 25 percent sandstone fragments as much as 20 inches in diameter; medium acid; clear wavy boundary.

B21t—16 to 29 inches; yellowish red (5YR 4/6) gravelly clay loam; weak medium subangular blocky structure; friable; common patchy clay films on faces of peds; common fine roots; common fine pores; about 20 percent sandstone fragments as much as 20 inches in diameter; medium acid; clear smooth boundary.

B22t—29 to 36 inches; red (2.5YR 4/8) gravelly clay loam; weak medium subangular blocky structure; friable; many patchy clay films on faces of peds; few fine roots; few fine pores; about 15 percent sandstone fragments as much as 3 inches in diameter; medium acid; clear smooth boundary.

B23t—36 to 44 inches; red (2.5YR 4/6) gravelly clay loam; moderate medium subangular blocky structure; friable; continuous clay films on faces of peds; few fine roots; few fine pores; about 25 percent sandstone fragments as much as 3 inches in diameter; very strongly acid; gradual smooth boundary.

B24t—44 to 54 inches; red (2.5YR 4/6) gravelly clay loam; few fine faint yellowish red mottles; moderate fine subangular blocky structure; friable; continuous clay films on faces of peds; few fine roots; few fine pores; about 15 percent sandstone fragments as much as 3 inches in diameter; very strongly acid; abrupt irregular boundary.

B25t—54 to 72 inches; red (2.5YR 4/6) clay loam; common fine faint dark red and yellowish red mottles; moderate fine subangular blocky structure; friable continuous clay films on faces of peds; few fine roots; few fine pores; about 50 percent sandstone fragments 10 to 24 inches in diameter; strongly acid.

The A1 horizon is gravelly or stony fine sandy loam. The A2 horizon is brown to very dark grayish brown. Some profiles have an Ap horizon 5 to 8 inches thick. It is brown or dark brown.

The B1 horizon is brown to yellowish red gravelly loam or gravelly sandy clay loam. The B2t horizons are yellowish red to dark red sandy clay loam or clay loam that is gravelly or stony in many profiles. Some profiles contain mottles in the lower part.

The A horizon is 15 to 35 percent coarse fragments, and the B1 horizon and upper part of the B2t horizons are 10 to 25 percent coarse fragments. The lower part of the B2t horizon is 10 to 50 percent coarse fragments. Depth to bedrock is more than 72 inches. Reaction is medium acid or strongly acid in the A horizon and medium acid to very strongly acid below.

Nella soils are associated with Enders, Leesburg, Linker, Mountainburg, and Pickwick soils. They have less clay in the B2t horizon than Enders soils. They are deeper to bedrock than Linker and Mountainburg soils. Nella soils contain more coarse fragments throughout the profile than Pickwick soils. They are redder in the B horizon than Leesburg soils.

NaB—Nella gravelly fine sandy loam, 1 to 3 percent slopes. This soil is on stream terraces. Areas range from 100 to 200 acres in size. Included in mapping are a few areas of Pickwick soils.

Although runoff is medium and the hazard of erosion is moderate on this soil, it is suited to cultivated crops. Tilled crops that leave large amounts of residue can be safely grown year after year if good management that includes contour cultivation and terracing on long slopes is used. Gravel in the surface layer makes tillage difficult.

This soil is well suited to pasture, wildlife habitat, and woodland, and most areas are used for these purposes. Suitable crops include corn and winter small grains. Grapes and peaches are also grown in some areas. Adapted pasture plants are bermudagrass, tall fescue, bahiagrass, annual lespedeza, and sericea lespedeza. Capability unit IIe–1; pasture and hayland group 8A; woodland suitability group 3o7; not assigned to a range site.

NaC—Nella gravelly fine sandy loam, 3 to 8 percent slopes. This soil is on stream terraces, foot slopes, and benches. Areas range from 10 to 200 acres in size. Included in mapping are a few areas of Enders, Linker, Mountainburg, and Pickwick soils.

Although runoff is medium and the hazard of erosion is severe on this soil, it is suited to cultivated crops. Tilled crops that leave large amounts of residue can be grown year after year on the less sloping soils when good management that includes contour cultivation and terraces is used. Conservation treatments need to be intensified where slopes are longer and slope more than most. Gravel in the surface layer makes tillage difficult.

This soil is better suited to pasture, wildlife habitat, and woodland than it is to other uses, and most areas are used for these purposes. Suitable crops include corn and winter small grains. Grapes and peaches are also grown in some areas. Adapted pasture plants are bermudagrass, bahiagrass, tall fescue, annual lespedeza, and sericea lespedeza. Capability unit IIIe–1; pasture and hayland group 8A; woodland suitability group 3o7; not assigned to a range site.

NaD—Nella gravelly fine sandy loam, 8 to 12 percent slopes. This soil is on stream terraces and foot slopes. Areas range from 10 to 100 acres in size. Included in mapping are a few areas of Enders, Linker, Mountainburg, and Pickwick soils.

Runoff is rapid, and the hazard of erosion is very severe on this soil. Thus, it is poorly suited to cultivated crops. Gravel in the surface layer limits tillage. Sown crops can be safely grown occasionally in a cropping system that includes close-growing cover most of the time.

This soil is better suited to pasture, wildlife habitat, and woodland than it is to other uses, and most areas are used for these purposes. Winter small grains are suitable crops, and orchards and vineyards are suitable if intensive management is used. Adapted pasture plants are bermudagrass, bahiagrass, tall fescue, annual lespedeza, and sericea lespedeza. Capability unit IVe–1; pasture and hayland group 8A; woodland suitability group 3o7; not assigned to a range site.

NED—Nella-Enders association, rolling. The soils in this association are on hillsides and mountainsides.

Slope ranges from 8 to 20 percent. Areas range from 50 to 500 acres in size. The individual soils are in areas large enough to map separately, but they were not separated because of poor accessibility and low intensity of use. The soils generally are in a regular pattern and in about the same relative proportions.

This association is about 50 to 70 percent Nella gravelly or stony fine sandy loam, and 20 to 45 percent Enders gravelly or stony fine sandy loam. The rest of the association is small areas of Leesburg, Linker, and Mountainburg soils and Rock outcrop.

Nella soils are on foot slopes and benches. Enders soils are on side slopes and benches. Nella soils have a profile similar to the one described as representative for the Nella series except the surface layer is stony in many areas. One of the Enders soils has the profile described as representative for the Enders series; others have a similar profile except the surface layer is gravelly.

Runoff is rapid, and the hazard of erosion is severe on these soils. They are not suited to cultivated crops and are poorly suited to pasture. The soils are better suited to wildlife habitat or woodland than they are to other uses. A few small areas are used as pasture. Surface stones and slopes make pasture management difficult. Adapted pasture plants are bermudagrass, bahiagrass, tall fescue, annual lespedeza, and sericea lespedeza. Nella soils in capability unit VIe–2; pasture and hayland group 8B; woodland suitability group 3o7; not assigned to a range site. Enders soils in capability unit VIIs–2; pasture and hayland group 8D; woodland suitability group 4x2; Clay Break, Shale range site.

NEE—Nella-Enders association, steep. The soils in this association are on hillsides and mountainsides. Slope ranges from 20 to 40 percent. Areas range from 50 to 700 acres in size. The individual soils are in areas large enough to map separately, but they were not separated because of poor accessibility and low intensity of use. The soils generally are in a regular pattern and in about the same relative proportions.

This association is about 40 to 60 percent Nella gravelly or stony fine sandy loam and 30 to 50 percent Enders gravelly or stony fine sandy loam. The rest of the association is small areas of Leesburg and Mountainburg soils and Rock outcrop.

Nella soils are on foot slopes and benches. Enders soils are on side slopes between benches. One of the Nella soils has the profile described as representative for the Nella series; others have a similar profile except the surface layer is stony. Some of the Enders soils have a profile similar to the one described as representative for the Enders series except the surface layer is gravelly.

Runoff is very rapid, and the hazard of erosion is very severe on these soils. They are not suited to cultivated crops and are poorly suited to pasture. The soils are better suited to wildlife habitat or woodland than they are to other uses. Nella soils in capability unit VIIe–1; pasture and hayland group 8B; woodland suitability group 3r8; not assigned to a range site. Enders soils in Capability unit VIIs–2; pasture and hayland group 8D; woodland suitability group 4x2; Clay Break, Shale range site.

NEF—Nella-Enders association, very steep. The soils in this association are on hillsides and mountainsides. Slope ranges from 40 to 60 percent. Areas range from 50 to 600 acres in size. The individual soils are in areas large enough to map separately, but they were not separated because of poor accessibility and low intensity of use. The soils generally are in a regular pattern and in about the same relative proportions.

This association is about 40 to 60 percent Nella stony or gravelly fine sandy loam and 30 to 50 percent Enders gravelly or stony fine sandy loam. The rest of the association is small areas of Leesburg and Mountainburg soils and Rock outcrop.

Nella soils are on benches, foot slopes, and in coves. Ender soils are on side slopes between the benches. Nella soils have a profile similar to the one described as representative for the Nella series except the surface layer is stony in most areas. Some of the Enders soils have a profile similar to the one described as representative for the Enders series except the surface layer is gravelly.

Runoff is very rapid, and the hazard of erosion is very severe on these soils. They are not suited to cultivated crops or pasture. The soils are better suited to wildlife habitat or woodland than they are to other uses. Nearly all of this association is forested with upland hardwood and shortleaf pine trees. Nella soils in Capability unit VIIe–1; pasture and hayland group 8B; woodland suitability group 3r9; not assigned to a range site. Enders soils in Capability unit VIIs–2; pasture and hayland group 8D; woodland suitability group 5r3; Clay Break, Shale range site.

NMD—Nella–Mountainburg association, rolling. The soils in this association are on sides of hills and mountains. Slope ranges from 8 to 20 percent. Areas range from 50 to 300 acres in size. The individual soils are in areas large enough to map separately, but they were not separated because of poor accessibility and low intensity of use. The soils generally are in a regular pattern and are in about the same relative proportions.

This association is 40 to 70 percent Nella gravelly or stony fine sandy loam and 15 to 45 percent Mountainburg gravelly or stony fine sandy loam. The rest of the association is small areas of Enders, Leesburg, and Linker soils and Rock outcrop.

Nella soils are on foot slopes and benches. Mountainburg soils are on ridgetops and slope breaks. Nella and Mountainburg soils have profiles similar to the ones described as representative for their respective series except the surface layer is stony in many areas.

Runoff is rapid, and the hazard of erosion is severe on these soils. They are not suited to cultivated crops and are poorly suited to pasture. The soils are better suited to wildlife habitat or woodland than to other uses. A few small areas are used as pasture. Surface stones and slopes make pasture management difficult. Adapted pasture plants are bermudagrass, bahiagrass, tall fescue, annual lespedeza, and sericea lespedeza. Nella soils in Capability unit VIe–2; pasture and hayland group 8B; woodland suitability group 3o7; not

assigned to a range site. Mountainburg soils in Capability unit VIIs–3; pasture and hayland group 14B; woodland suitability group 5d2; Sandstone Ridge range site.

NME—Nella-Mountainburg association, steep. The soils in this association are on hilltops and mountainsides. Slope ranges from 20 to 40 percent. Areas range from 50 to 500 acres in size. The individual soils are in areas large enough to map separately, but they were not separated because of poor accessibility and low intensity of use. The soils generally are in a regular pattern and are in about the same relative proportions.

This association is 45 to 65 percent Nella gravelly or stony fine sandy loam and 20 to 40 percent Mountainburg gravelly or stony fine sandy loam. The rest of the association is small areas of Enders, Leesburg, and Linker soils and Rock outcrop.

Nella soils are on foot slopes and benches. Mountainburg soils are on slope breaks and ridgetops. Nella and Mountainburg soils have profiles similar to the ones described as representative for their respective series except the surface layer is stony in most areas.

Runoff is very rapid, and the hazard of erosion is very severe on these soils. They are not suited to cultivated crops and are poorly suited to pasture. The soils are better suited to wildlife habitat or woodland than they are to other uses. Nearly all of the acreage of this association is forested with upland hardwood and shortleaf pine trees. Nella soils in Capability unit VIIe–1; pasture and hayland group 8B; woodland suitability group 3r8; not assigned to a range site. Mountainburg soils in Capability unit VIIs–3; pasture and hayland group 14B; woodland suitability group 5x3; Sandstone Ridge range site.

NMF—Nella-Mountainburg association, very steep. The soils in this association are on slopes of valley walls and mountain benches. Slope ranges from 40 to 65 percent. Areas range from 50 to 700 acres in size. The individual soils are in areas large enough to map separately, but they were not separated because of poor accessibility and low intensity of use. The soils generally are in a regular pattern and are in about the same relative proportions.

This association is 40 to 60 percent Nella gravelly or stony fine sandy loam and 25 to 50 percent Mountainburg gravelly or stony fine sandy loam. The rest of the association is small areas of Enders and Leesburg soils and Rock outcrop.

Nella soils are on foot slopes and benches. Mountainburg soils are on narrow sandstone ledges and ridgetops. Nella and Mountainburg soils have profiles similar to the ones described as representative for their respective series except the surface layer is stony in most areas.

Runoff is very rapid, and the hazard of erosion is very severe on these soils. They are not suited to cultivated crops or pasture. The soils are better suited to wildlife habitat or woodland than to other uses. Nearly all of the acreage of this association is forested with upland hardwood and shortleaf pine trees. Nella soils in Capability unit VIIe–1; pasture and hayland group 8B; woodland suitability group 3r9; not assigned to a range site. Mountainburg soils in Capability unit VIIs–3; pasture and hayland group 14B; woodland suitability group 5x3; Sandstone Ridge range site.

NSD—Nella soils, rolling. The soils in this undifferentiated group are on benches and foot slopes. Slopes range from 8 to 20 percent. Areas range from 50 to 200 acres in size. These Nella soils are in areas large enough to map separately, but they were not separated because of poor accessibility and low intensity of use.

This mapping unit is about 10 to 50 percent Nella stony fine sandy loam, 10 to 50 percent Nella gravelly fine sandy loam, and 20 to 60 percent Nella fine sandy loam. The rest of the mapping unit is small areas of Enders, Leesburg, and Mountainburg soils and Rock outcrop.

These soils are used as woodland, and management requirements are not greatly different for the several phases. Generally, the stony and gravelly soils are steeper. These soils have profiles similar to the one described as representative for the series except the surface layer is fine sandy loam or stony fine sandy loam in many areas.

Runoff is rapid, and the hazard of erosion is severe on these soils. They are not suited to cultivated crops and they are poorly suited to pasture. The soils are better suited to wildlife habitat or woodland than they are to other uses. A few small areas are used as pasture or range. Surface stones and slopes make pasture management difficult. Adapted pasture plants are bermudagrass, bahiagrass, tall fescue, annual lespedeza, and sericea lespedeza. Capability unit VIe–2; pasture and hayland group 8B; woodland suitability group 3o7; not assigned to a range site.

NSE—Nella soils, steep. The soils in this undifferentiated group are on benches and foot slopes. Slopes range from 20 to 40 percent. Areas range from 50 to 200 acres in size. These Nella soils are in areas large enough to map separately, but they were not separated because of poor accessibility and low intensity of use.

This mapping unit is about 40 to 60 percent Nella stony fine sandy loam, 30 to 50 percent Nella gravelly fine sandy loam, and 10 to 20 percent Nella fine sandy loam. The rest of the mapping unit is small areas of Enders, Leesburg, and Mountainburg soils and Rock outcrop.

These soils are used as woodland, and management requirements are not greatly different for the several phases. Generally, the stony and gravelly soils are steeper. These soils have profiles similar to the one described as representative for the series except the surface layer is fine sandy loam or stony fine sandy loam in many areas.

Runoff is very rapid, and the hazard of erosion is very severe on these soils. They are not suited to cultivated crops, and they are poorly suited to pasture. These soils are better suited to wildlife habitat or woodland than they are to other uses. Most areas are forested with upland hardwood and shortleaf pine trees. Capability unit VIIe–1; pasture and hayland group 8B; woodland suitability group 3r8; not assigned to a range site.

Pickwick Series

The Pickwick series consists of well drained, nearly level to gently sloping soils on stream terraces. These soils formed in alluvium washed from uplands of weathered sandstone and shale. The native vegetation was mainly hardwood trees and some pines.

In a representative profile the surface layer is dark brown silt loam about 6 inches thick. The subsoil extends to a depth of 72 inches or more. The upper 6 inches is yellowish red loam; the next 23 inches is red silty clay loam; the next 17 inches is dark red silty clay loam; and the lower 20 inches is dark red, mottled silty clay loam.

Pickwick soils are moderate to low in natural fertility. Permeability is moderate, and the available water capacity is high. These soils respond well to fertilization.

Pickwick soils are suited to cultivated crops when erosion is controlled. Most areas are cleared and were cultivated in the past, but they are now used mainly as pasture and meadow. These soils are easy to till.

Representative profile of Pickwick silt loam, 3 to 8 percent slopes, in a moist pasture in the SE¼SE¼SW¼ sec. 6, T. 9 N., R. 23 W:

Ap—0 to 6 inches; dark brown (7.5YR 4/4) silt loam; weak fine granular structure; friable; many fine roots; few pores; medium acid; abrupt smooth boundary.

B1—6 to 12 inches; yellowish red (5YR 4/6) loam; weak fine subangular blocky structure; friable; common fine roots; few pores; slightly acid; clear smooth boundary.

B21t—12 to 35 inches; red (2.5YR 4/6) silty clay loam; moderate medium subangular blocky structure; friable; common patchy clay films on faces of peds; common fine roots; few pores; very strongly acid; gradual smooth boundary.

B22t—35 to 52 inches; dark red (2.5YR 3/6) silty clay loam; moderate medium subangular blocky structure; friable; common patchy clay films on faces of peds; few fine roots; few pores; very strongly acid; gradual smooth boundary.

B23t—52 to 72 inches; dark red (10R 3/6) silty clay loam; common medium distinct grayish brown (10YR 5/2) and pale brown (10YR 6/3) mottles; moderate medium subangular blocky structure; firm; many patchy clay films on faces of peds; few fine roots; few pores; very strongly acid.

The Ap horizon is dark brown or reddish brown. The B1 horizon is reddish brown or yellowish red loam or silt loam. The B2t horizon is yellowish red to dark red clay loam or silty clay loam and is mottled in the lower part in some profiles. Reaction is slightly acid to strongly acid in the A and B1 horizons and strongly acid or very strongly acid in the B2 horizon.

Pickwick soils are associated with Cane, Leadvale, Nella, Spadra, and Taft soils. They are better drained than and do not have the fragipan horizon characteristic of Cane, Leadvale, and Taft soils. They are redder and contain more silt and clay than Spadra soils. They have fewer coarse fragments than Nella soils.

PcB—Pickwick silt loam, 1 to 3 percent slopes. This soil is on stream terraces. Areas range from about 10 to 400 acres in size. Included in mapping are a few areas of Cane, Leadvale, Nella, Spadra, and Taft soils and areas of soils that have a gravelly surface layer.

Although the hazard of erosion is moderate, this soil is suited to cultivated crops. Clean-tilled crops that leave a large amount of residue can be safely grown year after year if management is good and includes contour cultivation and terracing on long slopes. Sown crops can be grown without attention to row direction.

This soil is used mainly as pasture or meadow. It is suited to such crops as soybeans, grain sorghum, winter small grains, truck crops, peaches, and grapes, and these are grown in a few areas. Adapted pasture plants include bahiagrass, bermudagrass, tall fescue, white clover, sericea lespedeza, and annual lespedeza. Capability unit IIe–1; pasture and hayland group 8A; woodland suitability group 3o7; not assigned to a range site.

PcC—Pickwick silt loam, 3 to 8 percent slopes. This soil is on stream terraces. Areas range from about 10 to 400 acres in size. This soil has the profile described as representative for the series. Included in mapping are a few areas of Cane, Leadvale, and Nella soils and a few small areas of soils that have a gravelly surface layer.

Runoff is medium, and the hazard of erosion is severe on this soil. It is suited to cultivated crops. Clean-tilled crops that leave a large amount of residue can be safely grown year after year on the less sloping areas if management is good and includes contour cultivation and terracing. Conservation treatment must be intensified where slopes are longer and steeper than most.

This soil is used mainly as pasture or meadow. It is suited to such crops as soybeans, grain sorghum, winter small grains, truck crops, peaches, and grapes, and these crops are grown in a few areas. Adapted pasture plants include bahiagrass, bermudagrass, tall fescue, white clover, sericea lespedeza, and annual lespedeza. Capability unit IIIe–1; pasture and hayland group 8A; woodland suitability group 3o7; not assigned to a range site.

Rock Outcrop

Rock outcrop consists of sandstone outcrops. It is along the margins of ridges and mountaintops as nearly vertical bluffs 30 to 100 feet high and as narrow bands around the margins of mountainside benches. Slope ranges from about 40 percent to nearly vertical.

The surface layer of this land type typically is bare sandstone rock, but in scattered areas it is gravelly or stony sandy loam a few inches thick over sandstone.

This mapping unit is not suited to any agricultural use. Vegetation is sparse. Areas of rock outcrop can be used for wildlife habitat. In Johnson County, Rock outcrop is mapped only in association with Mountainburg soils.

Roellen Series

The Roellen series consists of poorly drained, level soils in slack water areas along the Arkansas River. These soils formed in clayey sediment. The native vegetation was hardwood trees.

In a representative profile the surface layer is very dark gray clay about 8 inches thick. The subsoil

extends to a depth of 72 inches or more. The upper 8 inches is very dark gray, mottled clay; the next 21 inches is dark gray, mottled clay; and the lower 35 inches is dark grayish brown, mottled clay.

Roellen soils are high in natural fertility. Permeability is slow, and the available water capacity is high. These soils respond well to fertilization.

These soils are suited to most crops grown in the county if they are adequately drained. Most of the acreage is cultivated. Some of these soils are subject to occasional flooding in winter, but this does not seriously limit their use for farming. Clods form and the soils are difficult to till if they are plowed when too wet. They shrink and crack when dry, and when wet, they expand and the cracks seal.

Representative profile of Roellen clay in a moist field in the SW¼SE¼NW¼ sec. 18, T. 9 N., R. 23 W:

Ap—0 to 8 inches; very dark gray (10YR 3/1) clay, weak fine granular structure; firm; plastic; many fine roots; few pores; slightly acid; abrupt smooth boundary.

B21g—8 to 16 inches; very dark gray (10YR 3/1) clay; few fine faint dark yellowish brown mottles; moderate medium angular blocky structure; firm; very plastic; common fine roots; few pores; many slickensides; common pressure faces; slightly acid; gradual smooth boundary.

B22g—16 to 37 inches; dark gray (10YR 4/1) clay; common fine faint dark yellowish brown mottles; moderate medium angular blocky structure; firm; very plastic; few fine roots; few pores; many slickensides; common pressure faces; slightly acid; gradual smooth boundary.

B23—37 to 63 inches; dark grayish brown (10YR 4/2) clay, common fine faint dark yellowish brown mottles; moderate medium angular blocky structure; firm; very plastic; many slickensides; common pressure faces; neutral; clear wavy boundary.

B3—63 to 72 inches; dark grayish brown (10YR 4/2) clay; common fine faint dark yellowish brown mottles; weak medium angular blocky structure; firm; very plastic; common slickensides; common pressure faces; mildly alkaline.

The A horizon is very dark gray or very dark grayish brown. The B2g horizon is very dark gray or dark gray. The B23 and B3 horizons are dark gray to dark grayish brown. Reaction ranges from medium acid to neutral in the A horizon and from slightly acid to mildly alkaline in the B horizon.

Roellen soils are associated with Caspiana and Moreland soils. They are grayer than either of these soils and contain more clay than Caspiana soils.

Ro—Roellen clay. This soil is in slack-water areas of the flood plain of the Arkansas River. Slope is less than 1 percent. Areas are about 30 to 500 acres in size. Included in mapping are a few areas of Caspiana and Moreland soils.

This soil is suited to farming, but excess water is a severe limitation (fig. 9). Farming is delayed several days after a rain unless surface drains are installed. Clean-tilled crops that leave a large amount of residue can be safely grown year after year if management is good and includes adequate drainage.

The main crop is soybeans. Other suitable crops are grain sorghum, cotton, and rice. Winter small grains can be grown if surface drainage is adequate. Some areas are subject to occasional winter flooding. Adapted pasture plants are bermudagrass, bahiagrass, tall fescue, and white clover. Capability unit IIIw–1; pasture and hayland group 1A; woodland suitability group 2w6; not assigned to a range site.

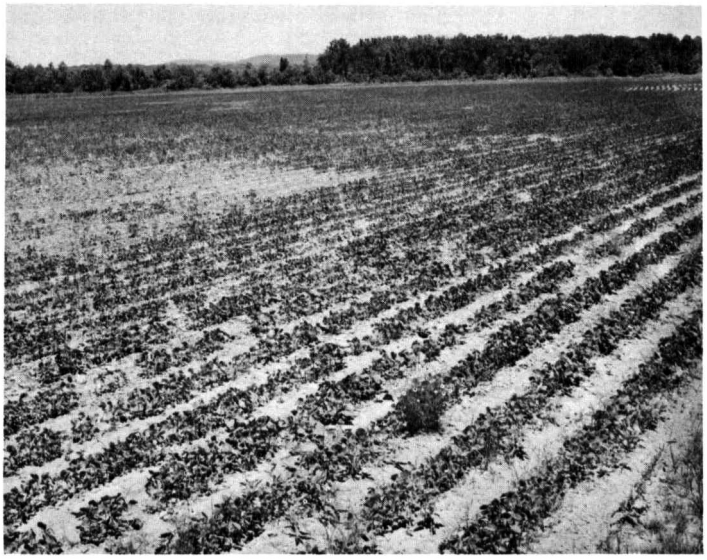

Figure 9.—**Stand of soybeans on Roellen Clay, which has poor surface drainage.**

Spadra Series

The Spadra series consists of well drained, nearly level soils on low stream terraces along the larger upland streams. These soils formed in alluvium washed from uplands derived from weathered sandstone and shale. The native vegetation was mainly hardwoods with some pine trees.

In a representative profile the surface layer is brown fine sandy loam about 8 inches thick. The subsoil extends to a depth of 55 inches. The upper 13 inches is yellowish red sandy clay loam; the next 18 inches is reddish brown sandy clay loam; and the lower 16 inches is reddish brown fine sandy loam. The underlying material is reddish brown fine sandy loam.

Spadra soils are moderate in natural fertility. Permeability is moderate, and the available water capacity is medium. These soils respond well to fertilization.

Most areas of these soils are subject to occasional flooding. Nearly all areas have been cleared and are cultivated or used as pasture or meadow. These soils are easy to till and can be cultivated over a wide range of moisture content.

Representative profile of Spadra fine sandy loam, 1 to 3 percent slopes, in a moist pasture in the NE¼NW¼SE¼ sec. 8, T. 9 N., R. 23 W:

Ap—0 to 8 inches; brown (7.5YR 4/4) fine sandy loam; weak fine granular structure; very friable; many fine roots; few pores; strongly acid; abrupt smooth boundary.

B21t—8 to 21 inches; yellowish red (5YR 4/6) sandy clay loam; weak fine subangular blocky structure; friable; common patchy clay films on faces of peds; common fine roots; few pores; strongly acid; gradual smooth boundary.

B22t—21 to 39 inches; reddish brown (5YR 4/4) sandy clay loam; weak fine subangular blocky structure; friable; common patchy clay films on faces of peds; few fine roots; few pores; strongly acid; gradual smooth boundary.

B3—39 to 55 inches; reddish brown (5YR 4/4) fine sandy loam; weak fine subangular blocky structure; friable; common patchy clay films on faces of peds; few fine roots; few pores; strongly acid; gradual smooth boundary.

C—55 to 72 inches; reddish brown (5YR 4/4) fine sandy loam; massive; friable; few fine roots; few pores; strongly acid.

The A horizon is brown to reddish brown. Some profiles have a B1 horizon, 4 to 12 inches thick, that is brown or reddish brown fine sandy loam or loam. The B2t horizon is brown to dark reddish brown loam or sandy clay loam. The B3 horizon is brown or reddish brown fine sandy loam or sandy loam. The C horizon is brown or reddish brown fine sandy loam, sandy loam, gravelly fine sandy loam, or gravelly sandy loam.

The A and B horizons are 0 to 10 percent coarse fragments, and the C horizon is 0 to 35 percent coarse fragments. Reaction is strongly acid or very strongly acid in the A horizon unless the soil is limed. Reaction is strongly acid or very strongly acid in the B and C horizons.

Spadra soils are associated with Ceda, Guthrie, Leadvale, and Pickwick soils. They contain less sand and more clay and have a B horizon, which the Ceda soils do not have. They are browner and better drained and do not have the fragipan characteristic of Guthrie and Leadvale soils. Spadra soils have a more weakly developed, thinner B horizon and are less red than Pickwick soils.

SpB—Spadra fine sandy loam, 1 to 3 percent slopes. This nearly level soil is on low stream terraces on the flood plains of the larger upland streams. Individual areas range from about 5 to 120 acres in size. Included in mapping are a few areas of Ceda, Guthrie, Leadvale, and Pickwick soils and a few areas of soils that have a gravelly surface layer.

This soil is suited to farming. Most areas are occasionally flooded, but floods rarely occur between June and January. Clean-tilled, warm-season crops that leave large amounts of residue can be safely grown year after year if good management that includes contour cultivation is used.

This soil is used mainly as pasture or meadow. Suitable crops include corn, grain sorghum, soybeans, and truck crops. Winter small grains can be grown, but the crop may be damaged by floods some years. Adapted pasture plants are bermudagrass, tall fescue, bahiagrass, and white clover. Capability unit IIe–2; pasture and hayland group 8A; woodland suitability group 2o7; not assigned to a range site.

Taft Series

The Taft series consists of somewhat poorly drained, level soils on stream terraces in broad valleys. These soils formed in loamy alluvium washed from uplands derived from weathered sandstone and shale. The native vegetation was mixed hardwood trees and some pine trees.

In a representative profile the surface layer is dark grayish brown silt loam about 4 inches thick. The subsurface layer is yellowish brown, mottled silt loam about 4 inches thick. The subsoil extends to a depth of 72 inches or more. The upper 11 inches is yellowish brown, mottled, friable silt loam, and the next 21 inches is a firm, brittle fragipan. The upper inch of the fragipan is light gray silt loam, and the lower 20 inches is mottled light gray, yellowish brown, and red silty clay loam. The lower 32 inches of the subsoil is mottled light gray and yellowish brown, firm silty clay.

Taft soils are low in natural fertility. Permeability is slow, and the available water capacity is medium. The firm, brittle layer in the subsoil restricts root penetration and slows the movement of water through the soil. These soils respond well to fertilization.

The soils are suited to most crops grown in the county if they are drained and well managed. Most areas are used as pasture or meadow. They are easy to till, but they contain excess water for long periods after rain.

Representative profile of Taft silt loam in a moist pasture in the SE¼SE¼NE¼ sec. 2, T. 9 N., R. 24 W.:

Ap—0 to 4 inches; dark grayish brown (10YR 4/2) silt loam; few fine faint brown mottles; weak fine subangular blocky structure; friable; many fine roots; common pores; strongly acid; abrupt wavy boundary.

A2—4 to 8 inches; yellowish brown (10YR 5/6) silt loam; common medium faint pale brown (10YR 6/3) and few fine distinct light gray mottles; weak fine subangular blocky structure; friable; common fine roots; common pores; very strongly acid; clear wavy boundary.

B2—8 to 19 inches; yellowish brown (10YR 5/6) silt loam; many medium distinct light gray (10YR 6/1) mottles; weak fine and medium subangular blocky structure; friable; common fine roots; common pores; very strongly acid; abrupt wavy boundary.

A'2—19 to 20 inches; light gray (10YR 7/1) silt loam; weak fine subangular blocky structure; friable; slightly brittle; few fine roots; few pores; very strongly acid; abrupt irregular boundary.

B'x1—20 to 40 inches; mottled light gray (10YR 6/1), yellowish brown (10YR 5/6), and red (2.5YR 4/8) silty clay loam; common tongues of light gray (10YR 6/1) silt loam; moderate medium subangular blocky structure; firm; brittle; common patchy clay films on faces of peds; common fine pores; many fine dark colored concretions; strongly acid; gradual wavy boundary.

B'2t—40 to 72 inches; mottled light gray (10YR 6/1) and yellowish brown (10YR 5/8) silty clay; tongues of light gray (10YR 6/1) silt loam; moderate medium subangular blocky structure; firm; continuous clay films on faces of peds; strongly acid.

The Ap or A1 horizon is dark grayish brown to brown. The A2 horizon is brown or yellowish brown silt loam. The B2 horizon is grayish brown to yellowish brown silt loam or loam. The A'2 horizon is light gray or light brownish gray. Depth to the B'x horizon ranges from 18 to 26 inches. The B'x horixon is silt loam or silty clay loam. The B'2t horizon is silty clay or silty clay loam. Depth to bedrock is 60 to more than 96 inches. Reaction is medium acid to very strongly acid in the A horizon and strongly acid or very strongly acid in the A'2 and B horizons.

Taft soils are associated with Cane, Guthrie, and Leadvale soils. They are grayer and contain less sand than Cane soils. Taft soils have mottling in the upper part of the B horizon, and Leadvale soils do not. They are browner and better drained in the upper part of the B horizon than Guthrie soils.

Ta—Taft silt loam. This soil is on old stream terraces in broad valleys. Slope is less than 1 percent. Areas range from about 5 to 100 acres in size. Included in mapping are a few small areas of low,

rounded mounds and areas of Cane, Guthrie, and Leadvale soils.

Runoff is slow, and excessive water is a severe limitation on this soil. It is suited to cultivated crops if it is drained and well managed. Farming is delayed several days after a rain unless surface drains are installed. Clean tilled crops that leave a large amount of residue can be safely grown year after year if management is good and includes adequate drainage.

This soil is used mainly as pasture and meadow. Among the suitable crops are soybeans and grain sorghum. Winter small grains can be grown if surface drainage is adequate. Adapted pasture plants are bermudagrass, bahiagrass, tall fescue, white clover, annual lespedeza, and sericea lespedeza. Capability unit IIIw–2; pasture and hayland group 8F; woodland suitability group 3w8; not assigned to a range site.

Udorthents

Ud—Udorthents. This unit consists of mixed shale, sandstone, and soil material of the original mantle. This material has been stripped from coal beds.

In mining operations the removal of material overlying the coal has left long pits and ridges and piles of excavated material.

Slopes are steep, runoff is rapid, and the hazard of erosion is very severe. A few small areas have been smoothed. Included with this unit in mapping are gravel pits, borrow pits, and rock quarries where no soil remains.

This mapping unit is not suited to cultivated crops, and most areas are idle. In places, native grasses and trees have become established where there is a source of seed nearby. A few areas have been planted to introduced or native grasses, but the results are generally poor. Trees have been planted on some tracts, but survival has been only fair to poor, and the growth rate is moderate to slow. This mapping unit is better suited to wildlife habitat and recreation than it is to other uses. Capability unit VIIs–4; pasture and hayland group 17B; woodland suitability group 5r9; not assigned to a range site.

Use and Management of the Soils

In this section the soils are discussed in relation to their use, suitability, and limitations for crops, pasture and hayland, wildlife, woodland, range, engineering, town and country planning, and recreation.

Use of the Soils for Crops[2]

In this section the management of soils in Johnson County for crops is discussed, and the system of capability grouping used by the Soil Conservation Service is explained. A table showing predicted yields under improved management is provided.

Most cleared areas in the county are used for small grains, pasture, and range. Small acreages are in orchards, vineyards, and truck farms, all of which are important agricultural enterprises in the county. A small acreage is used for row crops.

In general, the soils in this county are low in nitrogen, potassium, phosphorus, calcium, and organic matter. Many of those suited to cultivated crops are erodible. Poor surface or internal drainage are limitations on some soils. Many soils are poorly suited or unsuited to intensive use because of stony conditions, shallow depth to bedrock, high content of coarse fragments within the soil, or combinations of these features.

Contour cultivation, vegetated waterways, and terraces in many fields are needed on sloping soils that are used for tilled crops. Row arrangement and surface drains are needed for dependable growth on wet areas.

Annual cover crops or grasses and legumes should be grown regularly in the cropping system if the hazard of erosion is severe or if the crops that are grown leave only small amounts of residue. Crop residue should be shredded and spread evenly to provide protective cover and active organic matter to the soils. Minimum tillage should be practiced to the extent practical for the soil conditions and the crop requirements.

The kinds and amounts of fertilizer and lime applied are generally based on soil tests, kinds of crops to be grown, past experiences, capacity of the soil to produce, and expected yields. Cultivated crops such as corn and cotton, and pasture plants such as bermudagrass, bahiagrass, tall fescue, hop clover, and lespedezas generally grow well on adapted soils without the application of agricultural limestone. However, limestone is needed where high rates of acid-forming fertilizers are used or where crops such as alfalfa, sweet clover, and white clover that require a high lime content are grown.

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. These readers can make good use of the capability classification system, a grouping that shows, in a general way, the suitability of soils for most kinds of farming.

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 forest trees, for engineering, or for town and country planning.

[2] W. WILSON FERGUSON, conservation agronomist, Soil Conservation Service, helped prepare this section.

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 used. 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 up to 4 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 stormy; and *c* indicates that the chief limitation is climate that is too cold or too dry.

In class I here 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, that they require about the same management, and that they have generally similar productivity and other responses to management. Capability units are generally identified by numbers assigned locally, for example, IIe–1 or IIIs–1.

The eight classes in the capability system and the subclasses and units in Johnson County are described in the list that follows. The unit designation is given in the Guide to Mapping Units.

Class I. Soils having few limitations that restrict their their use.
- Unit I–1. Level, well drained, deep, loamy soils on bottom lands.

Class II. Soils having moderate limitations that reduce the choice of plants or that require moderate conservation practices.
- Subclass IIe. Soils subject to moderate erosion unless they are protected.
  - Unit IIe–1. Nearly level, moderately well drained and well drained, deep and moderately deep loamy soils on uplands.
  - Unit IIe–2. Nearly level, well drained, deep, loamy soils on stream terraces subject to occasional flooding.
- Subclass IIw. Soils moderately limited because of excess water.
  - Unit IIw–1. Level, somewhat poorly drained, deep, clayey soils on bottom lands.

Class III. Soils having severe limitations that reduce the choice of plants, that require special conservation practices, or both.
- Subclass IIIe. Soils subject to severe erosion if they are cultivated and are not protected.
  - Unit IIIe–1. Gently sloping, moderately well drained and well drained, moderately deep and deep, loamy soils on uplands.
- Subclass IIIw. Soils severely limited for cultivated crops because of excess water.
  - Unit IIIw–1. Level, poorly drained, deep, clayey soils on bottom lands.
  - Unit IIIw–2. Level, somewhat poorly drained, deep, loamy soils on uplands.
- Subclass IIIs. Soils severely limited because of low available water capacity.
  - Unit IIIs–1. Level and nearly level, excessively drained, deep, stratified, sandy soils on bottom lands.

Class IV. Soils having very severe limitations that reduce the choice of plants, require very careful management, or both.
- Subclass IVe. Soils subject to very severe erosion if they are cultivated and are not protected.
  - Unit IVe–1. Moderately sloping, well drained, deep and moderately deep, loamy soils on uplands.
  - Unit IVe–2. Gently sloping, well drained, deep, loamy soils that have a clayey subsoil, on uplands.
  - Unit IVe–3. Gently sloping and moderately sloping, well drained, shallow, loamy soils on uplands.
- Subclass IVw. Soils very severely limited for cultivated crops because of excess water.
  - Unit IVw–1. Level to depressional, poorly drained, deep, loamy soils on uplands.

Class V. (None in Johnson County.) Soils having limitations other than the hazard of erosion that make them impractical to remove and that limit their use largely to pasture, range, woodland, or wildlife habitat.

Class VI. Soils having severe limitations that make them generally unsuited to cultivated crops and that limit their use largely to pasture or range, woodland, or wildife habitat.
- Subclass VIe. Soils severely limited, chiefly by the hazard of erosion, unless protective cover is maintained.
  - Unit VIe–1. Gently sloping and moderately sloping, well drained, deep, loamy soils that have a clayey subsoil, on uplands.
  - Unit VIe–2. Moderately sloping and moderately steep, well drained, deep and moderately deep, loamy soils on uplands.
- Subclass VIs. Soils severely limited, chiefly by low available water capacity and stones.
  - Unit VIs–1. Nearly level to moderately sloping, well drained, shallow, stony soils on uplands.

Class VII. Soils having very severe limitations that make them unsuited to cultivated crops and that restrict their use mainly to pasture or range, woodland, or wildlife habitat.

Subclass VIIe. Soils very severely limited, chiefly by the hazard of erosion, unless protective cover is maintained.
Unit VIIe–1. Steep and very steep, well drained, deep, loamy soils on uplands.
Subclass VIIs. Soils very severely limited, mainly by low available water capacity and stones.
Unit VIIs–1. Level and nearly level, well drained, deep, cobbly, loamy soils on flood plains of small streams that are subject to frequent flooding.
Unit VIIs–2. Moderately sloping to very steep, well drained, deep, stony and loamy soils that have a clayey subsoil, on uplands.
Unit VIIs–3. Moderately sloping to very steep, well drained, shallow, stony and loamy soils on uplands.
Unit VIIs–4. Steep to very steep, well drained, deep, loamy and stony soils on uplands.
Class VIII. Soils and landforms having limitations that preclude their use for commercial crop production and that restrict their use to recreation, wildlife habitat, water supply, or esthetic purposes. (None in Johnson County.)

Predicted yields

Table 2 lists predicted yields of the principal crops grown in the county. The predictions are based on estimates made by farmers, soil scientists, agronomists, and others who have knowledge of yields in the county, and on information based on research data. The predicted yields are average yields per acre that can be expected by good commercial farmers at the level of management that tends to produce the highest economic returns.

Crops other than those shown in table 2 are grown in the county, but their predicted yields are not included because their acreage is small or reliable data on yields are not available.

The predicted yields given in table 2 can be expected if the following management practices are used.

1. Rainfall is effectively used and conserved.
2. Surface drainage systems are installed.
3. Crop residue is managed to maintain soil tilth.
4. Minimum but timely tillage is used.
5. Insect, disease, and weed control measures are consistently used.
6. Fertilizers are supplied according to soil tests and crop needs.
7. Adapted crop varieties are used at recommended seeding rates.

Use of the Soils for Pasture and Hayland [3]

General guidelines for managing soils for pasture and hay are described in this section. Following this, the soils in the county are placed, according to suitability, in 13 pasture and hayland groups, and each group is described. Those who wish to know the pasture and hayland group of a soil can refer to the "Guide to Mapping Units" at the back of this survey. Those desiring more detailed information about the management of soils for these uses can refer to the section "Descriptions of the Soils."

A large part of the cleared land in Johnson County is used as pasture and hayland. Perennial grasses or legumes or mixtures of these are grown for pasture and hay. The mixtures generally consist of either a summer perennial grass or a winter perennial grass and a suitable legume.

Coastal bermudagrass, common bermudagrass, and bahiagrass are the summer perennials most commonly grown. Coastal bermudagrass and bahiagrass are fairly new to the county, but both are highly satisfactory in production of good-quality forage. Johnsongrass is also suited to many of the soils in the county. Tall fescue is the main winter perennial grass grown in the county. All of these grasses respond well to fertilizers and particularly well to nitrogen.

White clover, alfalfa, vetch, crimson clover, annual lespedeza, and sericea lespedeza are the most commonly grown legumes.

Management and maintenance

Proper grazing is essential for the production of high quality forage, stand survival, and erosion control. This requires leaving sufficient top growth on the plants during the growing season to maintain vigorous, healthy growth. It also requires exclusion of livestock or restricted grazing of tall fescue during summer. Brush control is essential, and weed control is often needed.

Rotation grazing and renovation are also important measures in a good pasture and hayland management program.

Pasture and hayland suitability groups

Soils have been placed, according to similar suitability, into pasture and hayland groups. These groups assist land users in the selection of suitable forage plants. They are described in the following paragraphs. The soils included in each group support similar kinds of forage plants and require similar treatment and management. Forage production for one soil in the group is essentially the same as for other soils in the group when management and treatment are the same. Failure to control brush results in an eventual stand of trees and a gradual reduction of forage.

Yields of pasture are given in the section "Predicted Yields." Grazing data are estimated in terms of animal-unit-months. An animal-unit-month (A.U.M.) is the amount of forage or feed required to maintain one animal unit—one cow, one horse, or five sheep—for a period of 30 days.

PASTURE AND HAYLAND GROUP 1A

In this group are deep, clayey soils on bottom lands. They are slowly permeable to very slowly permeable and are poorly drained to somewhat poorly drained. Some areas are subject to occasional flooding. These soils have a high potential for growing such forage

[3] W. WILSON FERGUSON, conservation agronomist, Soil Conservation Service, helped prepare this section.

TABLE 2.—*Predicted average yields per acre of principal crops under an improved level of management*

[Absence of a figure indicates the crop is not suited or is not commonly grown]

Soil	Corn	Soybeans	Cotton	Wheat	Grapes	Peaches	Tall fescue	Bermuda-grass	Bahia-grass
	Bu	*Bu*	*Lb of lint*	*Bu*	*Tons*	*Bu*	*A.U.M.*[1]	*A.U.M.*[1]	*A.U.M.*[1]
Bruno loamy fine sand		20	400	30				5.5	5.5
Cane fine sandy loam, 1 to 3 percent slopes	65	30		35	6	210	6.0	6.0	7.0
Cane fine sandy loam, 3 to 8 percent slopes	60	25		30	6	200	6.0	6.0	7.0
Caspiana silt loam	75	40	800	40			8.5	8.5	9.0
Ceda cobbly fine sandy loam									
Enders gravelly fine sandy loam, 5 to 15 percent slopes							4.0	5.0	5.5
Enders-Mountainburg association, rolling									
Enders-Mountainburg association, steep									
Guthrie silt loam							5.5	5.5	6.0
Leadvale silt loam, 1 to 3 percent slopes		30		35	6		7.0	6.5	7.5
Leadvale silt loam, 3 to 8 percent slopes		25		30	6		6.5	6.5	7.0
Leesburg association, rolling							5.5	5.5	6.0
Leesburg association, steep									
Leesburg-Enders association, steep									
Leesburg-Enders association, very steep									
Linker fine sandy loam, 1 to 3 percent slopes		25		30	8	200	6.0	6.0	6.5
Linker fine sandy loam, 3 to 8 percent slopes		20		25	8	180	5.5	5.5	6.0
Linker fine sandy loam, 8 to 12 percent slopes					7	170	5.0	5.0	5.5
Linker association, rolling							5.5	5.0	5.5
Linker-Mountainburg association, rolling.									
Linker soils							5.0	4.5	5.0
Mountainburg soils									
McKamie silt loam, 3 to 8 percent slopes				25			5.0	5.0	5.5
Moreland clay	50	35	650	30			7.0	7.0	7.5
Morganfield silt loam		40	1,000	40			8.0	8.0	8.5
Mountainburg gravelly fine sandy loam, 3 to 12 percent slopes						150	4.0	5.0	5.5
Mountainburg stony fine sandy loam, 1 to 12 percent slopes							3.5	4.5	5.0
Mountainburg stony fine sandy loam, 12 to 65 percent slopes									
Mountainburg-Enders association, rolling									
Mountainburg-Enders association, steep									
Mountainburg-Enders association, very steep									
Mountainburg-Rock outcrop association, very steep									
Muskogee silt loam, 1 to 3 percent slopes	65	25		30			7.0	7.0	7.5
Nella gravelly fine sandy loam, 1 to 3 percent slopes	65			30	6	210	6.5	6.5	7.0
Nella gravelly fine sandy loam, 3 to 8 percent slopes	50			25	6	200	6.0	6.0	6.5
Nella gravelly fine sandy loam, 8 to 12 percent slopes							5.5	5.5	6.0
Nella-Enders association, rolling.									
Nella soils							5.0	5.0	5.5
Enders soils									
Nella-Enders association, steep									
Nella-Enders association, very steep									

See footnote at end of table.

TABLE 2.—*Predicted average yields per acre of principal crops under an improved level of management*—Continued

Soil	Corn	Soybeans	Cotton	Wheat	Grapes	Peaches	Tall fescue	Bermuda-grass	Bahia-grass
	Bu	*Bu*	*Lb of lint*	*Bu*	*Tons*	*Bu*	*A.U.M.*[1]	*A.U.M.*[1]	*A.U.M.*[1]
Nella-Mountainburg association, rolling.									
Nella soils							5.0	5.0	5.5
Mountainburg soils									
Nella-Mountainburg association, steep									
Nella-Mountainburg association, very steep									
Nella soils, rolling							5.0	5.0	5.5
Nella soils, steep									
Pickwick silt loam, 1 to 3 percent slopes	75	30		35	6	220	7.0	7.0	7.5
Pickwick silt loam, 3 to 8 percent slopes	70	25		30	6	210	6.5	6.5	7.0
Roellen clay	50	35	550	30			6.0	6.0	7.0
Spadra fine sandy loam, 1 to 3 percent slopes	75	30		30	6		7.0	7.0	7.5
Taft silt loam		25					7.0	6.0	6.5
Udorthents									

[1] Animal unit months. The figures represent the number of months that 1 acre will provide grazing for 1 animal unit (1,000 pounds live weight), or the number of months the pasture can be grazed multiplied by the number of animal units an acre will support. For example, 1 acre of Cane fine sandy loam in an improved pasture of tall fescue will provide grazing for 2 animals for 3 months, so it has a rating of 6 animal-unit-months.

plants as bermudagrass, tall fescue, bahiagrass, and white clover.

PASTURE AND HAYLAND GROUP 2A

In this group are deep soils that are loamy throughout. They are moderately permeable and are well drained. Some are subject to occasional flooding. These soils have a high potential for growing such forage plants as bermudagrass, tall fescue, bahiagrass, and white clover.

PASTURE AND HAYLAND GROUP 2B

Ceda cobbly fine sandy loam is the only soil in this group. It is a deep, loamy soil that is cobbly throughout. This soil is rapidly permeable, and it is well drained. It is on flood plains and is subject to frequent flooding. Surface cobbles severely limit the use of farm equipment. This soil has a low potential for growing such forage plants as bermudagrass, bahiagrass, and annual lespedeza.

PASTURE AND HAYLAND GROUP 3B

Bruno loamy fine sand is the only soil in this group. It is a deep, sandy soil. This soil is rapidly permeable, and it is excessively drained. Some areas of this soil are subject to occasional flooding. This soil has a low to moderately low potential for growing such forage plants as bermudagrass, weeping lovegrass, johnsongrass, and crimson clover.

PASTURE AND HAYLAND GROUP 8A

In this group are moderately deep and deep, loamy soils that have a loamy or clayey subsoil. Some have a fragipan, and some are gravelly. These soils are slowly permeable to moderately permeable and are moderately well drained to well drained. The soils in this group are on uplands and stream terraces. Some are subject to occasional flooding. These soils have a moderately high potential for growing such forage plants as bermudagrass, bahiagrass, tall fescue, white clover, annual lespedeza, and sericea lespedeza.

PASTURE AND HAYLAND GROUP 8B

In this group are moderately deep to deep, loamy soils. They are moderately permeable and are well drained. These soils are on uplands, and because of slope, they are difficult to manage for forage production with conventional equipment. They have a moderate potential for growing such forage plants as bermudagrass, bahiagrass, tall fescue, annual lespedeza, and sericea lespedeza.

PASTURE AND HAYLAND GROUP 8C

In this group are moderately deep to deep soils on uplands and terraces. They have a loamy surface layer and a predominantly clayey subsoil, and some are gravelly. They are very slowly permeable and are well drained. These soils have a moderately low potential for growing such forage plants as bermudagrass, bahiagrass, annual lespedeza, and sericea lespedeza.

PASTURE AND HAYLAND GROUP 8D

In this group are moderately deep to deep, predominantly stony soils on uplands. They have a loamy surface layer and are clayey throughout most of the subsoil. They are very slowly permeable and are well drained. Surface stones and slope make these soils difficult to manage using conventional equipment for forage production. These soils have a moderately low to low potential for growing such forage plants as bermudagrass, bahiagrass, tall fescue, annual lespedeza, and sericea lespedeza.

PASTURE AND HAYLAND GROUP 8F

In this group are deep, loamy soils that have a fragipan. They are slowly permeable and are somewhat poorly drained to poorly drained. They are on stream terraces in broad valleys. These soils have a moderately high potential for growing such forage plants as bermudagrass, bahiagrass, tall fescue, white clover, annual lespedeza, and sericea lespedeza.

PASTURE AND HAYLAND GROUP 14B

In this group are shallow soils on uplands. They are loamy soils that have a high content of stones and pebbles throughout. These soils are droughty, and surface stones and slope limit the use of conventional equipment for forage production. These soils have a low potential for growing such forage plants as weeping lovegrass, tall fescue, bermudagrass, bahiagrass, annual lespedeza, and sericea lespedeza.

PASTURE AND HAYLAND GROUP 14C

Mountainburg stony fine sandy loam, 1 to 12 percent slopes, is the only soil in this group. It is a shallow soil on uplands. This soil is loamy, but it has a high content of stones and pebbles throughout. It is droughty, and surface stones limit the use of conventional equipment for forage production. This soil has a low potential for growing such forage plants as weeping lovegrass, tall fescue, bermudagrass, bahiagrass, annual lespedeza, and sericea lespedeza.

PASTURE AND HAYLAND GROUP 14D

Mountainburg gravelly fine sandy loam, 3 to 12 percent slopes, is the only soil in this group. It is a shallow soil on uplands. This soil is loamy but has a high content of gravel throughout. This soil is droughty. It has a low potential for growing such forage plants as weeping lovegrass, tall fescue, bermudagrass, bahiagrass, annual lespedeza, and sericea lespedeza.

PASTURE AND HAYLAND GROUP 17B

Udorthents is the only mapping unit in this group. It consists of mixed shale, sandstone, and soil material of the original mantle that has been stripped from coal beds. Steep slopes and stone fragments limit the use of conventional equipment for forage production. This soil has a very low potential for growing such forage plants as weeping lovegrass, bermudagrass, tall fescue, and bahiagrass.

Use of the Soils for Wildlife Habitat [4]

Soils directly influence kinds and amounts of vegetation and amounts of water available, and in this way indirectly influence the kinds of wildlife that can live in an area. Soil properties that affect the growth of wildlife habitat are thickness of soil useful to crops, surface texture, available water capacity, wetness, flood hazard, slope, and permeability of the soil to air and water.

In table 3 the soils of Johnson County are rated for producing seven elements of wildlife habitat and for three groups, or kinds, of wildlife. The ratings indicate relative suitability for various elements.

A rating of *good* means the element of wildlife and kinds of habitats generally are easily created, improved, and maintained. Few or no limitations affect management in this category, and satisfactory results are expected when the soil is used for the prescribed purpose.

A rating of *fair* means the element of wildlife habitat and kinds of habitats can be created, improved, or maintained in most places. Moderate intensity of management and fairly frequent attention may be required for satisfactory results, however.

A rating of *poor* means limitations for the element of wildlife habitat and the designated kinds of habitat are severe. Habitats can be created, improved, or maintained in most places, but management is difficult and requires intensive effort.

A rating of *very poor* means limitations for use of the soil for the element of wildlife habitat are very severe and that unsatisfactory results are to be expected. It is either impossible or impractical to create, improve, or maintain habitats on soils in this category.

The significance of each subheading in table 3 under "Elements of Wildlife Habitat" and "Kinds of Wildlife" is given in the following paragraphs.

Each soil is rated in table 3 according to its suitability for producing various kinds of plants and other elements that make up wildlife habitats. The ratings take into account mainly the characteristics of the soils and closely related natural factors of the environment. They do not take into account climate, present use of soils, or present distribution of wildlife and people. For this reason, selection of a site for development as a habitat for wildlife requires inspection of the site.

Grain and seed crops.—These crops are such annual grain producing plants as corn, sorghum, millet, and soybeans.

Grasses and legumes.—Domestic grasses and legumes that are established by planting make up this group. They provide food and cover for wildlife. Grasses include bahiagrass, ryegrass, and panicgrass; legumes include annual lespedeza, shrub lespedeza, and clovers.

Wild herbaceous plants.—This group consists of native or introduced perennial grasses, forbs, and weeds that provide food and cover for upland wildlife. Beggarweed, perennial lespedeza, wildbean, pokeweed, and cheatgrass are typical examples.

Hardwood woody plants.—These plants are nonconiferous trees, shrubs, and woody vines that produce wildlife food in the form of fruits, nuts, buds, catkins, or browse. Such plants commonly grow in their natural environment, but they may be planted and developed through wildlife management programs. Typical species are oak, beech, cherry, dogwood, maple, viburnum, grape, honeysuckle, greenbrier, and mulberry.

Coniferous plants.—These plants are cone-bearing trees and shrubs that provide cover and frequently furnish food in the form of browse, seeds, or fruitlike

[4] ROY A. GRIZZELL, biologist, Soil Conservation Service, helped prepare this section.

cones. They commonly grow in their natural environment, but they may be planted and managed. Typical plants are pines, cedars, and ornamental trees and shrubs.

Wetland plants.—Annual and perennial herbaceous plants that grow wild on wet or moist sites are in this group. They furnish food and cover mostly for wetland wildlife. Typical examples are smartweed, wild millet, spikerush and other rushes, sedges, burreed, cutgrasses, and arrowhead. Submersed and floating aquatics are not included in this category.

Shallow water developments.—These developments are impoundments or excavations for controlling water, generally not more than five feet deep, to create habitats that are suitable for waterfowl. Some are designed to be drained, planted, and then flooded; others are permanent impoundments that grow submersed aquatic plants.

In table 3 each soil is also rated according to its suitability as habitat for the three kinds of wildlife in the county—open land, woodland, and wetland. These ratings are related to ratings made for the elements of habitat. For example, soils rated very poor for shallow water developments are rated very poor for wetland wildlife.

Open-land wildlife.—Birds and mammals that normally live in meadows, pastures, and open areas where grasses, herb, and shrubby plants grow. Quail, doves, meadowlarks, field sparrows, cottontail rabbits, and foxes are typical examples of open-land wildlife.

Woodland wildlife.—Birds and mammals that normally live in wooded areas of hardwood trees, coniferous trees, and shrubs. Woodcocks, thrushes, wild turkeys, vireos, deer, squirrels, and raccoons are typical examples of woodland wildlife.

Wetland wildlife.—Birds and mammals that normally live in wet areas, marshes, and swamps. Ducks, geese, rails, shore birds, herons, minks, and muskrats are typical examples of wetland wildlife.

Use of the Soils for Woodland [5]

Trees cover about 69 percent of the county, including about 173,500 acres of public land in the Ozark National Forest.

Good to poor stands of commercial trees are growing in the woodlands of the county. Broadleaf forest types are dominant in the Boston Mountains in the northern part of the county, and mixed broadleaf and needleleaf types are dominant in the Arkansas Valley.

The value of the wood products is substantial, though it is far below its potential. Other values include grazing, wildlife, recreation, natural beauty, and conservation of soil and water. This section has been provided to explain how soils affect tree growth and management in the county. In table 4 hazards and limitations, potential productivity, and preferred tree species for the soils in Johnson County are listed.

In the first column the soils are listed by their mapping unit symbols under the series to which they belong. The next column gives the woodland suitability group. Each group is made up of soils that are suited to the same kind of trees, that need about the same kind of management to produce these trees, and that have about the same potential productivity.

Each woodland suitability group is identified by a three-part symbol. The first part of the symbol, a numeral, indicates the relative productivity of the soils: 1 means very high; 2 means high; 3 means moderately high; 4 means moderate; and 5 means low.

The second part of the sumbol, a letter, indicates the important soil property that imposes a moderate or severe hazard or limitation in managing the soils for wood crops. The letter *x* means that the main limitation is stoniness or rockiness; *w* means that excessive water on or in the soil is the chief limitation; *t* means that toxic substances in the soil are the chief limitation; *d* means that the rooting depth is restricted; *c* means that clay in the upper part of the soil is a limitation; *s* means that the soils are sandy; *f* means that the soils have large amounts of coarse fragments; *r* means that the soils have steep slopes; and *o* means the soils have no significant restrictions or limitations for woodland use or management.

The third element in the symbol indicates the degree of management problems and the general suitability of the soils for certain kinds of trees.

The management problems evaluated in the next three columns are hazard of erosion, equipment limitations, and seedling mortality. Hazard of erosion measures the risk of soil losses in well-managed woodlands. The hazard of erosion is *slight* if expected soil losses are small, *moderate* if some measures to control erosion are needed in logging and construction, and *severe* if intensive treatment or special equipment and methods are needed to prevent excessive soil losses.

Equipment limitation ratings reflect the soil conditions that restrict the use of equipment normally used in woodland management or harvesting. *Slight* ratings indicate equipment use is not limited to kind or time of year. A rating of *moderate* indicates a seasonal limitation or need for modification in methods or equipment. *Severe* limitations indicate the need for specialized equipment or operations.

Seedling mortality ratings indicate the degree of expected mortality of planted seedlings when plant competition is not a limiting factor. Normal rainfall, good planting stock, and proper planting are assumed. A *slight* rating indicates expected mortality is less than 25 percent. A *moderate* rating indicates a 25 to 50 percent loss; and *severe* indicates over 50 percent loss of seedlings.

In the next column some of the commercially important trees that are adapted to the soil are listed. These are the trees that woodland managers will generally favor in intermediate or improvement cuttings. The potential productivity of the trees as indicated by site index is presented in the next column. The site index is the average height of dominant trees, in feet, at age 30 for cottonwood; at age 35 for sycamore; at age 25 for planted pines; and at age 50 for all other species or types. Although some of the listed trees are known

[5] MAX D. BOLAR, woodland conservationist, and IVAN R. PORTER, range conservationist, Soil Conservation Service, helped prepare this section.

TABLE 3.—*Suitability of soils for elements of*

Mapping unit and symbols	Elements of wildlife habitat		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants
Bruno loamy fine sand: Br	Poor	Poor	Poor
Cane fine sandy loam, 1 to 3 percent slopes: CaB	Good	Good	Good
Cane fine sandy loam, 3 to 8 percent slopes: CaC	Good to fair	Good	Good
Caspiana silt loam: Cp	Good	Good	Good
Ceda cobbly fine sandy loam: Cy	Poor	Fair	Fair
Enders gravelly fine sandy loam, 5 to 15 percent slopes: EnD	Fair	Good	Good
Enders-Mountainburg association, rolling: EMD.			
Enders soils	Poor	Fair	Good
Mountainburg soils	Very poor	Poor	Poor
Enders-Mountainburg association, steep: EME.			
Enders soils	Very poor	Poor	Good
Mountainburg soils	Very poor	Poor	Poor
Guthrie silt loam: Ge	Poor	Fair	Fair
Leadvale silt loam, 1 to 3 percent slopes: LeB	Good	Good	Good
Leadvale silt loam, 3 to 8 percent slopes: LeC	Good to fair	Good	Good
Leesburg association, rolling: LBD	Fair to poor	Good to fair	Good
Leesburg association, steep: LBE	Poor to very poor	Fair to poor	Good
Leesburg-Enders association, steep: LEE.			
Leesburg soils	Poor to very poor	Fair to poor	Good
Enders soils	Very poor	Poor	Good
Leesburg-Enders association, very steep: LEF.			
Leesburg soils	Very poor	Poor	Good
Enders soils	Very poor	Poor	Good
Linker fine sandy loam, 1 to 3 percent slopes: LnB	Fair	Good	Good
Linker fine sandy loam, 3 to 8 percent slopes: LnC	Fair	Good	Good
Linker fine sandy loam, 8 to 12 percent slopes: LnD	Fair	Good	Good
Linker association, rolling: LKD	Fair	Good	Good
Linker-Mountainburg association, rolling: LMD.			
Linker soils	Fair to poor	Good to fair	Good
Mountainburg soils	Very poor	Poor	Poor
McKamie silt loam, 3 to 8 percent slopes: McC	Good to fair	Good	Good
Moreland clay: Md	Fair	Fair	Fair
Morganfield silt loam: Mg	Good	Good	Good
Mountainburg gravelly fine sandy loam, 3 to 12 percent slopes: MoD	Very poor	Poor	Poor
Mountainburg stony fine sandy loam, 1 to 12 percent slopes: MsD	Very poor	Poor	Poor
Mountainburg stony fine sandy loam, 12 to 65 percent slopes: MsF	Very poor	Poor	Poor
Mountainburg-Enders association, rolling: MED.			
Mountainburg soils	Very poor	Poor	Poor
Enders soils	Poor	Fair	Good
Mountainburg-Enders association, steep: MEE.			
Mountainburg soils	Very poor	Poor	Poor
Enders soils	Very poor	Poor	Good
Mountainburg-Enders association, very steep: MEF.			
Mountainburg soils	Very poor	Poor	Poor
Enders soils	Very poor	Poor	Good
Mountainburg-Rock outcrop association, very steep: MRF.			
Mountainburg soils	Very poor	Poor	Poor
Rock outcrop	Not rated	Not rated	Not rated
Muskogee silt loam, 1 to 3 percent slopes: MzB	Good	Good	Good
Nella gravelly fine sandy loam, 1 to 3 percent slopes: NaB	Good	Good	Good
Nella gravelly fine sandy loam, 3 to 8 percent slopes: NaC	Good to fair	Good	Good
Nella gravelly fine sandy loam, 8 to 12 percent slopes: NaD	Fair	Good	Good
Nella-Enders association, rolling: NED.			
Nella soils	Fair to poor	Good to fair	Good
Enders soils	Poor	Fair	Good
Nella-Enders association, steep: NEE.			
Nella soils	Poor to very poor	Fair to poor	Good
Enders soils	Very poor	Poor	Good
Nella-Enders association, very steep: NEF.			
Nella soils	Very poor	Poor	Good
Enders soils	Very poor	Poor	Good
Nella-Mountainburg association, rolling: NMD.			
Nella soils	Fair to poor	Good to fair	Good
Mountainburg soils	Very poor	Poor	Poor
Nella-Mountainburg association, steep: NME.			
Nella soils	Poor to very poor	Fair to poor	Good
Mountainburg soils	Very poor	Poor	Poor
Nella-Mountainburg association, very steep: NMF.			
Nella soils	Very poor	Poor	Good
Mountainburg soils	Very poor	Poor	Poor

wildlife habitat and for kinds of wildlife

Elements of wildlife habitat—Continued				Kinds of wildlife		
Hardwood woody plants	Coniferous plants	Wetland plants	Shallow water developments	Open-land	Woodland	Wetland
Poor	Poor	Very poor	Very poor	Poor	Poor	Very poor.
Good	Good	Poor	Poor	Good	Good	Poor.
Good	Good	Poor	Very poor	Good	Good	Very poor.
Good		Poor	Very poor	Good	Good	Very poor.
Poor	Poor	Very poor	Very poor	Fair	Poor	Very poor.
Good	Good	Very poor	Very poor	Good	Good	Very poor.
Good	Good	Very poor	Very poor	Fair	Good	Very poor.
Very poor	Very poor	Very poor	Very poor	Poor	Very poor	Very poor.
Good	Good	Very poor	Very poor	Poor	Good	Very poor.
Very poor	Very poor	Very poor	Very poor	Poor	Very poor	Very poor.
Fair	Fair	Good	Good	Fair	Fair	Good.
Good	Good	Poor	Poor	Good	Good	Poor.
Good	Good	Poor	Very poor	Good	Good	Very poor.
Good	Good	Very poor	Very poor	Fair to good	Good	Very poor.
Good	Good	Very poor	Very poor	Fair to poor	Good	Very poor.
Good	Good	Very poor	Very poor	Fair to poor	Good	Very poor.
Good	Good	Very poor	Very poor	Poor	Good	Very poor.
Good	Good	Very poor	Very poor	Poor	Good	Very poor.
Good	Good	Poor	Very poor	Good	Good	Very poor.
Good	Good	Poor	Very poor	Good	Good	Very poor.
Good	Good	Very poor	Very poor	Good	Good	Very poor.
Good	Good	Poor to very poor	Very poor	Good	Good	Very poor.
Good	Good	Very poor	Very poor	Good to fair	Good	Very poor.
Very poor	Very poor	Very poor	Very poor	Poor	Very poor	Very poor.
	Good	Poor	Very poor	Good	Good	Very poor.
Good		Good	Good to fair	Fair	Good	Good to fair.
Good		Poor	Very poor	Good	Good	Very poor.
Very poor	Very poor	Poor to very poor	Very poor	Poor	Very poor	Very poor.
Very poor	Very poor	Very poor	Very poor	Poor	Very poor	Very poor.
Very poor	Very poor	Very poor	Very poor	Poor	Very poor	Very poor.
Very poor	Very poor	Very poor	Very poor	Poor	Very poor	Very poor.
Good	Good	Very poor	Very poor	Fair	Good	Very poor.
Very poor	Very poor	Very poor	Very poor	Poor	Very poor	Very poor.
Good	Good	Very poor	Very poor	Poor	Good	Very poor.
Not rated	Not rated	Not rated	Not rated	Not rated	Not rated	Not rated.
Good	Good	Poor	Poor	Good	Good	Poor.
Good	Good	Poor	Very poor	Good	Good	Very poor.
Good	Good	Poor	Very poor	Good	Good	Very poor.
Good	Good	Very poor	Very poor	Good	Good	Very poor.
Good	Good	Very poor	Very poor	Good to fair	Good	Very poor.
Good	Good	Very poor	Very poor	Fair	Good	Very poor.
Good	Good	Very poor	Very poor	Fair to poor	Good	Very poor.
Good	Good	Very poor	Very poor	Poor	Good	Very poor.
Good	Good	Very poor	Very poor	Poor	Very poor	Very poor.
Good	Good	Very poor	Very poor	Poor	Very poor	Very poor.
Good	Good	Very poor	Very poor	Good to fair	Good	Very poor.
Very poor	Very poor	Very poor	Very poor	Poor	Very poor	Very poor.
Good	Good	Very poor	Very poor	Fair to poor	Good	Very poor.
Very poor	Very poor	Very poor	Very poor	Poor	Very poor	Very poor.
Good	Good	Very poor	Very poor	Poor	Good	Very poor.
Very poor	Very poor	Very poor	Very poor	Poor	Very poor	Very poor.

TABLE 3.—*Suitability of soils for elements of*

Mapping unit and symbols	Elements of wildlife habitat		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants
Nella soils, rolling: NSD	Fair to poor	Good to fair	Good
Nella soils, steep: NSE	Poor to very poor	Fair to poor	Good
Pickwick silt loam, 1 to 3 percent slopes: PcB	Good	Good	Good
Pickwick silt loam, 3 to 8 percent slopes: PcC	Good to fair	Good	Good
Roellen clay: Ro	Fair	Fair	Fair
Spadra fine sandy loam, 1 to 3 percent slopes: SpB	Good	Good	Good
Taft silt loam: Ta	Fair	Good	Good
Udorthents: Ud	Very poor to poor	Poor	Fair

to make suitable growth on the soils, site index information is not available. This is indicated by dashes in place of the site index.

In the next columns are the potential productivity of understory grasses, legumes, forbs, and low shrubs for a medium tree canopy class (36 to 55 percent canopy) and yields of forage species which are within reach of livestock and game animals. It is expressed in pounds of air dry forage per acre. Where yield data are not available, the important forage-producing species are listed in approximate order of their productivity.

In the last column is a list of trees suitable to plant for commercial wood production.

Use of the Soils for Range [6]

Different kinds of soil vary in their capacity to produce grass and other plants for grazing. Soils that produce about the same kinds and amounts of forage, if the range is in similar condition, make up a range site.

Range sites are kinds of range that differ in their ability to produce vegetation. The soils of any one range site produce about the same kind of climax vegetation. Climax vegetation is the stabilized plant community; it reproduces itself and does not change as long as the environment remains unchanged. Throughout the prairie and the savannas, the climax vegetation consists of the plants that were growing there when the region was first settled. The most productive combination of forage plants on a range site is generally the climax vegetation if cultivated crops are not grown.

Decreasers are plants in the climax vegetation that tend to decrease in relative amount under close grazing. They generally are the tallest and most productive perennial grasses and forbs and the most palatable to livestock.

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

Invaders are plants that cannot compete with plants in the climax plant community for moisture, nutrients, and light. Hence, invaders come in and grow along with increasers after the climax vegetation has been reduced by grazing. Many are annual weeds, and some are shrubs that have some grazing value, but others have little value for grazing.

Four range condition classes are used to indicate the degree of departure from the potential, or climax, vegetation brought about by grazing or other uses. The classes show the present condition of the native vegetation on a range site in relation to the native vegetation that could grow there.

A range is in excellent condition if 76 to 100 percent of the vegetation is of the same kind as that in the climax stand. It is in good condition of the percentage is 51 to 75; in fair condition if the percentage is 26 to 50; and in poor condition if the percentage is less than 25.

Range condition is judged according to standards that apply to the particular range site. It expresses the present kind and amount of vegetation in relation to the climax plant community for that site.

Potential forage production depends on the range site. Current forage production depends on the range condition and the moisture available to plants during their growing season.

A primary objective of good range management is to keep range in excellent or good condition. If this is done, water is conserved, yields are improved, and the soils are protected. The problem is recognizing important changes in the kind of cover on a range site. These changes take place gradually and can be misinterpreted or overlooked. Growth encouraged by heavy rainfall may lead to the conclusion that the range is in good condition, when actually the cover is weedy and the long term trend is toward lower production. On the other hand, some range that has been closely grazed for short periods, under the supervision of a careful manager, may have a degraded appearance that temporarily conceals its quality and ability to recover.

Descriptions of range sites

In the following pages, the range sites of Johnson County are described and the climax plants and principal invaders on the sites are named. Also given is an estimate of the potential annual yield of air-dry herbage for each site when it is in excellent condition.

[6] IVAN R. PORTER, range conservationist, Soil Conservation Service, helped prepare this section.

wildlife habitat and for kinds of wildlife—Continued

Elements of wildlife habitat—Continued				Kinds of wildlife		
Hardwood woody plants	Coniferous plants	Wetland plants	Shallow water developments	Open-land	Woodland	Wetland
Good	Good	Very poor	Very poor	Good to fair	Good	Very poor.
Good	Good	Very poor	Very poor	Fair to poor	Good	Very poor.
Good	Good	Poor	Very poor	Good	Good	Very poor.
Good	Good	Poor	Very poor	Good	Good	Very poor.
Fair		Good	Good	Fair	Fair	Good.
Good	Good	Poor	Very poor	Good	Good	Very poor.
Good	Good	Fair	Fair	Good	Good	Fair.
Poor	Poor	Very poor	Very poor	Poor	Poor	Very poor.

The soils in each site can be determined by referring to the "Guide to Mapping Units" at the back of this soil survey.

CLAY BREAK, SHALE RANGE SITE

Soils of this site are moderately deep and deep, gently sloping to very steep, and well drained. Permeability is very slow. These soils have high available water capacity, but runoff is rapid. Content of plant nutrients is low in most of these soils. The surface layer is sandy loam, gravelly fine sandy loam, stony loams, or fine sandy loam. The subsoil is mainly clay.

When the site is in excellent condition, the vegetation consists of open stands of oak, hickory, and winged elm that make up about 35 to 45 percent of the cover. The remainder is grasses, legumes, and forbs. Little bluestem, big bluestem, indiangrass, and Canada wildrye are the main decreaser grasses; Virginia tephrosia, native lespedezas, and catclaw sensitivebrier are the main legumes.

As the condition of the site deteriorates, eastern redcedar and hardwood trees, broomsedge bluestem, ragweeds, white snakeroot, and annual three-awn grasses will invade or increase.

In years when soil moisture is favorable, total production is about 5,000 pounds per acre. Production is about 2,500 pounds per acre in unfavorable years. Forage production ranges from 1,500 to 3,000 pounds per acre.

SANDSTONE RIDGE RANGE SITE

Soils of this site are shallow, gently sloping to very steep, and well drained. Permeability is moderately rapid. These soils have low available water capacity, and are low in plant nutrients. The rooting zone is 12 to 20 inches thick over sandstone bedrock. The surface layer is gravelly fine sandy loam, or stony fine sandy loam. The subsoil is gravelly sandy clay loam and gravelly fine sandy loam. Many profiles are stony throughout.

When this site is in excellent condition, the cover consists of open stands of scrubby post oak, blackjack oak, and hickories that make up about 25 to 35 percent of the cover. The remainder is grasses, legumes, and forbs. Little bluestem makes up most of the understory; indiangrass, big bluestem, Canada wildrye, and switchgrass are other decreasers. The main forbs and legumes are perennial sunflowers, native lespedezas, Virginia tephrosia, and ticklovers. Two important shrubs are New Jersey tea and fragrant sumac.

When the range condition is poor, the decreaser grasses are replaced by oak seedlings and sprouts and by plants such as hidden dropseed, three-awns, broomsedge bluestem, poverty oatgrass, ironweed, ragweeds, sassafras, and persimmon. In places the canopy may be filled with hardwoods, shortleaf pine, and redcedar with but few palatable understory plants.

In years when soil moisture is favorable, total production is about 4,800 pounds per acre. Production is about 2,000 pounds per acre in unfavorable years. Forage production ranges from 800 to 2,000 pounds per acre.

LOAMY UPLAND RANGE SITE

Soils of this site are moderately deep, nearly level to moderately steep, and well drained. Permeability is moderate. These soils have medium available water capacity, but runoff is medium to rapid. Content of plant nutrients is low in most of these soils. The rooting zone is 20 to 40 inches thick over sandstone bedrock. The surface layer is fine sandy loam, gravelly fine sandy loam, or stony fine sandy loam. The subsoil is loam, clay loam, or gravelly clay loam.

When this site is in excellent condition, the cover is about 40 to 50 percent trees such as white oak, red oak, post oak, hickories, and shortleaf pine. Tall grasses, legumes, and forbs make up the remainder of the cover. The main decreaser plants are little bluestem, big bluestem, indiangrass, beaked panicum, native lespedezas, and perennial sunflowers.

As range condition deteriorates, the decreaser plants are replaced by broomsedge, bluestem, annual three-awns, ragweeds, white snakeroot, ironweed, and tree seedlings. In places the canopy may be filled with hardwoods, shortleaf pine, and redcedar with a few palatable understory plants.

In years when soil moisture is favorable, total production is about 5,500 pounds per acre. Production is about 3,000 pounds per acre in unfavorable years. Forage production ranges from 1,500 to 2,500 pounds per acre.

TABLE 4.—*Woodland suitability groups, hazards and limitations,*

[Dashes indicate site index

Soil series and map symbols	Woodland suitability group	Ratings of major hazards and limitations to use and management		
		Erosion	Equipment limitation	Seedling mortality
Bruno: Br	2s5	Slight	Moderate	Moderate
Cane: CaB, CaC	3o7	Slight	Slight	Slight
Caspiana: Cp	2o4	Slight	Slight	Slight
Ceda: Cy	3x9	Slight	Severe	Moderate
Enders: EnD	4o1	Slight	Slight	Slight
EMD, EME, (LEE, MED, MEE, NED, NEE)—For interpretations of Mountainburg parts of EMD and EME, see Mountainburg series.	4x2	Slight to moderate	Moderate	Slight to moderate
(LEF, MEF, NEF)	5r3	Severe	Severe	Moderate
Guthrie: Ge	2w9	Slight	Severe	Severe

See footnotes at end of table.

potential productivity, and preferred tree species for planting

data are unavailable]

Potential productivity				Preferred species for planting
Important woodland trees	Site index [1]	Understory vegetation (medium canopy) used as forage	Yields	
			Lb per acre	
Cherrybark oak Water oak Sweetgum Eastern cottonwood Sycamore Black walnut Black cherry	90 90 95 105 90 --- ---	Giant cane, Virginia wildrye, switchgrass, beaked panicum, uniolas, low panicums, honeysuckle, and other plants and shrubs.	3,500 favorable years; 2,000 unfavorable years.	Black walnut, yellow-poplar, black cherry, cherrybark oak, water oak, sweetgum, eastern cottonwood, sycamore.
Loblolly pine Shortleaf pine Eastern redcedar Sweetgum Red oak Black cherry Black walnut	80 70 50 80 70 --- ---	Little bluestem, big bluestem, beaked panicum, plumegrass, wildryes, low panicums, other grasses, legumes, and forbs.	3,000 favorable years; 1,000 unfavorable years.	Loblolly pine, shortleaf pine, eastern redcedar, sweetgum, red oaks, black walnut.[2]
Green ash Cottonwood Cherrybark oak Pecan Sweetgum Sycamore Black walnut	75 105 100 --- 100 --- ---	Big bluestem, little bluestem, eastern gamagrass, giant cane, Virginia wildrye, switchgrass, beaked panicum, sedges, greenbrier, other forbs and shrubs.	4,000 favorable years; 3,000 unfavorable years.	Green ash, cottonwood, sweetgum, sycamore, black walnut, water oak, Shumard oak, cherrybark oak.
Sweetgum Sycamore Shortleaf pine	80 80 70	Beaked panicum, Virginia wildrye, switchgrass, broadspike uniola, eastern gamagrass, low panicum, sedges, sunflower, goldenrod, wild aster.	2,500 favorable years; 1,000 unfavorable years.	Shortleaf pine, sycamore, sweetgum, loblolly pine, eastern redcedar.
Shortleaf pine Red oak Loblolly pine Eastern redcedar	60 60 --- ---	Little bluestem, big bluestem, indiangrass, Canada wildrye, catclaw sensitivebrier, Virginia tephrosia, other grasses, legumes, and forbs.	3,000 favorable years; 1,500 unfavorable years.	Loblolly pine, shortleaf pine, eastern redcedar.
Shortleaf pine Red oak Loblolly pine Eastern redcedar	60 60 --- ---	Little bluestem, big bluestem, indiangrass, Canada wildrye, catclaw sensitivebrier, Virginia tephrosia, other grasses, legumes, and forbs.	3,000 favorable years; 1,500 unfavorable years.	Loblolly pine, shortleaf pine, eastern redcedar.
Shortleaf pine Red oak Loblolly pine Eastern redcedar	50 50 --- ---	Little bluestem, big bluestem, indiangrass, Canada wildrye, catclaw sensitivebrier, Virginia tephrosia, other grasses, legumes, and forbs.	3,000 favorable years; 1,500 unfavorable years.	Loblolly pine, shortleaf pine, eastern redcedar.
Sweetgum Loblolly pine Water oak	90 80<br---	Switchgrass, velvet panicum, beaked panicum, uniolas, low panicums, sedges, forbs, other shrubs.	3,000 favorable years; 1,000 unfavorable years.	Loblolly pine, sweetgum, Nuttall oak, willow oak, water oak, swamp chestnut oak, green ash.

TABLE 4.—*Woodland suitability groups, hazards and limitations,*

Soil series and map symbols	Woodland suitability group	Ratings of major hazards and limitations to use and management		
		Erosion	Equipment limitation	Seedling mortality
Leadvale: LeB, LeC	3o7	Slight	Slight	Slight
Leesburg: LBD	3o7	Slight	Slight	Slight
LBE, LEE For interpretations of Enders part of LEE, see Enders series.	3r8	Moderate	Moderate	Slight
LEF For interpretations of Enders part of LEF, see Enders series.	3r9	Severe	Severe	Moderate
Linker: LnB, LnC, LnD, LKD, LMD For interpretations of Mountainburg part of LMD, see Mountainburg series.	4o1	Slight	Slight	Slight
McKamie: McC	3c2	Slight	Moderate	Slight to moderate
Moreland: Md	2w6	Slight	Severe	Moderate
Morganfield: Mg	2o4	Slight	Slight	Slight

See footnotes at end of table.

potential productivity, and preferred tree species for planting—Continued

Potential productivity: Important woodland trees	Potential productivity: Site index [1]	Potential productivity: Understory vegetation (medium canopy) used as forage	Potential productivity: Yields	Preferred species for planting
			Lb per acre	
Loblolly pine Shortleaf pine Red oaks White oaks Eastern redcedar Black walnut Black cherry	80 70 70 60 50 ---- ----	Bluestems, plumegrass, switchgrass, indiangrass, wildryes, low panicums, sedges, other forbs and shrubs.	2,500 favorable years; 1,000 unfavorable years.	Loblolly pine, shortleaf pine, eastern redcedar, southern red oak, black locust,[2] black walnut,[2] black cherry.[2]
Southern red oak White oak Shortleaf pine Loblolly pine Sweetgum Redcedar	70 ---- 70 80 70 50	Little bluestem, big bluestem, beaked panicum, switchgrass, wildrye, low panicum, sedges, native lespedezas, goldenrods, other forbs and shrubs.	2,000 favorable years; 1,000 unfavorable years.	Loblolly pine, shortleaf pine, eastern redcedar, southern red oak, black locust,[2] black walnut,[2] black cherry.[2]
Southern red oak White oak Shortleaf pine Loblolly pine Sweetgum Redcedar	70 ---- 70 80 70 50	Little bluestem, big bluestem, beaked panicum, switchgrass, wildrye, low panicum, sedges, native lespedezas, goldenrods, other forbs and shrubs.	2,000 favorable years; 1,000 unfavorable years.	Loblolly pine, shortleaf pine, eastern redcedar, southern red oak, black locust,[2] black walnut,[2] black cherry.[2]
Southern red oak White oak Shortleaf pine Loblolly pine Sweetgum Redcedar	70 ---- 70 80 70 50	Little bluestem, big bluestem, beaked panicum, switchgrass, wildrye, low panicum, sedges, native lespedezas, goldenrods, other forbs and shrubs.	2,000 favorable years; 1,000 unfavorable years.	Loblolly pine, shortleaf pine, eastern redcedar, southern red oak, black locust,[2] black walnut,[2] black cherry.[2]
Shortleaf pine Southern red oak White oak Eastern redcedar	60 50 50 40	Bluestems, indiangrass, switchgrass, Canada wildrye, low panicums, sedges, other forbs and shrubs.	2,500 favorable years; 1,500 unfavorable years.	Loblolly pine, shortleaf pine, eastern redcedar.
Loblolly pine Shortleaf pine Eastern redcedar	80 70 50	Switchgrass, bluestems, Virginia wildrye, beaked panicum, plumegrasses, low panicums, sedges, native lespedezas, other forbs and shrubs.	2,500 favorable years; 1,000 unfavorable years.	Loblolly pine, shortleaf pine, eastern redcedar.
Eastern cottonwood Sweetgum Cherrybark oak Water oak Green ash	100 90 90 90 75	Switchgrass, eastern gamagrass, Virginia wildrye, broadleaf uniola, beaked panicum, redtop panicum, velvet panicum, sedges and rushes, miscellaneous forbs and shrubs.	2,500 favorable years; 1,500 unfavorable years.	Cherrybark oak, sweetgum, sycamore, eastern cottonwood, green ash, water oak, swamp chestnut oak, Shumard oak.
Eastern cottonwood Cherrybark oak Nuttall oak Water oak Sweetgum	110 90 90 90 90	Giant cane, bluestems, eastern gamagrass, Virginia wildrye, switchgrass, beaked panicum, broadleaf uniola, sedges, trailing wildbean, greenbrier, other forbs, shrubs, and vines.	4,000 favorable years; 3,000 unfavorable years.	Green ash, eastern cottonwood, sweetgum, cherrybark oak, sycamore, black walnut, black locust, black cherry.

TABLE 4.—*Woodland suitability groups, hazards and limitations,*

Soil series and map symbols	Woodland suitability group	Ratings of major hazards and limitations to use and management		
		Erosion	Equipment limitation	Seedling mortality
Mountainburg: MoD (NMD)	5d2	Slight	Slight	Moderate
MsD, MsF, MED, MEE, MEF, MRF, (EMD, EME, LMD, NME, NMF) For interpretations of Enders part of MED, MEE, and MEF, see Enders series. Rock outcrop part of MRF was not rated.	5x3	Slight to moderate	Severe	Slight to moderate
Muskogee: MzB	3o7	Slight	Slight	Slight
Nella: NaB, NaC, NaD, NED, NMD, NSD For interpretations of Enders part of NED, see Enders series. For interpretations of Mountainburg part of NMD, see Mountainburg series.	3o7	Slight	Slight	Slight
NEE, NME, NSE For interpretations of Enders part of NEE, see Enders series. For interpretations of Mountainburg part of NME, see Mountainburg series.	3r8	Moderate	Moderate	Slight
NEF, NMF For interpretations of Enders part of NEF, see Enders series. For interpretations of Mountainburg part of NMF, see Mountainburg series.	3r9	Severe	Severe	Moderate
Pickwick: PcB, PcC	3o7	Slight	Slight	Slight
Rock outcrop. Not rated. Mapped only in association with Mountainburg soils.				
Roellen: Ro	2w6	Slight	Severe	Moderate

See footnotes at end of table.

potential productivity, and preferred tree species for planting—Continued

Potential productivity				Preferred species for planting
Important woodland trees	Site index [1]	Understory vegetation (medium canopy) used as forage	Yields	
Shortleaf pine Eastern redcedar Loblolly pine	50 30 ----------	Bluestems, indiangrass, Canada wildrye, switchgrass, low panicums, sedges, and native lespedezas.	2,000 favorable years; 800 unfavorable years.	Loblolly pine, shortleaf pine, eastern redcedar.
Shortleaf pine Eastern redcedar Loblolly pine	50 30 ----------	Bluestems, indiangrass, Canada wildrye, switchgrass, low panicums, sedges, and native lespedezas.	2,000 favorable years; 800 unfavorable years.	Loblolly pine, shortleaf pine, eastern redcedar.
Shortleaf pine Sweetgum Loblolly pine Water oak Red oaks	70 80 ---------- ---------- ----------	Virginia wildrye, little bluestem, big bluestem, plumegrass, switchgrass, low panicums, sedges, native lespedezas, and greenbrier.	2,500 favorable years; 1,500 unfavorable years.	Loblolly pine, shortleaf pine, redcedar, southern red oak, water oak, sweetgum.
Loblolly pine Shortleaf pine Eastern redcedar Southern red oak	80 70 50 70	Bluestems, plumegrass, indiangrass, switchgrass, wildrye, low panicums, native lespedezas, perennial sunflowers.	2,500 favorable years; 1,500 unfavorable years.	Loblolly pine, redcedar, shortleaf pine, southern red oak, sweetgum.
Loblolly pine Shortleaf pine Eastern redcedar Southern red oak	80 70 50 70	Bluestems, plumegrass, indiangrass, switchgrass, wildrye, low panicums, native lespedezas, perennial sunflowers.	2,500 favorable years; 1,500 unfavorable years.	Loblolly pine, redcedar, shortleaf pine, southern red oak, sweetgum.
Loblolly pine Shortleaf pine Eastern redcedar Southern red oak	80 70 50 70	Bluestems, plumegrass, indiangrass, switchgrass, wildrye, low panicums, native lespedezas, perennial sunflowers.	2,500 favorable years; 1,500 unfavorable years.	Loblolly pine, redcedar, shortleaf pine, southern red oak, sweetgum.
Upland oaks Shortleaf pine Loblolly pine Eastern redcedar	75 70 80 50	Virginia wildrye, bluestems, plumegrass, beaked panicum, switchgrass, low panicum, sedges, native lespedezas, goldenrods, farkleberry, flowering dogwood.	2,500 favorable years; 1,500 unfavorable years.	Black walnut, loblolly pine, eastern redcedar, black locust.
Eastern cottonwood Sweetgum Cherrybark oak Water oak Green ash	100 90 90 90 75	Virginia wildrye, broadleaf uniola, beaked panicum, redtop panicum, velvet panicum, sedges, rushes, other vines and shrubs.	2,500 favorable years; 1,500 unfavorable years.	Cherrybark oak, Nuttall oak, sweetgum, sycamore, eastern cottonwood, green ash, water oak, swamp chestnut oak, Shumard oak.

TABLE 4.—*Woodland suitability groups, hazards and limitations,*

Soil series and map symbols	Woodland suitability group	Ratings of major hazards and limitations to use and management		
		Erosion	Equipment limitation	Seedling mortality
Spadra: SpB	2o7	Slight	Slight	Slight
Taft: Ta	3w8	Slight	Moderate	Slight
Udorthents: Ud	5r9	Severe	Moderate to severe	Moderate to severe

[1] Site class rating adapted from data gathered in soil site studies by the Soil Conservation Service and the Forest Service.

Engineering Uses of the Soils [7]

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, soil drainage condition, shrink-swell potential, grain size, plasticity, and soil 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 5, 6, and 7, which show, respectively, several estimated soil properties significant to engineering; interpretations for various engineering uses; and results of engineering laboratory tests on soil samples.

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 6 and 7, and it also can be used to make other useful maps.

This information, however, does not eliminate the need for further investigations at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths greater than 6 feet. Also, inspection of sites, especially 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.

[7] TERENCE P. BASS, agricultural engineer, Soil Conservation Service, helped prepare this section.

potential productivity, and preferred tree species for planting—Continued

Potential productivity				Preferred species for planting
Important woodland trees	Site index [1]	Understory vegetation (medium canopy) used as forage	Yields	
Shortleaf pine Southern red oak Eastern redcedar	80 80 60	Big bluestem, little bluestem, switchcane, switchgrass, beaked panicum, eastern gamagrass, low panicums, Virginia wildrye, sedges, wild grape, other forbs and shrubs.	3,500 favorable years; 1,500 unfavorable years.	Loblolly pine, shortleaf pine, black walnut, black cherry, black locust, southern red oak, eastern redcedar, cherrybark oak.
Water oak Sweetgum Loblolly pine Shortleaf pine	70 70 70 60	Switchgrass, eastern gamagrass, Florida paspalum, plumegrass, longspike tridens, beaked panicum, broadleaf uniola, St. Johnswort, wild grape, and other shrubs.	3,500 favorable years; 1,800 unfavorable years.	Loblolly pine, sweetgum, water oak.
Shortleaf pine Eastern redcedar	55 35	Switchgrass, eastern gamagrass, Florida paspalum, plumegrass, longspike tridens, beaked panicum, broadleaf uniola, St. Johnswort, wild grape, and other shrubs.	3,500 favorable years; 1,800 unfavorable years.	Loblolly pine, shortleaf pine, eastern redcedar, black locust, Virginia pine.

[1] Plant only on north- and east-facing slopes, coves, benches, and bases of slopes.

Some of the terms used in this soil survey have special meaning to soil scientists but are not known to all engineers. Many of the terms commonly used in soil science are defined in the Glossary.

Engineering soil classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified Soil Classification system (*4*) used by the SCS engineers, Department of Defense, and others, and the AASHTO system (*2*) adopted by the American Association of State Highway (and Transportation) Officials.

In the Unified system soils are classified according to particle size distribution, plasticity, liquid limit, and organic matter. Soils are grouped in 15 classes: eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as 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 (*1*) 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 AASHTO classification for tested soils, with group index numbers in parentheses, is shown in table 7; the estimated classification, without group index numbers, is given in table 5 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 millimeters in diameter. "Sand," "silt," "clay," and some of the other terms used in the USDA textural classification are defined in the Glossary.

Soil properties significant to engineering

Several estimated soil properties significant in engineering are given in table 5. These estimates are made for typical soil profiles, by layers sufficiently different to have different significance for soil engineering. 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 5.

TABLE 5.—*Estimated soil properties*

[Absence of data indicates that the soil is too variable to be rated or that no estimate was made. The symbol > means greater than; the kinds of soils that may have different properties. For this reason the reader should

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification		Coarse fraction greater than 3 inches
	Bedrock	Seasonal high water table			Unified	AASHTO	
	In	*Ft*	*In*				
Bruno [1]: Br	>72	>6	0–72	Loamy fine sand, loamy very fine sand, and fine sand.	SM	A–2	
Cane: CaB, CaC	>60	3–4	0–5	Fine sandy loam	ML or CL–ML	A–4	
			5–11	Loam	CL, CL–ML, or ML	A–4	
			11–20	Clay loam	CL	A–6	
			20–59	Clay loam and sandy clay loam.	CL	A–6	
			59–72	Sandy clay loam	CL	A–6	
Caspiana [1]: Cp	>72	>6	0–10	Silt loam	ML or CL–ML	A–4	
			10–40	Silty clay loam and silt loam.	CL	A–6	
			40–72	Very fine sandy loam.	ML, CL–ML, or CL	A–4	
Ceda [1]: Cy	>72	>6	0–10	Cobbly fine sandy loam.	SM	A–2 or A–4	10–50
			10–72	Cobbly fine sandy loam.	SM	A–2 or A–4	20–70
*Enders: EnD, EMD, EME	>42	>6	0–6	Fine sandy loam	CL or CL–ML	A–4	0–35
			6–14	Clay loam	CL	A–6	
			14–76	Clay	MH or CH	A–7	
For properties of Mountainburg parts of EMD and EME, see Mountainburg series.							
Guthrie: Ge	>60	½–1	0–6	Silt loam	CL or CL–ML	A–4	
			6–15	Silt loam	CL	A–6 or A–4	
			15–58	Silty clay loam	CL	A–6	
			58–72	Silty clay loam	CL	A–6	
Leadvale: LeB, LeC	>60	2–2½	0–5	Silt loam	ML or CL–ML	A–4	
			5–10	Silt loam	ML or CL–ML	A–4	
			10–23	Silt loam and silty clay loam.	CL	A–6	
			23–72	Silty clay loam	CL	A–6	
*Leesburg: LBD, LBE, LEE, LEF	>72	>6	0–5	Gravelly loam	SM, SC–SM, ML, CL–ML, GM or GC–GM	A–2 or A–4	0–20
For properties of Enders parts of LEE and LEF, see Enders series.							
			5–36	Gravelly loam and gravelly clay loam.	CL, SC, or GC	A–4 or A–6	0–15
			36–72	Gravelly clay loam.	CL, SC, or GC	A–2, A–4, or A–6	0–15
*Linker: LnB, LnC, LnD, LKD, LMD	20–40	>6	0–6	Fine sandy loam	SM, SC–SM, ML, or CL–ML	A–2 or A–4	0–25
For properties of Mountainburg part of LMD, see Mountainburg series.							
			6–11	Loam	ML, CL–ML, CL, SM, SC–SM, or SC	A–4 or A–6	0–5
			11–22	Clay loam	SC or CL	A–4 or A–6	0–10
			22–29	Gravelly clay loam.	SC or CL	A–2, A–4, or A–6	0–10

See footnotes at end of table.

significant in engineering

symbol < means less than. An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more follow carefully the instructions for referring to another series in the first column]

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability [1]	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
						Ins per hr	*Ins per in of soil*	*pH*			
--------	100	70–100	20–35	--------	[3] NP	>6.0	0.05–0.11	6.1–7.3	Low------	Low------	Low.
90–100	85–95	80–95	55–70	<30	NP–7	0.6–2.0	0.11–0.15	5.1–6.0	Low------	Low------	Moderate.
90–100	85–95	80–95	65–80	20–30	2–10	0.6–2.0	0.15–0.20	5.1–6.0	Low------	Moderate--	Moderate.
90–100	85–95	80–95	70–85	30–40	12–22	0.2–0.6	0.15–0.20	4.5–5.5	Moderate--	Moderate--	Moderate to high.
90–100	85–95	80–95	55–85	30–40	12–22	0.06–0.2	0.07–0.10	4.5–5.5	Moderate--	High------	Moderate to high.
90–100	85–95	80–95	55–70	30–40	12–22	0.2–0.6	0.12–0.17	4.5–5.5	Moderate--	High------	Moderate to high.
95–100	95–100	90–100	70–90	<30	NP–7	0.6–2.0	0.16–0.24	5.6–6.5	Low------	Low------	Moderate to low.
95–100	95–100	90–100	80–95	30–40	12–22	0.6–2.0	0.18–0.22	5.6–7.3	Moderate--	Moderate--	Moderate to low.
95–100	95–100	85–95	55–70	20–30	2–10	0.6–2.0	0.13–0.20	6.6–7.8	Low------	Low------	Low.
80–90	75–85	55–70	25–45	<20	NP–3	>6.0	0.05–0.08	5.1–6.5	Low------	Low------	Moderate.
75–85	70–80	50–65	20–40	<20	NP–3	>6.0	0.04–0.07	5.1–6.5	Low------	Low------	Moderate.
70–80	65–80	60–75	55–70	20–30	4–10	0.6–2.0	0.07–0.15	4.5–5.5	Low------	Low------	Moderate to high.
90–100	85–100	85–95	70–85	30–40	12–22	0.2–0.6	0.12–0.20	4.5–5.5	Moderate--	Moderate--	Moderate to high.
90–100	90–100	85–95	75–90	65–80	35–45	<0.06	0.12–0.18	4.5–5.5	Moderate to high.	High------	Moderate to high.
100	95–100	95–100	85–95	23–30	4–10	0.6–2.0	0.16–0.24	5.1–6.5	Low------	High------	Moderate to low.
100	95–100	95–100	85–95	27–37	10–18	0.6–2.0	0.16–0.24	4.5–5.5	Low------	High------	Moderate to high.
100	95–100	95–100	85–95	30–40	12–20	0.06–0.2	0.09–0.11	4.5–5.5	Low------	High------	Moderate to high.
100	95–100	95–100	85–95	30–40	12–20	0.06–0.2	0.09–0.11	5.1–6.5	Low------	High------	Moderate to low.
95–100	95–100	90–100	65–95	<25	NP–4	0.6–2.0	0.16–0.24	5.1–6.5	Low------	Moderate--	Moderate to low.
95–100	95–100	90–100	65–95	<30	NP–7	0.6–2.0	0.16–0.24	4.5–6.0	Low------	High------	Moderate to high.
95–100	95–100	90–100	85–95	30–40	11–20	0.6–2.0	0.16–0.24	4.5–5.5	Low------	High------	Moderate to high.
95–100	95–100	90–100	85–95	30–40	11–20	0.2–0.6	0.09–0.11	4.5–5.5	Low------	High------	Moderate to high.
55–80	50–70	40–65	20–55	<25	NP–5	2.0–6.0	0.10–0.16	5.1–6.0	Low------	Low------	Moderate.
65–85	60–80	55–75	36–65	27–40	8–20	0.6–2.0	0.10–0.16	4.5–6.0	Low------	Low------	Moderate to high.
40–85	35–80	30–75	15–65	30–40	10–20	0.6–2.0	0.07–0.16	4.5–6.0	Low------	Low------	Moderate to high.
75–95	60–90	50–75	25–55	<30	NP–7	0.6–2.0	0.08–0.12	5.1–6.0	Low------	Low------	Moderate.
80–100	75–100	65–95	40–70	<35	NP–12	0.6–2.0	0.11–0.20	4.5–5.5	Low------	Low------	Moderate to high.
75–100	75–100	55–95	40–75	25–40	8–20	0.6–2.0	0.12–0.20	4.5–5.5	Low------	Low------	Moderate to high.
65–90	65–90	45–85	30–65	25–40	8–20	0.6–2.0	0.10–0.18	4.5–5.5	Low------	Low------	Moderate to high.

TABLE 5.—*Estimated soil properties*

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification		Coarse fraction greater than 3 inches
	Bedrock	Seasonal high water table			Unified	AASHTO	
	In	*Ft*	*In*				
McKamie: McC	>72	>6	0–3	Silt loam	ML or CL–ML	A–4	
			3–7	Silty clay loam	CL	A–6	
			7–55	Clay	CH	A–7	
			55–72	Clay loam	CL	A–6 or A–7	
Moreland [2]: Md	>72	2–2½	0–37	Clay	CH	A–7	
			37–72	Silty clay loam and clay loam.	CL	A–6 or A–7	
Morganfield [2]: Mg	>72	>6	0–72	Silt loam and very fine sandy loam.	ML or CL–ML	A–4	
*Mountainburg: MoD, MsD, MsF, MED, MEE, MEF, MRF. For properties of Enders parts of MED, MEE, and MEF, see Enders series. Rock outcrop part of MRF was not rated.	12–20	>6	0–3	Gravelly fine sandy loam.	GM	A–1 or A–2	5–15
			3–13	Gravelly sandy clay loam and gravelly fine sandy loam.	GM, GC, GC–GM, or GM–GP	A–1 or A–2	15–30
Muskogee: MzB	>60	>6	0–9	Silt loam	ML, CL, CL–ML	A–4	
			9–23	Silty clay loam	CL	A–6 or A–7	
			23–72	Clay	CH or MH	A–7	
*Nella: NaB, NaC, NaD, NED, NEE, NEF, NMD, NME, NMF, NSD, NSE. For properties of Enders part of NED, NEE, and NEF, see Enders series. For properties of Mountainburg parts of NMD, NME, and NMF, see Mountainburg series.	>72	>6	0–7	Gravelly fine sandy loam.	GM, GC–GM, SM, or SC–SM	A–2 or A–4	0–20
			7–36	Gravelly sandy clay loam and gravelly clay loam.	CL or SC	A–2, A–4, or A–6	0–15
			36–54	Gravelly clay loam.	GC, SC, or CL	A–2, A–4, or A–6	0–15
			54–72	Clay loam	GC, SC, or CL	A–4 or A–6	0–50
Pickwick: PcB, PcC	>72	>6	0–12	Silt loam and loam.	ML or CL–ML	A–4	
			12–72	Silty clay loam	CL	A–6	
Rock outcrop. Bedrock at or near the surface. Mapped only in association with Mountainburg soils.							
Roellen [2]: Ro	>72	1–2	0–37	Clay	CH	A–7	
			37–72	Clay	CH	A–7	
Spadra [2]: SpB	>72	>6	0–8	Fine sandy loam	ML, CL–ML, SM, or SC–SM	A–2 or A–4	
			8–39	Sandy clay loam	CL	A–4 or A–6	
			39–55	Fine sandy loam	ML, CL–ML, SM, or SC–SM	A–4	
			55–72	Fine sandy loam	ML, CL–ML, SM, or SC–SM	A–2 or A–4	
Taft: Ta	>60	0–1	0–8	Silt loam	ML or CL–ML	A–4	
			8–20	Silt loam	CL	A–4 or A–6	
			20–40	Silty clay loam	CL	A–6	
			40–72	Silty clay	CL, CH, or MH	A–6 or A–7	
Udorthents: Ud. Too variable to be estimated.							

[1] These values should not be confused with the coefficient "K" used by engineers.
[2] All or parts of these soils are subject to flooding.

significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability [1]	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
						Ins per hr	*Ins per in of soil*	*pH*			
--------	100	95–100	85–95	<30	NP–7	0.6–2.0	0.16–0.24	5.1–6.0	Low------	Low------	Moderate.
--------	100	95–100	85–95	30–40	12–20	0.2–0.6	0.18–0.22	5.1–6.0	Moderate..	Moderate..	Moderate.
--------	100	95–100	85–95	51–70	25–40	<0.06	0.12–0.18	4.5–5.5	High------	High------	Moderate to high.
--------	100	95–100	85–95	30–50	12–25	0.2–0.6	0.15–0.20	4.5–7.8	Moderate..	High------	Low to high.
--------	100	95–100	90–100	51–75	25–45	<0.06	0.12–0.18	6.1–7.8	High------	High------	Low.
--------	100	95–100	90–100	30–50	12–25	<0.06	0.15–0.22	6.1–7.8	Moderate..	High------	Low.
--------	100	95–100	65–95	<30	NP–5	0.6–2.0	0.13–0.24	6.1–8.4	Low------	Low------	Low.
35–50	30–50	25–40	20–35	--------	NP	2.0–6.0	0.05–0.10	5.1–6.0	Low------	Low------	Moderate.
30–50	25–50	20–40	10–25	<30	NP–10	2.0–6.0	0.05–0.10	4.5–5.5	Low------	Low------	Moderate to high.
100	95–100	90–100	85–95	20–32	1–10	0.6–2.0	0.16–0.24	4.5–5.5	Low------	Low------	Moderate to high.
100	95–100	90–100	85–95	30–45	12–22	0.2–0.6	0.18–0.22	4.5–5.5	Moderate..	Moderate..	Moderate to high.
100	95–100	90–100	85–95	51–70	22–40	0.06–0.2	0.12–0.18	4.5–5.5	High------	High------	Moderate to high.
55–85	50–75	40–65	15–45	<25	NP–5	0.6–2.0	0.08–0.13	5.1–6.0	Low------	Low------	Moderate.
65–90	60–85	50–75	25–55	27–40	8–20	0.6–2.0	0.10–0.15	4.5–6.0	Low------	Low------	Moderate to high.
40–90	35–85	40–75	15–55	30–40	10–20	0.6–2.0	0.10–0.15	4.5–6.0	Low------	Low------	Moderate to high.
65–90	55–85	50–70	40–60	30–40	10–20	0.6–2.0	0.08–0.15	4.5–6.0	Low------	Low------	Moderate to high.
95–100	95–100	90–100	65–90	<30	NP–7	0.6–2.0	0.15–0.24	5.1–6.5	Low------	Low------	Moderate.
100	95–100	95–100	75–95	30–40	14–22	0.6–2.0	0.18–0.22	4.5–5.5	Moderate..	Moderate..	Moderate to high.
--------	100	95–100	90–100	51–80	28–50	0.06–0.2	0.12–0.18	5.6–7.3	High------	High------	Low.
--------	100	95–100	90–100	51–80	28–50	0.06–0.2	0.12–0.18	5.6–7.8	High------	High------	Low.
85–100	80–100	65–80	30–75	<30	NP–5	0.6–2.0	0.09–0.15	5.1–6.0	Low------	Low------	Moderate.
90–100	85–100	80–95	55–75	28–40	8–15	0.6–2.0	0.10–0.17	4.5–5.5	Low------	Low to moderate.	Moderate to high.
90–100	85–100	70–85	36–80	<30	NP–7	0.6–2.0	0.09–0.15	4.5–5.5	Low------	Low------	Moderate to high.
70–100	55–100	40–80	20–65	<30	NP–5	0.6–2.0	0.08–0.15	4.5–5.5	Low------	Low------	Moderate to high.
100	95–100	90–100	85–95	<30	NP–	0.6–2.0	0.16–0.24	4.5–6.0	Low------	High------	Moderate to high.
100	95–100	90–100	85–95	25–35	8–15	0.6–2.0	0.16–0.24	4.5–5.5	Low------	High------	Moderate to high.
100	95–100	90–100	85–95	30–40	11–20	0.06–0.2	0.07–0.10	4.5–5.5	Low------	High------	Moderate to high.
100	95–100	90–100	85–95	35–60	15–30	0.06–0.2	0.14–0.18	4.5–5.5	Moderate..	High------	Moderate to high.

[3] Nonplastic.

TABLE 6.—*Interpretations of engineering*

[An asterisk in the first column indicates that at least one of the mapping units in this series is made up of two or more kinds of soils that to another series given

Soil series and map symbols	Suitability as a source of—		Soil features affecting—
	Topsoil	Roadfill [1]	Pond reservoir areas
Bruno: Br	Poor: sandy material	Good to fair: high to moderate bearing capacity.	High seepage rate
Cane: CaB, CaC	Fair: thin layer over moderately plastic material; material below a depth of 20 inches is difficult to reclaim.	Fair: moderate bearing capacity.	Soil features generally favorable
Caspiana: Cp	Fair: thin layer over moderately plastic material.	Fair: moderate bearing capacity.	Moderate permeability
Ceda: Cy	Poor: coarse fragments	Good to fair: high to moderate bearing capacity.	High seepage rate
*Enders: EnD, EMD, EME. For interpretations for Mountainburg parts of EMD and EME, see Mountainburg series.	Poor: coarse fragments; many slopes exceed 15 percent.	Poor: low bearing capacity; moderate to high shrink-swell potential; many slopes exceed 25 percent.	Bedrock at a depth between 42 and 76 inches or more.
Guthrie: Ge	Poor: poorly drained	Poor: poorly drained; low bearing capacity.	Soil features generally favorable.
Leadvale: LeB, LeC	Good: material below a depth of 20 inches is difficult to reclaim.	Fair: moderate bearing capacity.	Soil features generally favorable.
*Leesburg: LBD, LBE, LEE, LEF. For properties of Enders parts of LEE and LEF, see Enders series.	Poor: coarse fragments; most slopes exceed 15 percent.	Fair to good where slopes are less than 15 percent; moderate to high bearing capacity. Fair where slopes are 15 to 25 percent. Severe where slopes exceed 25 percent.	Moderate permeability
*Linker: LnB, LnC, LnD, LKD	Fair to poor: coarse fragments; thin layer over moderately plastic material; excavated areas difficult to reclaim in places.	Fair to poor: moderate bearing capacity; material between 20 and 40 inches thick; excavated area difficult or impossible to reclaim.	Moderate seepage rate; bedrock at a depth between 20 and 40 inches.
LMD. For interpretations of Mountainburg part, see Mountainburg series.	Poor: coarse fragments; thin layer over moderately plastic material; excavated areas difficult to reclaim in places; some slopes exceed 15 percent.	Fair to poor: moderate bearing capacity; material between 20 and 40 inches thick; excavated areas difficult or impossible to reclaim.	Moderate seepage rate; bedrock at a depth between 20 and 40 inches.

See footnote at end of table.

properties of the soils

may have different properties and different interpretations. For this reason the reader should follow carefully the instructions for referring in the first column]

Soil features affecting—Continued			
Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Medium strength; low to medium compressibility; medium to low permeability; fair compaction characteristics; subject to piping.	Excessively drained	Rapid intake rate; rapid permeability; low available water capacity.	Level to nearly level soil on bottom lands; practice not applicable.
Fair to good strength and compaction characteristics; medium to high compressibility.	Moderately well drained; slopes	Slow intake rate; slow permeability; medium available water capacity; medium runoff.	Soil features generally favorable.
Medium to low strength; medium compressibility; medium to low permeability; fair to good compaction characteristics; subject to piping unless well mixed.	Well drained	Moderate intake rate; high available water capacity.	Level to nearly level soil; practice not applicable.
Medium strength; low to medium compressibility; medium to low permeability; fair compaction characteristics; subject to piping.	Well drained	Rapid intake rate; low available water capacity.	Level to nearly level; frequently flooded soil on bottom lands; practice not applicable.
Low strength; high compressibility; low to medium permeability; fair to poor compaction characteristics.	Well drained; slopes	Slow intake rate; very slow permeability; high available water capacity; rapid runoff, generally nonarable soil.	Generally nonarable soil; impractical where slopes are more than 8 percent; erodible; very slow permeability; difficult to vegetate terrace channel; subsoil material in terrace embankment likely to crack when dry; terraces may fail.
Medium to low strength; medium compressibility; fair compaction characteristics; subject to piping.	Slow permeability; poorly drained.	Slow intake rate; slow permeability; poorly drained; medium available water capacity.	Level soil; practice not applicable.
Medium to low strength; medium compressibility; fair compaction characteristics; subject to piping unless well mixed.	Moderately well drained; slopes	Moderate intake rate; moderately slow permeability; medium available water capacity.	Soil features generally favorable.
Medium to low strength; low to medium compressibility; low permeability; fair to good compaction characteristics.	Well drained; slopes	Moderate intake rate; moderate permeability; medium available water capacity; rapid to very rapid runoff; generally nonarable soil.	Slopes excessive.
Medium strength; medium compressibility; fair compaction characteristics; thin layer of borrow material.	Well drained; slopes	Moderate intake rate; moderate permeability; medium available water capacity; medium to rapid runoff.	Soil features generally favorable; impractical where slopes are more than 8 percent; erodible; subject to piping; bedrock at a depth between 20 and 40 inches.
Medium strength; medium compressibility; fair compaction characteristics; thin layer of borrow material.	Well drained; slopes	Moderate intake rate; moderate permeability; medium available water capacity; rapid runoff.	Slopes excessive.

TABLE 6.—*Interpretations of engineering*

Soil series and map symbols	Suitability as a source of—		Soil features affecting—
	Topsoil	Roadfill [1]	Pond reservoir areas
McKamie: McC	Poor: thin layer over plastic, clayey material.	Poor: low bearing capacity; high shrink-swell potential.	Soil features generally favorable.
Moreland: Md	Poor: plastic, clayey material.	Poor: low bearing capacity; high shrink-swell potential.	Soil features generally favorable.
Morganfield: Mg	Good	Fair: moderate bearing capacity.	Moderate permeability
*Mountainburg: MoD, MsD, MsF, MED, MEE, MEF, MRF. For interpretations of Enders parts of MED, MEE, and MEF, see Enders series. For interpretations of Rock outcrop part of MRF, see Rock outcrop.	Poor: coarse fragments; thin layer; bedrock at a depth between 12 and 20 inches; many slopes exceed 15 percent; excavated area difficult or impossible to reclaim.	Poor: thin layer; coarse fragments; many slopes exceed 25 percent; excavated area impossible to reclaim.	High seepage rate; bedrock at a depth between 12 and 16 inches.
Muskogee: MzB	Fair: thin layer over moderately plastic material.	Poor: low bearing capacity; high shrink-swell potential.	Soil features generally favorable.
*Nella: NaB, NaC, NaD	Poor: coarse fragments	Fair to good: moderate to high bearing capacity.	Moderate permeability
NED, NEE, NEF, NMD, NME, NMF, NSD, NSE. For interpretations of Enders parts of NED, NEE, and NEF, see Enders series. For interpretations of Mountainburg parts of NMD, NME, and NMF, see Mountainburg series.	Poor: coarse fragments; most slopes exceed 15 percent.	Fair where slopes are less than 25 percent. Poor where slopes exceed 25 percent.	Moderate permeability
Pickwick: PcB, PcC	Fair: thin layer over moderately plastic material.	Fair to poor: moderate bearing capacity.	Moderate permeability
Rock outcrop. Mapped only in association with Mountainburg soils.	Unsuited: bedrock at or near the surface.	Unsuited: bedrock at or near the surface.	Bedrock at or near the surface.
Roellen: Ro	Poor: plastic, clayey material.	Poor: low bearing capacity; high shrink-swell potential.	Soil features generally favorable.
Spadra: SpB	Fair: thin layer over moderately plastic material.	Fair: moderate bearing capacity.	Moderate permeability

See footnote at end of table.

properties of the soils—Continued

Soil features affecting—Continued			
Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Medium to low strength; high compressibility; low permeability; fair to poor compaction characteristics.	Well drained; slopes	Slow intake rate; very slow permeability; high available water capacity; rapid runoff.	Erodible; very slow permeability; difficult to vegetate terrace channel; subsoil material in terrace embankment likely to crack when dry; terraces may fail.
Medium to low strength; high compressibility; low permeability; fair to poor compaction characteristics.	Very slow permeability; somewhat poorly drained.	Slow intake rate; very slow permeability; high available water capacity.	Level to nearly level soil on bottom lands; practice not applicable.
Medium to low strength; medium compressibility; medium to low permeability; fair to poor compaction characteristics; subject to piping.	Well drained	Moderate intake rate; moderate permeability; high available water capacity.	Level to nearly level soil on bottom lands; practice not applicable.
Thin layer of borrow material; coarse fragments; medium permeability; subject to piping.	Well drained; slopes	Rapid intake rate; moderately rapid permeability; low available water capacity; rapid runoff; generally nonarable soil.	Generally nonarable soil; coarse fragments; bedrock at a depth between 12 and 20 inches; most slopes excessive.
Medium to low strength; medium to high compressibility; low permeability; fair to poor compaction characteristics.	Moderately well drained; slopes	Slow intake rate; slow permeability; high available water capacity; medium to rapid runoff.	Soil features generally favorable.
Medium to low strength; low to medium compressibility; low permeability; fair to good compaction characteristics.	Well drained; slopes	Moderate intake rate; moderate permeability; medium available water capacity; medium to rapid runoff.	Soil features generally favorable; impractical where slopes are more than 8 percent.
Medium to low strength; low to medium compressibility; low permeability; fair to good compaction characteristics.	Well drained; slopes	Moderate intake rate; moderate permeability; medium available water capacity; rapid to very rapid runoff; generally nonarable soil.	Slopes excessive.
Medium to low strength; medium compressibility; low permeability; fair to good compaction characteristics.	Well drained; slopes	Moderate intake rate; moderate permeability; high available water capacity; medium runoff.	Soil features generally favorable.
Bedrock at or near the surface	Excessively drained; bedrock at or near the surface.	Bedrock at or near the surface; nonarable; practice not applicable.	Bedrock at or near the surface; nonarable; practice not applicable.
Medium to low strength; high compressibility; low permeability; fair to poor compaction characteristics.	Slow permeability; poorly drained.	Slow intake rate; slow permeability; high available water capacity.	Level soil on bottom lands; practice not applicable.
Medium to low strength; medium compressibility; low to medium permeability; fair to good compaction characteristics; subject to piping unless well mixed.	Well drained; slopes	Moderate intake rate; moderate permeability; medium available water capacity.	Soil features generally favorable; subject to occasional flooding.

TABLE 6.—*Interpretations of engineering*

Soil series and map symbols	Suitability as a source of—		Soil features affecting—
	Topsoil	Roadfill [1]	Pond reservoir areas
Taft: Ta	Good	Fair: moderate bearing capacity; poor below a depth of 40 inches; low bearing capacity.	Soil features generally favorable.
Udorthents: Ud	Poor: coarse fragments; most slopes exceed 15 percent.	Poor: coarse fragments; many slopes exceed 25 percent.	Variable material; moderately slow to moderately rapid permeability.

[1] Engineers and others should not apply specific values to estimates given for bearing capacity of soils.

TABLE 7.—*Engineering*

[Tests performed by the Arkansas State Highway Department, Division of Materials

Soil name and location	Parent material	Arkansas SCS report number S71-Ark-60-	Moisture density [1]		
			Depth	Maximum dry density	Optimum moisture
			In	*Lb per ft³*	*Pct*
Caspiana silt loam: SW¼NW¼NW¼ sec. 32, T. 9 N., R. 25 W. (Modal).	Loamy alluvium.	2-2	10-24	107	17
		2-4	30-40	111	16
		2-5	40-52	106	15
Leadvale silt loam: NW¼NE¼SW¼ sec. 20, T. 9 N., R. 25 W. (Modal).	Loamy valley fill.	15-2	5-10	111	13
		15-4	18-23	113	16
		15-5	23-49	104	20
Morganfield silt loam: NW¼NE¼SW¼ sec. 32, T. 9 N., R. 25 W. (Modal).	Loamy alluvium.	16-2	7-14	106	16
		16-3	14-30	101	18
		16-4	30-41	103	17
Muskogee silt loam: SE¼NE¼NE¼ sec. 20, T. 9 N., R. 24 W. (Modal).	Loamy and clayey alluvium.	13-2	4-9	108	17
		13-4	23-39	95	26
		13-5	39-50	96	21
Pickwick silt loam: SE¼SE¼SW¼ sec. 6, T. 9 N., R. 23 W. (Modal).	Loamy alluvium.	6-1	0-6	113	12
		6-3	12-22	115	15
		6-5	35-52	111	17

[1] Based on AASHTO designation T-99-57, Method A (*2*).

[2] Mechanical analyses according to the AASHTO designation T-88-57 (*2*). Results of this procedure may differ somewhat from the results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by hydrometer method, and the various grain-sized fractions are calculated on the basis of all material up to and including that 3 inches in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from the calculation of grain-sized fractions. The mechanical analyses data used in this table are not suitable for use in naming textural classes of soil.

properties of the soils—Continued

Soil features affecting—Continued			
Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Medium to low strength; medium compressibility; low permeability; fair to good compaction characteristics.	Slow permeability; somewhat poorly drained.	Slow intake rate; slow permeability; medium available water capacity.	Level soil; practice not applicable.
Variable material; coarse fragments.	Well drained to somewhat poorly drained; slopes.	Moderate to rapid intake rate; moderately slow to moderately rapid permeability; low available water capacity; rapid runoff; generally nonarable soil material.	Generally nonarable soil material; coarse fragments; slopes excessive.

test data

and Tests. Absence of an entry indicates that no determination was made]

Mechanical analysis [2]				Liquid limit [3]	Plasticity index [4]	Classification	
Percentage less than 3 inches passing sieve—							
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)			AASHTO [5]	Unified [6]
----------	----------	100	88	34	15	A-6 (15)	CL
----------	----------	100	83	28	9	A-4 (7)	CL
----------	----------	100	72	----------	[7] NP	A-4 (4)	ML
100	99	98	67	----------	NP	A-4 (1)	ML
100	99	96	76	31	12	A-6 (8)	CL
100	98	96	78	41	18	A-7-6 (14)	CL
----------	----------	100	93	----------	NP	A-4 (4)	ML
----------	----------	100	70	----------	NP	A-4 (2)	ML
----------	----------	100	84	----------	NP	A-4 (3)	ML
100	98	91	86	31	9	A-4 (7)	ML-CL
100	98	91	82	54	25	A-7-6 (23)	MH-CH
100	99	97	91	55	30	A-7-6 (31)	CH
99	98	95	71	----------	NP	A-2-4 (0)	ML
----------	100	99	82	32	16	A-6 (12)	CL
----------	100	99	80	40	21	A-6 (16)	CL

[3] Based on AASHTO designation T-89-60 (*2*).
[4] Based on AASHTO designations T-90-56 and T-91-54 (*2*).
[5] Based on AASHTO designation M145-66-I (*1*).
[6] Based on ASTM designation D 2487-66T (*3*).
[7] NP = nonplastic.

Depth to bedrock is distance from the surface of the soil to the upper surface of the rock layer.

Depth to seasonal high water table is distance from the surface of the soil to the highest level that ground water reaches in the soil in most years. The depths given in table 5 are the depths to a seasonal perched water table that is separated from the permanent water table by an impervious layer or a dry zone.

Soil texture is described in table 5 in the standard terms used by the Department of Agriculture. These terms take into account relative percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "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, for example, "gravelly fine sandy loam." "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 moisture content of a clayey soil is increased from a dry state, the material changes from a semisolid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material changes from the semisolid to plastic state; and the liquid limit, from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic. Liquid limit and plasticity index are estimated in table 5, but in table 7 the data on liquid limit and plasticity index are based on tests of soil samples.

Permeability is that quality of a soil that enables it to transmit water or air. It is estimated on the basis of those soil characteristics observed in the field, particularly structure and texture. The estimates in table 5 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts. These estimates should not be confused with the coefficient "K" used by engineers.

Available water capacity is the ability of soils to hold water for use by most plants. It is commonly defined as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most crop plants.

Reaction is the degree of acidity or alkalinity of a soil, expressed in pH values. The pH value and terms used to describe soil reaction are defined in the Glossary.

Shrink-swell potential is the relative change in volume to be expected of soil material with changes in moisture content, that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. Extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils causes much damage to building foundations, roads, and other structures. A *high* shrink-swell potential indicates a hazard to maintenance of structures built in, on, or with material having this rating.

Corrosivity, as used in table 5, pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. Rate of corrosion of uncoated steel is related to soil properties such as drainage, texture, total acidity, and electrical conductivity of the soil material. Corrosivity for concrete is influenced mainly by the content of sodium or magnesium sulfate, but also by soil texture and acidity. Installations of uncoated 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. A corrosivity rating of *low* means that there is a low probability of soil-induced corrosion damage. A rating of *high* means that there is a high probability of damage, so that protective measures for steel and more resistant concrete should be used to avoid or minimize damage.

Engineering interpretations

The estimated interpretations in table 6 are based on the engineering properties of soils shown in table 5, 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 Johnson County. In table 6, ratings are used to summarize suitability of the soils for listed purposes other than for pond reservoir areas; embankments, dikes and levees; drainage of cropland and pasture; irrigation; and terraces and diversions. For these particular uses, table 6 lists those soil features not to be overlooked in planning, installation, and maintenance. Specific values should not be assigned to the ratings of bearing capacity given in table 6.

Soil suitability is rated by the terms *good, fair,* and *poor,* which have, respectively, meanings approximately parallel to the terms slight, moderate, and severe. The latter terms are defined in the section "Town and Country Planning."

Sand and gravel are used in great quantities in many kinds of construction. Because these materials of suitable quality for use as aggregate are of very limited quantity in Johnson County, soils are not rated for suitability as possible sources.

Following are explanations of the columns in table 6.

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 response of 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 at the area from which topsoil is taken.

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.

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 unfavorable factors.

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; accumulations 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; depth to bedrock or other unfavorable material; presence of stones; 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.

Additional interpretations of engineering uses of soils are given in the section "Town and Country Planning."

Soil test data

Table 7 contains engineering test data for some of the major soil series in Johnson County. These tests were made to help evaluate the soils for engineering purposes. The engineering classifications given are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods.

Compaction (or moisture-density) data are important in earthwork. If a soil material is compacted at successively higher moisture content, assuming that the compactive effort remains constant, the density of the compacted material increases until the *optimum moisture content* is reached. After that, density decreases as moisture content increases. The highest dry density obtained in the compactive test is termed *maximum dry density*. As a rule, maximum strength of earthwork is obtained if the soil is compacted to the *maximum dry density*.

Tests to determine liquid limit and plastic limit measure the effect of water on the consistence of soil material, as has been explained for table 6.

Town and Country Planning

Table 8 gives the degree and kind of limitation of the soils of Johnson County for selected nonfarm uses. The degrees of limitation reflect all the features of the given soil, to a depth of about 6 feet or to bedrock, that affect a particular use (fig. 10).

Soil limitations are indicated by the ratings slight, moderate, and severe. *Slight* means that soil properties are generally favorable for the rated use—limitations are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means that soil properties are so unfavorable and so difficult to overcome or correct that they require major soil reclamation, special designs, or intense maintenance.

Following are explanations of the columns in table 8.

Dwellings without basements 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.

Shallow excavations are those that require digging or trenching to a depth of less than 6 feet, for example, excavations for pipelines, sewer lines, phone 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 from a high water table.

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 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.

Ratings for light industry are for undisturbed soils that are used to support building foundations. Emphasis is on foundations, ease of excavation for underground utilities, and corrosion potential of uncoated

TABLE 8.—*Degree and kind of limitation for building*

Soil series and map symbols	Dwellings without basements [1]	Shallow excavations	Local roads and streets [1]
Bruno: Br	Slight in areas not subject to flooding. Severe in areas subject to occasional flooding.	Severe: predominantly sandy material; sidewalls unstable.	Slight in areas not subject to flooding. Moderate in areas subject to occasional flooding.
Cane: CaB, CaC	Moderate: moderate bearing capacity.	Moderate: moderately well drained; perched seasonal high water table.	Moderate: moderate bearing capacity.
Caspiana: Cp	Moderate in areas not subject to flooding; moderate bearing capacity. Severe in areas subject to occasional flooding.	Slight in areas not subject to flooding. Moderate in areas subject to occasional flooding.	Moderate: moderate bearing capacity; some areas are subject to occasional flooding.
Ceda: Cy	Severe: subject to frequent flooding.	Severe: coarse fragments; subject to frequent flooding.	Severe: subject to frequent flooding.
Enders: EnD, EMD, EME For interpretation of Mountainburg parts of EMD and EME, see Mountainburg series.	Severe: low bearing capacity; moderate to high shrink-swell potential; many slopes exceed 15 percent.	Severe: predominantly clayey material; many slopes exceed 15 percent.	Severe: low bearing capacity; moderate to high shrink-swell potential; many slopes exceed 15 percent.
Guthrie: Ge	Severe: poorly drained; perched seasonal high water table; low bearing capacity.	Severe: poorly drained; perched seasonal high water table.	Severe: poorly drained; low bearing capacity.
Leadvale: LeB, LeC	Moderate: moderately well drained; moderate bearing capacity.	Moderate: moderately well drained; perched seasonal high water table.	Moderate: moderate bearing capacity.
Leesburg: LBD, LBE, LEE, LEF For interpretations of Enders part of LEE and LEF, see Enders series.	Moderate where slopes are 8 to 15 percent; moderate bearing capacity. Severe where slopes exceed 15 percent.	Moderate where slopes are 8 to 15 percent; coarse fragments. Severe where slopes exceed 15 percent.	Moderate where slopes are 8 to 15 percent; moderate bearing capacity. Severe where slopes exceed 15 percent.
Linker: LnB, LnC, LnD, LKD, LMD For interpretations of Mountainburg part of LMD, see Mountainburg series.	Moderate where slopes are 15 percent or less; moderate bearing capacity; hard bedrock is at a depth of 20 to 40 inches. Severe where slopes exceed 15 percent.	Severe: hard bedrock is at a depth of 20 to 40 inches; some slopes exceed 15 percent.	Moderate where slopes are 15 percent or less; moderate bearing capacity; hard bedrock is at a depth of 20 to 40 inches. Severe where slopes exceed 15 percent.
McKamie: McC	Severe: low bearing capacity; high shrink-swell potential.	Severe: plastic, clayey material.	Severe: low bearing capacity; high shrink-swell potential.
Moreland: Md	Severe: low bearing capacity; high shrink-swell potential; perched seasonal high water table; some areas subject to occasional flooding.	Severe: somewhat poorly drained; perched seasonal high water table; predominantly plastic, clayey material.	Severe: low bearing capacity; high shrink-swell potential.
Morganfield: Mg	Moderate in areas not subject to flooding; moderate bearing capacity. Severe in areas subject to occasional flooding.	Slight in areas not subject to flooding. Moderate in areas subject to occasional flooding.	Moderate: moderate bearing capacity; some areas subject to occasional flooding.
Mountainburg: MoD, MsD, MsF, MED, MEE, MEF, MRF. For interpretations of Enders parts of MED, MEE, and MEF, see Enders series. For Rock outcrop part of MRF, see Rock outcrop.	Severe: hard bedrock is at a depth of 12 to 20 inches; many slopes exceed 15 percent.	Severe: coarse fragments; hard bedrock is at a depth of 12 to 20 inches; many slopes exceed 15 percent.	Severe: hard bedrock is at a depth of 12 to 20 inches; many slopes exceed 15 percent.

See footnotes at end of table.

sites and sewage and solid-waste disposal systems

Light industry [1]	Septic-tank absorption fields	Sewage lagoons [2]	Sanitary landfill (trench type) [3]
Slight in areas not subject to flooding. Severe in areas subject to occasional flooding.	Slight in areas not subject to flooding or pollution of ground water. Severe in areas subject to occasional flooding or that have a hazard of pollution of ground water.	Severe: rapid permeability; some areas subject to occasional flooding.	Severe: rapid permeability.
Moderate: moderate bearing capacity.	Severe: slow permeability	Slight where slopes are less than 2 percent. Moderate where slopes are 2 to 7 percent. Severe where slopes exceed 7 percent.	Moderate: moderately well drained; material somewhat plastic.
Moderate in areas not subject to flooding; moderate bearing capacity. Severe in areas subject to occasional flooding.	Moderate in areas not subject to flooding; moderate permeability. Severe in areas subject to occasional flooding.	Moderate in areas not subject to flooding; moderate permeability. Severe in areas subject to occasional flooding.	Moderate in areas not subject to flooding; material somewhat plastic. Severe in areas subject to occasional flooding.
Severe: subject to frequent flooding.	Severe: subject to frequent flooding.	Severe: coarse fragments; subject to frequent flooding.	Severe: coarse fragments; subject to frequent flooding.
Severe: low bearing capacity; moderate to high shrink-swell potential; most slopes exceed 8 percent.	Severe: very slow permeability; many slopes exceed 15 percent.	Moderate where slopes are 7 percent or less. Severe where slopes exceed 7 percent.	Severe: predominantly clayey material; many slopes exceed 25 percent.
Severe: poorly drained; perched seasonal high water table; low bearing capacity.	Severe: slow permeability; perched seasonal high water table.	Slight	Severe: poorly drained; perched seasonal high water table.
Moderate: moderately well drained; moderate bearing capacity; many slopes exceed 4 percent.	Severe: moderately slow permeability; perched seasonal high water table.	Slight where slopes are 2 percent or less. Moderate where slopes are 2 to 7 percent. Severe where slopes exceed 7 percent.	Moderate: moderately well drained; material somewhat plastic.
Severe: slopes exceed 8 percent	Moderate where slopes are 8 to 15 percent. Severe where slopes exceed 15 percent.	Severe: slopes exceed 7 percent.	Moderate where slopes are 8 to 25 percent; coarse fragments. Severe where slopes exceed 25 percent.
Moderate where slopes are 8 percent or less; moderate bearing capacity; hard bedrock is at a depth of 20 to 40 inches. Severe where slopes exceed 8 percent.	Severe: hard bedrock is at a depth of 20 to 40 inches; many slopes in LMD exceed 15 percent.	Severe: hard bedrock is at a depth of 20 to 40 inches; many slopes exceed 7 percent.	Severe: hard bedrock is at a depth of 20 to 40 inches.
Severe: low bearing capacity; high shrink-swell potential.	Severe: very slow permeability.	Moderate where slopes are 3 to 7 percent. Severe where slopes exceed 7 percent.	Severe: plastic, clayey material.
Severe: low bearing capacity; high shrink-swell potential; perched seasonal high water table; some areas subject to occasional flooding.	Severe: very slow permeability; perched seasonal high water table.	Slight in areas not subject to flooding. Severe in areas subject to occasional flooding.	Severe: perched seasonal high water table; predominantly plastic, clayey material.
Moderate in areas not subject to flooding; moderate bearing capacity. Severe in areas subject to occasional flooding.	Slight in areas not subject to flooding. Severe in areas subject to occasional flooding.	Moderate in areas not subject to flooding; moderate permeability. Severe in areas subject to occasional flooding.	Slight in areas not subject to flooding. Moderate in areas subject to occasional flooding.
Severe: hard bedrock is at a depth of 12 to 20 inches; many slopes exceed 8 percent.	Severe: hard bedrock is at a depth of 12 to 20 inches; many slopes exceed 15 percent.	Severe: hard bedrock is at a depth of 12 to 20 inches; coarse fragments; many slopes exceed 7 percent.	Severe: hard bedrock is at a depth of 12 to 20 inches; coarse fragments; some slopes exceed 25 percent.

TABLE 8.—*Degree and kind of limitation for building*

Soil series and map symbols	Dwellings without basements [1]	Shallow excavations	Local roads and streets [1]
Muskogee: MzB	Severe: low strength; moderate to high shrink-swell potential.	Severe: predominantly plastic, clayey material.	Severe: low bearing capacity; moderate to high shrink-swell potential.
Nella: NaB, NaC, NaD, NED, NEE, NEF, NMD, NME, NMF, NSD, NSE. For interpretations of Enders parts of NED, NEE, and NEF, see Enders series. For interpretations of Mountainburg parts of NMD, NME, and NMF, see Mountainburg series.	Slight to moderate where slopes are 1 to 8 percent; moderate to high bearing capacity. Moderate where slopes are 8 to 15 percent. Severe where slopes exceed 15 percent.	Moderate where slopes are 1 to 15 percent; coarse fragments. Severe where slopes exceed 15 percent.	Slight to moderate where slopes are 1 to 8 percent; moderate to high bearing capacity. Moderate where slopes are 8 to 15 percent. Severe where slopes exceed 15 percent.
Pickwick: PcB, PcC	Moderate: moderate bearing capacity.	Slight	Moderate: moderate bearing capacity.
Rock outcrop. Mapped only in association with Mountainburg soils.	Severe: bedrock at or near the surface.	Severe: bedrock at or near the surface.	Severe: bedrock at or near the surface.
Roellen: Ro	Severe: poorly drained; low bearing capacity; high shrink-swell potential; perched seasonal high water table; some areas subject to occasional flooding.	Severe: poorly drained; perched seasonal high water table; predominantly plastic, clayey material.	Severe: poorly drained; low bearing capacity; high shrink-swell potential.
Spadra: SpB	Severe: subject to occasional flooding.	Severe: subject to occasional flooding.	Moderate: moderate bearing capacity; subject to occasional flooding.
Taft: Ta	Severe: perched seasonal high water table.	Severe: somewhat poorly drained; perched seasonal high water table.	Severe: perched seasonal high water table.
Udorthents: Ud	Severe in areas that have not been smoothed; most slopes exceed 15 percent. Moderate in areas that have been smoothed.	Severe: coarse fragments; most slopes exceed 15 percent.	Severe: coarse fragments; most slopes exceed 15 percent.

[1] Engineers and others should not apply specific values to estimates given for bearing capacity of soils.
[2] For information about lagoon embankments, see Table 6, column "Embankments, dikes, and levees."

steel pipe. The undisturbed soil is rated for spread footing foundations for buildings less than three stories high or foundation loads not in excess of that weight. Properties affecting load-supporting capacity and settlement under load are wetness, flooding, texture, plasticity, density, and shrink-swell behavior. Properties affecting excavation are wetness, flooding, slope, and depth to bedrock. Properties affecting corrosion of buried uncoated steel pipe are wetness, texture, total acidity, and electrical resistivity.

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 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 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 that affect the pond floor and the embankment are considered. Those that affect the pond floor are permeability, organic matter, and slope, and if the floor needs to be leveled, depth to bedrock is 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

sites and sewage and solid-waste disposal systems—Continued

Light industry [1]	Septic-tank absorption fields	Sewage lagoons [2]	Sanitary landfill (trench type) [3]
Severe: low strength; moderate to high shrink-swell potential.	Severe: slow permeability	Slight where slopes are 1 to 2 percent. Moderate where slopes exceed 2 percent.	Severe: predominantly plastic, clayey material.
Slight to moderate where slopes are 1 to 4 percent; moderate to high bearing capacity. Moderate where slopes are 4 to 8 percent. Severe where slopes exceed 8 percent.	Slight where slopes are 1 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes exceed 15 percent.	Moderate where slopes are 1 to 7 percent; moderate permeability. Severe where slopes exceed 7 percent.	Moderate where slopes are 1 to 25 percent; coarse fragments. Severe where slopes exceed 25 percent.
Moderate: moderate bearing capacity.	Slight	Moderate where slopes are 1 to 7 percent; moderate permeability. Severe where slopes exceed 7 percent.	Moderate: material somewhat plastic.
Severe: bedrock at or near the surface.	Severe: bedrock at or near the surface.	Severe: bedrock at or near the surface.	Severe: bedrock at or near the surface.
Severe: poorly drained; low bearing capacity; high shrink-swell potential; perched seasonal high water table; some areas subject to occasional flooding.	Severe: slow permeability; perched seasonal high water table.	Slight in areas not subject to flooding. Severe in areas subject to occasional flooding.	Severe: plastic clayey material; perched seasonal high water table.
Severe: subject to occasional flooding.	Severe: subject to occasional flooding.	Severe: subject to occasional flooding.	Severe: subject to occasional flooding.
Severe: perched seasonal high water table.	Severe: slow permeability; perched seasonal high water table.	Slight	Severe: perched seasonal high water table.
Severe: slopes exceed 8 percent	Severe in areas that have not been smoothed; most slopes exceed 15 percent. Moderate in areas that have been smoothed.	Severe: coarse fragments; slopes exceed 7 percent.	Severe: coarse fragments; many slopes exceed 25 percent.

[3] Onsite studies of the underlying strata, water tables, and hazards of aquifer pollution and drainage into ground water need to be made for landfills deeper than 6 feet.

of stone, if any, that influence the ease of excavation and compaction of the embankment material.

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 or 15 feet; regardless of that, every site should be investigated before it is selected. For information about the use of soils for area type sanitary landfill, contact the local Soil Conservation Service office.

The detailed soil map and information in table 8 are guides for evaluating areas for the specific uses. They do not eliminate the need for detailed onsite investigations before a final determination is made.

Additional information that may be useful in town and country planning is given in the section "Engineering Uses of the Soils."

Use of the Soils for Recreational Development

Knowledge of soils is necessary in planning, developing, and maintaining areas used for recreation (fig. 11). In table 9 the soils of Johnson County are rated according to limitations that affect their suitability for camp areas, playgrounds, picnic areas, and paths and trails.

Figure 10.—**The Linker fine sandy loam shown has severe limitations for most nonfarm uses but only moderate limitations for homesites.**

In table 9 the soils are rated as having slight, moderate, or severe limitations for the specified uses. For all of these ratings, it is assumed that a good cover of vegetation can be established and maintained. A limitation of *slight* means that soil properties are generally favorable and limitations are so minor that they easily can be overcome. A *moderate* limitation can be overcome or modified by planning, by design, or by special maintenance. A *severe* limitation means that costly soil reclamation, special design, intense maintenance, or a combination of these, is required.

Camp areas are used intensively for tents and small camp trailers and the accompanying activities of outdoor living. Little preparation of the site is required other than shaping and leveling for tent and parking areas. Camp areas are subject to heavy foot traffic and limited vehicular traffic. The best soils have mild slopes, good drainge, a surface free of rocks and coarse fragments, freedom from flooding during periods of heavy use, and a surface that is firm after rains but not dusty when dry.

Playgrounds are areas used intensively for baseball, football, badminton, and similar organized games. Soils suited to this use need to withstand intensive foot traffic. The best soils have a nearly level surface free of coarse fragments and rock outcrops, good drainage, freedom from flooding during periods of heavy use, and a surface that is firm after rains but not dusty when dry. If grading and leveling are required, depth to rock is important.

Picnic areas are attractive natural or landscaped tracts used primarily for preparing meals and eating outdoors. These areas are subject to heavy foot traffic. Most of the vehicular traffic, however, is confined to access roads. The best soils are firm when wet but not dusty when dry; are free of flooding during the season of use; do not have slopes or stoniness that greatly increases cost of leveling sites or of building access roads.

Paths and trails are used for local and cross country travel by foot or horseback. Design and layout should require little or no cutting and filling. The best soils are at least moderately well drained, are firm when wet but not dusty when dry, are flooded not more than once during the season of use, have slopes of less than 15 percent, and have few or no rocks or stones on the surface.

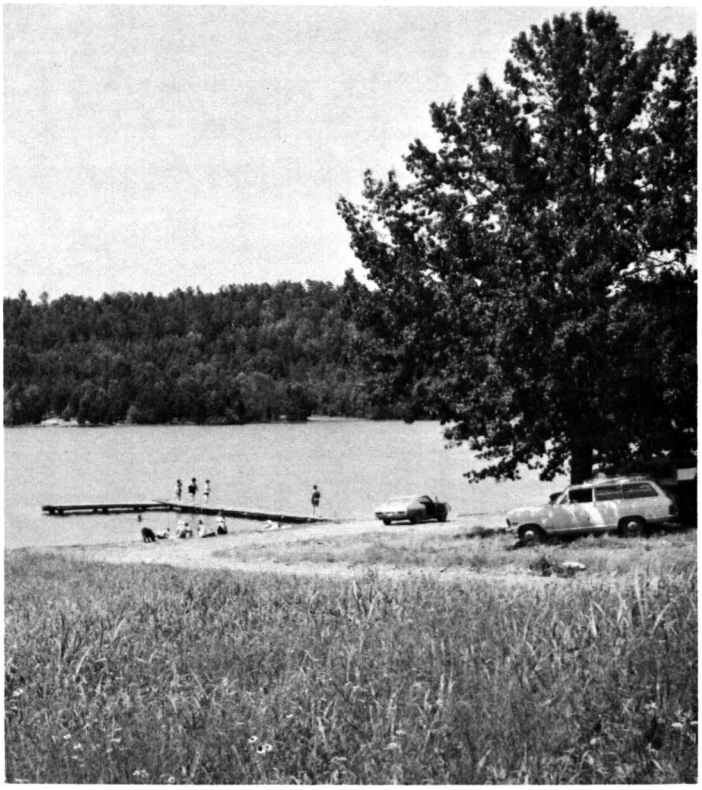

Figure 11.—Recreation on Lake Ludwig. Pickwick silt loam, 3 to 8 percent slopes (foreground) is well suited to this use; Mountainburg-Enders association, rolling (opposite side of lake) has severe limitations for most recreational uses.

Formation and Classification of the Soils

In this section the factors that affect soil formation in Johnson County and the processes of horizon differentiation are discussed. The current system of soil classification is then explained, and the soil series are placed in some of the higher categories of that system. Following that, physical and chemical analyses are given for representative profiles of selected soil series. The soil series in the county, including a profile representative of each series, are described in the section "Descriptions of the Soils."

Factors of Soil Formation

Soil is formed by weathering and other processes that act upon the soil. The characteristics of the soil at any given point depend upon climate, living organisms, parent material, relief, and time. Each factor acts on the soil and modifies the effect of the other four. When climate, living organisms, or any other one of the five factors is varied to a significant extent, a different soil may be formed (*9*).

Climate and living organisms are the active forces in soil formation. Relief modifies the effects of climate and living organisms, mainly by its influence on temperature and runoff. Because climate, vegetation, parent material, and relief interact over a period of time, time is the fifth factor of soil formation. Thus, the effect of time is also reflected in the soil characteristics.

The interaction of the five factors of soil formation is more complex for some soils than for others. The five factors and how they interact to form some of the soils in the county are discussed in the following paragraphs.

Climate

The climate of Johnson County is characterized by warm summers, mild winters, and fairly abundant rainfall. The generally warm temperatures and high precipitation probably are similar to the climate under which the soils in the county formed. The average daily temperature is about 81° F in July and about 39° in January. The total annual rainfall is about 46 inches and is well distributed throughout the year. For additional information about the climate, refer to the section "General Nature of the County."

The warm, moist climate promotes rapid soil formation, and the warm temperature permits rapid chemical reactions. Abundant rainfall makes a large amount of water available for moving dissolved or suspended materials downward in the profile. As a result the remains of plants decompose rapidly, and the organic acids produced hasten the removal of carbonates and the development of clay minerals. Because the soil is frozen only to shallow depths and for relatively short periods, these soil forming processes can continue almost the year round. The climate throughout the county is relatively uniform, though its effect is modified locally by runoff and slope aspect. Climate alone does not account for differences in the soils of the county.

Living organisms

The higher plants and animals, as well as insects, bacteria, and fungi, are important in the formation of soils. Among the changes they cause are gains in organic matter and nitrogen in the soil, gains or losses in plant nutrients, and changes in structure and porosity.

Before Johnson County was settled, the native vegetation had more influence on soil formation than did animal activity. Hardwood forests covered the bottom lands. Bruno, Caspiana, Moreland, Morganfield, and Roellen soils formed in these areas. They differ from each other chiefly because of the effects of parent material and age.

The upland part of the county had about three different types of native vegetation. The level and nearly level areas in the broad valleys in the southern half of the county supported a luxuriant growth of tall bunchgrasses with scattered hardwood trees. The soils, mainly Guthrie, Muskogee, and Taft soils, do not have the thick, dark-colored surface layer commonly associated with soils formed under this type of vegetation. Apparently, their characteristics were influenced more by parent material, climate, and relief than by vegetation.

TABLE 9.—*Degree and kind of limitation for recreational development*

Soil series and map symbols	Camp areas	Playgrounds	Picnic areas	Paths and trails
Bruno: Br	Moderate where areas are not subject to flooding: sandy surface; poor trafficability; difficult to establish and maintain vegetation. Severe where areas are subject to occasional flooding.	Moderate where areas are not subject to flooding: sandy surface; poor trafficability; difficult to establish and maintain vegetation. Severe where areas are subject to occasional flooding.	Moderate where areas are not subject to flooding: sandy surface; poor trafficability; difficult to establish and maintain vegetation. Severe where areas are subject to occasional flooding.	Severe: sandy surface; poor trafficability.
Cane: CaB, CaC	Moderate: slow permeability.	Moderate where slopes are 6 percent or less: slow permeability. Severe where slopes exceed 6 percent.	Slight	Slight.
Caspiana: Cp	Slight where areas are not subject to flooding. Moderate where areas are subject to occasional flooding.	Slight where areas are not subject to flooding. Moderate where areas are subject to occasional flooding.	Slight where areas are not subject to flooding. Moderate where areas are subject to occasional flooding.	Slight.
Ceda: Cy	Severe: subject to frequent flooding.	Severe: coarse fragments; subject to frequent flooding.	Moderate: coarse fragments; subject to frequent flooding.	Moderate: coarse fragments; subject to frequent flooding.
Enders: EnD (MED, NED)	Severe: very slow permeability.	Severe: very slow permeability; coarse fragments; most slopes exceed 6 percent.	Moderate: coarse fragments.	Moderate: coarse fragments.
EMD, EME (LEE, LEF, MED, MEE, MEF, NED, NEE, NEF). For interpretations of Mountainburg parts, see Mountainburg series.	Severe: very slow permeability; surface stones; most slopes exceed 15 percent.	Severe: very slow permeability; surface stones; most slopes exceed 6 percent.	Moderate where slopes are less than 15 percent: surface stones. Severe where slopes exceed 15 percent.	Severe: surface stones; many slopes exceed 25 percent.
Guthrie: Ge	Severe: poorly drained	Severe: poorly drained	Severe: poorly drained	Severe: poorly drained.
Leadvale: LeB, LeC	Moderate: moderately slow permeability.	Moderate where slopes are 6 percent or less: moderately slow permeability. Severe where slopes exceed 6 percent.	Slight	Slight.
Leesburg: LBD, LBE, LEE, LEF. For interpretations of Enders parts of LEE and LEF, see Enders series.	Moderate where slopes are 15 percent or less: surface stones in some areas. Severe where slopes exceed 13 percent.	Severe: slopes exceed 6 percent; surface stones in some areas.	Moderate where slopes are 15 percent or less. Severe where slopes exceed 15 percent.	Slight where slopes are less than 15 percent: surface stones in some areas. Moderate where slopes are 15 to 25 percent. Severe where slopes exceed 25 percent.
Linker: LnB, LnC, LnD, LKD, LMD. For interpretations of Mountainburg part of LMD, see Mountainburg series.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes exceed 15 percent.	Slight where slopes are less than 2 percent. Moderate where slopes are 2 to 6 percent. Severe where slopes exceed 6 percent.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes exceed 15 percent.	Slight where slopes are less than 15 percent. Moderate where slopes exceed 15 percent.
McKamie: McC	Severe: very slow permeability.	Severe: very slow permeability.	Slight	Slight.
Moreland: Md	Severe: somewhat poorly drained; very slow permeability; clayey surface; poor trafficability.	Severe: somewhat poorly drained; very slow permeability; clayey surface; poor trafficability.	Severe: clayey surface; poor trafficability.	Severe: clayey surface; poor trafficability.

TABLE 9.—*Degree and kind of limitation for recreational development*—Continued

Soil series and map symbols	Camp areas	Playgrounds	Picnic areas	Paths and trails
Morganfield: Mg	Slight where areas are not subject to flooding. Moderate where areas are subject to occasional flooding.	Slight where areas are not subject to flooding. Moderate where areas are subject to occasional flooding.	Slight where areas are not subject to flooding. Moderate where areas are subject to occasional flooding.	Slight.
Mountainburg: MoD	Moderate: coarse fragments; many slopes exceed 8 percent; difficult to maintain vegetative cover.	Severe: coarse fragments; hard bedrock is at a depth of 12 to 20 inches; most slopes exceed 6 percent; difficult to maintain vegetative cover.	Moderate: coarse fragments; many slopes exceed 8 percent; difficult to maintain vegetative cover.	Moderate: coarse fragments.
MsD, MsF, MED, MEE, MEF, MRF (LMD, NMD, NME, NMF). For interpretations of Enders part of MED, MEE, and MEF, see Enders series. For interpretations of Rock outcrop part of MRF, see Rock outcrop.	Severe: surface stones; many slopes exceed 15 percent; difficult to maintain vegetative cover.	Severe: surface stones; hard bedrock is at a depth of 12 to 20 inches; most slopes exceed 6 percent; difficult to maintain vegetative cover.	Moderate where slopes are 15 percent or less: surface stones; difficult to maintain vegetative cover. Severe where slopes exceed 15 percent.	Severe: surface stones; many slopes exceed 25 percent.
Muskogee: MzB	Moderate: slow permeability.	Moderate: slow permeability; some slopes exceed 2 percent.	Slight	Slight.
Nella: NaB, NaC, NaD	Moderate: coarse fragments; slope.	Moderate where slopes are 6 percent or less; coarse fragments. Severe where slopes exceed 6 percent.	Moderate: coarse fragments; slope.	Moderate: coarse fragments.
NED, NEE, NEF, NMD, NME, NMF, NSD, NSE. For interpretations of Enders parts of NED, NEE, and NEF, see Enders series. For interpretations of Mountainburg parts of NMD, NME, and NMF, see Mountainburg series.	Moderate where slopes are 15 percent or less; coarse fragments; slope; surface stones in some areas. Severe where slopes exceed 15 percent.	Moderate where slopes are 15 percent or less: coarse fragments; surface stones in some areas. Severe where slopes exceed 15 percent.	Moderate where slopes are 15 percent or less: coarse fragments; slope. Severe where slopes exceed 15 percent.	Moderate where slopes are 25 percent or less: coarse fragments; slope; surface stones in some areas. Severe where slopes exceed 25 percent.
Pickwick: PcB, PcC	Slight	Slight where slopes are less than 2 percent. Moderate where slopes are 2 to 6 percent. Severe where slopes exceed 6 percent.	Slight	Slight.
Rock outcrop. Mapped only in association with Mountainburg soils.	Severe: bedrock at or near the surface.	Severe: bedrock at or near the surface.	Severe: bedrock at or near the surface.	Severe: bedrock at or near the surface.
Roellen: Ro	Severe: poorly drained; clayey surface; poor trafficability.	Severe: poorly drained; clayey surface; poor trafficability.	Severe: poorly drained; clayey surface; poor trafficability.	Severe: poorly drained; clayey surface; poor trafficability.
Spadra: SpB	Moderate: subject to occasional flooding.	Moderate: subject to occasional flooding; some slopes exceed 2 percent.	Moderate: subject to occasional flooding.	Slight.

TABLE 9.—*Degree and kind of limitation for recreational development*—Continued

Soil series and map symbols	Camp areas	Playgrounds	Picnic areas	Paths and trails
Taft: Ta	Severe: somewhat poorly drained; perched seasonal high water table.	Severe: somewhat poorly drained; perched seasonal high water table.	Severe: perched seasonal high water table.	Severe: perched seasonal high water table.
Udorthents: Ud	Severe where areas have not been smoothed: coarse fragments; most slopes exceed 15 percent. Moderate where areas have been smoothed.	Severe: coarse fragments; slopes exceed 6 percent.	Severe where areas have not been smoothed: coarse fragments; most slopes exceed 15 percent. Moderate where areas have been smoothed.	Severe where areas have not been smoothed: coarse fragments; many slopes exceed 25 percent. Moderate where areas have been smoothed.

The more sloping and hilly parts of these valleys had mixed pines and hardwoods on the deeper soils where Cane, Leadvale, Pickwick and Spadra soils formed. These soils differ chiefly in age, relief, and degree of weathering. On the shallower parts, chiefly on low hills, were savannas of scattered, stunted hardwoods, cedars, and pines, with an understory of tall grasses. Linker and Mountainburg soils formed here. They differ chiefly in age and degree of weathering.

The native vegetation in most of the mountainous area in the northern part of the county consisted of forests of upland oaks, hickory, redcedar, and shortleaf pine. Only the upper few inches of the soils in these areas have a significant accumulation of organic matter and are dark colored. Enders, Leesburg, and Nella soils formed on these uplands. They differ chiefly in age and degree of weathering, in relief, and in the kind of parent material.

The differences in native vegetation on the uplands seem to be related mainly to variations in the available water capacity of the soils; on the lowlands, the differences seem to be related mainly to variations in drainage. For example, Roellen soils formed in swampy places and have thick, dark surface soils caused by an accumulation of organic debris in the swamps. Adjacent well drained soils do not have dark surface layers. Only the major differences in the original vegetation are reflected to any extent by the characteristics of the soils.

Man is important to the future rate and direction of soil formation. He clears the forest, cultivates the soils, and introduces new kinds of plants. He adds fertilizer, lime, and chemicals for insect, disease, and weed control. Building levees and dams for flood control, improving drainage, and grading the soil surface also affect the future development of soils. Some results of these changes will not be evident for many centuries. Nevertheless, the complex of living organisms affecting soil formation in this county has been drastically changed by man. Thus, man has become the most important organism affecting soil formation.

Parent material

The acid sandstones and shales which cover most of Johnson County were deposited in marine waters during the Pennsylvanian geologic period (*5, 6*). These sedimentary rocks are of various textures. They range from rather coarse-grained sandstone to shaly sandstone and from sandy shale to clay shale. There are four different formations. The Atoka Formation is the oldest, most extensive, and thickest. It is composed of interbedded shale and thin-bedded sandstone; shale predominates. It weathers into materials from which such residual soils as Enders soils are derived; where sandstone caps the ridges, Mountainburg and Linker soils are formed.

The Hartshorne Formation rests on the Atoka Formation. It is composed of sandstone and sandy shale. It weathers into material from which Mountainburg and Linker soils are formed. The sandstone is generally brown or yellowish brown. In some places, it is almost white. It is medium grained and well cemented; locally, it is saccharoidal and poorly cemented. The Spadra Shale rests on the Hartshorne Formation. It consists of fine grained, blue-black or gray clay shale but contains some sandstone lenses. Spadra Shale crops out on hillsides in places and in some of the valley floors. Valuable coal beds are at the base of this formation. Where Spadra Shale crops out on hillsides, Enders soils formed in its weathered material.

The Fort Smith Formation overlies the Spadra Shale and consists principally of sandstone and sandy shale. Most of the beds are ripple marked. The weathered material is usually sandy and is yellowish to reddish in color. Mountainburg and Linker soils are the principal residual soils formed from this material.

Soils on the flood plains of upland drainageways are mainly of the Ceda and Spadra series. These soils formed in loamy sediment washed down from local uplands. The soils differ in age and degree of development and in particle-size gradation of the parent material.

Soils that have formed on the valley terraces include Cane, Guthrie, Leadvale, Pickwick, and Taft soils. These soils have well developed horizons, and they formed in loamy local sediment. The soils on benches along the mountainsides formed in friable, loamy and silty material that washed or rolled down from above. These are soils of the Leesburg and Nella series. They are deep, medium textured, acid, and well drained. In

many places they are stony or gravelly because coarse fragments of sandstone have rolled down from the caprock on the bluffs.

Soils along the Arkansas River formed in poorly graded, well sorted alluvium deposited by flood waters. The Bruno soils formed in sandy sediment deposited along or near the river as natural levees (*15*). The McKamie, Moreland, Muskogee, and Roellen soils formed in predominantly clayey sediment deposited by slack water on flats and flood bays at places farther from the river. The Caspiana and Morganfield soils formed in the loamy sediment deposited between areas of sandy sediment and clayey sediment.

Relief

Relief, or differences in elevation, in Johnson County has been brought about chiefly by faulting, folding, and the subsequent entrenchment of drainage channels into the land surface. The highest recorded elevation in the county, about 2,250 feet above sea level, is in the northwestern part of the county, within the boundary of the Ozark National Forest. The lowest elevation, about 420 feet above sea level, is in the southeastern part of the county at the Dardanelle Reservoir.

Some of the greatest differences in the soils of Johnson County are caused by differences in relief through its effect on drainage, runoff, erosion, and percolation of water through the soil. Local relief is great on near-vertical bluffs and small on broad flats.

Generally, the steeper soils and those on narrow ridges are shallow because they have lost so much soil material through geologic erosion. An example is the Mountainburg soils. In contrast, broad areas of the nearly level or gently sloping soils have lost little soil material, and the soils are moderately deep or deep. Examples are Linker, Leadvale, and Cane soils.

In coves and on foot slopes are deep accumulations of material that washed or slid down from adjoining steep slopes. The Leesburg and Nella soils are in such areas. In places where rocks have broken off and rolled downslope, these soils are stony.

The Guthrie and Taft soils are in the level to depressional areas in the broad valleys. Surface drainage is slow or ponded, and the soils are poorly drained to somewhat poorly drained. Permeability is slow. The soils are gray or have gray mottles caused by the reduction of iron and have a seasonal high or perched water table.

The flood plain of the Arkansas River is level to nearly level and was subject to frequent flooding before flood control dams were built on the river. The floodwater, loaded with soil particles, moved at different speeds, depending partly on the topography. Rapidly moving water deposited the sandy sediment in which Bruno soils formed. The less rapidly moving water deposited the mixed sediment that was high in silt content and in which Caspiana and Morganfield soils formed. The slack or still water trapped in flood bays and on broad flats deposited the clayey sediment in which Moreland and Roellen soils formed.

Time

The length of time required for soil formation depends largely on other factors of soil formation. Less time generally is required if the climate is warm and humid and if the vegetation is luxuriant. If other factors are equal, less time is also required if the parent material is loamy than if it is clayey.

In terms of geological time, most of the soils of Johnson Counnty are old regardless of whether they are on mountaintops, mountainsides, or stream terraces. The young soils formed in alluvium along streams.

Some of the soils on the uplands are examples of old soils. They formed in material weathered from rocks and shale of Pennsylvanian Age. Most are old enough that nearly all of the cations have been leached out, reaction is strongly acid or very strongly acid, there has been considerable weathering and translocation of clay, and the horizons are clearly expressed. Iron as well as clay has been translocated from the A horizon to the B horizon and then oxidized, causing the B horizon to have stronger red, brown, and yellow colors than the A horizon. Enders and Linker soils clearly show the impact of time, acting with other soil-forming factors, on parent material.

Bruno and Morganfield soils are examples of very young soils that formed in recent alluvium on the flood plain of the Arkansas River. No definite horizons have formed below the A horizon. Instead, these soils still have the depositional rock structure, or bedding planes, and little or no soil structure. Base saturation is high, and reaction is slightly acid to moderately alkaline, which indicates that leaching has been slight. Except for the slight physical changes caused by worms and roots, there is little evidence of soil-forming activity.

Processes of Soil Formation

In this section a brief definition of the horizon nomenclature and processes responsible for soil formation are given.

The marks that the soil-forming factors leave on the soil are recorded in the soil profile, which is a succession of layers, or horizons, from the surface layer to the parent rock. The horizons differ in one or more properties such as color, texture, structure, consistency, and porosity.

Most soil profiles contain three major horizons called A, B, and C. Very young soils do not have a B horizon.

If the A horizon is the horizon of maximum accumulation of organic matter, it is called the A1 horizon, or the surface layer. If it is the horizon of maximum leaching of dissolved or suspended materials, it is called the A2 horizon, or subsurface layer.

The B horizon is immediately below the A horizon and is sometimes called the subsoil (*14*). It is a horizon of maximum accumulation of suspended materials such as clay and iron. The B horizon commonly has blocky structure and is firmer than the horizons immediately above and below it.

Beneath the B horizon is the C horizon. It has been little affected by the soil-forming processes, but the C horizon can be materially modified by weathering. In some young soils, the C horizon immediately underlies the A horizon and has been slightly modified by living organisms as well as by weathering.

Several processes have been active in the formation of soil horizons in Johnson County. Among these processes are accumulation of organic matter, leaching of bases, oxidation or reduction and transfer of iron, and formation and translocation of silicate clay minerals. In most of the soils of the county, more than one of these processes have been active in soil formation.

Physical weathering of rocks, through heating and cooling and wetting and drying, slowly breaks them into small pieces. These pieces form the parent material for the residual soils in the county. This is most evident in Linker and Mountainburg soils.

Accumulation of organic matter in the upper part of the profile to form an A1 horizon has been an important process of soil formation.

Leaching of bases has occurred to some degree in nearly all of the soils of Johnson County. Among soil scientists it is generally accepted that bases are leached downward in soils before silicate clay minerals begin to move. Most of the soils in the county are moderately leached, an important factor in horizon development. Some soils, such as Bruno and Morganfield soils, are only slightly leached. Others, such as Enders, Linker, and Mountainburg soils, are strongly leached.

Oxidation of iron is evident in the moderately well drained and well drained soils in the county. Oxidation of iron is indicated by the red and brown colors in the B horizon of such soils as Linker, Mountainburg, and Enders soils on uplands and Cane and Leadvale soils on lowlands.

Reduction and transfer of iron has occurred to a significant degree in the poorly drained and somewhat poorly drained soils of the lowlands. In the naturally wet soils, this process is called gleying. Gray colors in the horizons below the surface layer indicate the reduction and loss of iron. Some horizons contain reddish or yellowish mottles and concretions derived from segregated iron. Gleying is most pronounced in Guthrie and Roellen soils.

Translocation of silicate clay minerals has contributed to horizon development in most of the soils in the county. In cultivated areas most of the eluviated A2 horizon has been destroyed. Where it is present, the structure is blocky, clay content is less than in the lower horizons where it has accumulated, and the horizon is lighter in color. Clay films generally have accumulated in pores and on the surfaces of peds in the B horizon. The soils were probably leached of carbonates and soluble salts to a great extent before translocation of silicate clay took place, even though the content of bases is still high in some of the soils on lowlands.

Leaching of bases and translocation of silicate clay are among the most important processes in horizon differentiation in the soils of Johnson County.

Classification of 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 comparision 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 (*11*). Because this system is under continual study, readers interested in developments of the current system should search the latest literature available (*13*).

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 or origin, are grouped. In table 10, the soil series of Johnson County are placed in three other categories of the current system. Classes of the current system 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. The two exceptions to this are the Entisols and Histosols, which occur in many different climates. Each order is named with a word of three or four syllables ending in *sol* (Ent-i-sol).

SUBORDER. Each order is subdivided into suborders that are based primarily on those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging, or soil differences resulting from the climate or vegetation. The names of suborders have two syllables. The last syllable indicates the order. An example is *Udult* (*Ud,* meaning humid, and *ult,* from Ultisol).

GREAT GROUP. Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated; those that have pans that interfere with growth of roots, movement of water, or both; and thick, dark-colored surface horizons. The features used are the self-mulching properties of clay, soil temperature, major differences

TABLE 10.—*Soil series classified in higher categories*

Series	Family	Subgroup	Order
Bruno	Sandy, mixed, thermic	Typic Udifluvents	Entisols.
Cane	Fine-loamy, siliceous, thermic	Typic Fragiudults	Ultisols.
Caspiana	Fine-silty, mixed, thermic	Typic Arguidolls	Mollisols.
Ceda	Loamy-skeletal, siliceous, nonacid, thermic	Typic Udifluvents	Entisols.
Enders	Clayey, mixed, thermic	Typic Hapludults	Ultisols.
Guthrie	Fine-silty, siliceous, thermic	Typic Fragiaquults	Ultisols.
Leadvale	Fine-silty, siliceous, thermic	Typic Fragiudults	Ultisols.
Leesburg	Fine-loamy, siliceous, thermic	Typic Paleudults	Ultisols.
Linker	Fine-loamy, siliceous, thermic	Typic Hapludults	Ultisols.
McKamie	Fine, mixed, thermic	Vertic Hapludalfs	Alfisols.
Moreland	Fine, mixed, thermic	Vertic Hapludolls	Mollisols.
Morganfield	Coarse-silty, mixed, nonacid, thermic	Typic Udifluvents	Entisols.
Mountainburg	Loamy-skeletal, siliceous, thermic	Lithic Hapludults	Ultisols.
Muskogee	Fine-silty, mixed, thermic	Aquic Paleudalfs	Alfisols.
Nella	Fine-loamy, siliceous, thermic	Typic Paleudults	Ultisols.
Pickwick	Fine-silty, mixed, thermic	Typic Hapludults	Ultisols.
Roellen	Fine, montmorillonitic, thermic	Vertic Haplaquolls	Mollisols.
Spadra	Fine-loamy, siliceous, thermic	Typic Hapludults	Ultisols.
Taft	Fine-silty, siliceous, thermic	Glossaquic Fragiudults	Ultisols.

in chemical composition (mainly calcium, magnesium, sodium, and potassium), dark red and dark brown colors associated with basic rocks, and the like. The names of great groups have three or four syllables and are made by adding a prefix to the name of the suborder. An example is *Paliudults* (*Pali,* meaning old, *ud* for humid, and *ult* from Ultisols).

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. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is Typic Paleudults (a typical Paleudult).

FAMILY. Soil families are separated within a subgroup primarily on the basis of properties important to the growth of plants or on the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. A family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names for texture, mineralogy, and so on, that are used as family differentia. An example is the fine-loamy, siliceous, thermic family of Typic Paleudults.

Physical and Chemical Analyses

Physical and chemical data resulting from laboratory analyses can be useful to the soil scientist in classifying soils. These data are helpful in estimating available water capacity, acidity, cation exchange capacity, mineral composition, organic matter content, and other soil characteristics that affect management needs. The data are also helpful in developing concepts of soil formation. More recently, laboratory data have proved helpful in rating soils for nonfarm uses, that is, for residential, industrial, recreational, or transportational use.

Several factors are involved in selecting soils for laboratory analyses. Soils that are extensive and most important in the survey area are considered first. A review of available laboratory data is made to determine the need for additional information on these particular soils. Generally, priority is given to soils for which little or no laboratory data are available.

In Johnson County, soils representing 12 soil series were selected for laboratory analyses. Profiles of these soils are described in the section "Descriptions of the Soils." The analyses were made by the University of Arkansas in Fayetteville. Table 11 shows the results.

Silt and clay particle size distribution was determined by the hydrometer method (*7*). Sands were measured by sieving (*12*).

Organic matter was determined by a modified Wakley-Black method (*8*). The organic matter is digested with potassium dichromate-sulfuric acid, and the quantity of chromic acid reduced is measured colorimetrically.

Soil pH was determined on 1:1 soil to water mixture. Available phosphorus was extracted with the Bray No. 1 solution and measured colorimetrically.

The bases were extracted with 1*N*, pH 7.0, ammonium acetate. Calcium, potassium, and sodium were determined with a flamephotometer, and magnesium was measured by atomic absorption. The extractable acidity was determined by the barium chloride-tri-ethanolamine method (*12*).

The total of extractable calcium, potassium, magnesium, sodium, and extractable acidity is an approximation of the cation exchange capacity of the soil. Except in soils that contain soluble salts, base saturation was determined by dividing this total into the sum of calcium, potassium, magnesium, and sodium, and multiplying by 100.

TABLE 11.—*Physical and chemical*

[Analysis made by the University of Arkansas, Fayetteville, Arkansas; dashes in place of

Soil, sample number, and depth in inches	Horizon	Particle-size distribution (smaller than 2.0 mm)					
		Very coarse through medium sand (2.0–0.25 mm)	Fine sand (0.25–0.10 mm)	Very fine sand (0.10–0.05 mm)	Total sand (2.0–0.05 mm)	Silt (0.05–0.002 mm)	Clay (0.002 mm)
		Pct	*Pct*	*Pct*	*Pct*	*Pct*	*Pct*
Caspiana silt loam:							
S68-Ark-36-2							
0–10	Ap	----------	1	18	19	64	17
10–24	B21t	----------	----------	11	11	63	26
24–30	B22t	----------	----------	18	18	62	20
30–40	B23t	----------	----------	19	19	59	22
40–52	C	----------	----------	32	32	59	9
52–72	C2	----------	1	28	29	62	9
Enders fine sandy loam:							
S70-Ark-36-6							
0–6	A1	8	11	8	27	58	15
6–14	B1	6	9	7	22	50	28
14–28	B21t	6	7	7	20	37	43
28–38	B22t	5	4	5	14	28	58
38–50	B3	5	2	2	9	26	65
50–76	C	8	2	2	12	23	65
Guthrie silt loam:							
S68-Ark-36-9							
0–6	Ap	2	1	2	5	70	25
6–15	B1g	5	1	3	9	64	27
15–22	B2g	3	1	3	7	60	33
22–38	Bx1	7	2	4	13	52	35
38–58	Bx2	3	3	5	11	55	34
58–72	Bx3	4	4	6	14	52	34
Leadvale silt loam:							
S68-Ark-36-15							
0–5	Ap	3	20	20	43	55	2
5–10	B1	1	23	17	41	50	9
10–18	B21t	1	13	15	29	57	14
18–23	B22t	2	10	14	26	46	28
23–49	Bx1	1	11	11	23	42	35
49–72	Bx2	3	12	11	26	42	32
Leesburg gravelly loam:							
S70-Ark-36-7							
0–5	A1	10	7	4	21	66	13
5–10	B1	5	7	5	17	63	20
10–20	B21t	4	6	4	14	60	26
20–36	B22t	4	5	4	13	59	28
36–50	B23t	20	6	3	29	47	24
50–72	B24t	12	7	3	22	52	26
Linker fine sandy loam:							
S70-Ark-36-4							
0–6	Ap	12	34	8	54	40	6
6–11	B1	7	27	6	40	45	15
11–22	B21t	7	23	6	36	39	25
22–29	B22t	6	36	7	49	23	28
Moreland clay:							
S68-Ark-36-5							
0–8	Ap	----------	1	2	3	55	42
8–22	B21	----------	----------	1	1	38	61
22–37	B22	----------	1	3	4	52	44
37–51	B23	1	3	11	15	53	32
51–72	B3	----------	7	20	27	45	28

See footnotes at end of table.

analyses of selected soils

entry indicate that analysis was not made or data resulting from the analysis was insignificant]

Milliequivalents per 100 grams of soil					Base saturation	Reaction (1:1 soil-water ratio)	Organic matter
Exchangeable bases				Extractable acidity			
Calcium	Magnesium	Sodium	Potassium				
					Pct	*pH*	*Pct*
6.3	2.0	0.2	0.6	2.3	80	6.3	1.4
9.4	2.6	0.3	0.4	2.8	82	6.4	1.4
7.5	2.7	0.2	0.3	2.9	79	6.3	1.0
7.3	2.8	0.2	0.3	2.9	79	6.4	0.6
3.9	1.4	0.2	0.2	0.9	86	6.6	0.3
4.4	1.7	0.2	0.3	1.4	82	6.7	0.2
0.8	0.4	0.1	0.2	15.8	9	5.1	3.5
0.3	0.3	0.1	0.1	12.6	6	4.9	1.3
0.3	0.4	0.1	0.2	18.6	5	5.0	0.6
0.2	0.5	0.2	0.2	24.8	4	5.0	0.5
0.2	0.7	0.2	0.4	34.0	4	4.9	0.7
0.1	0.9	0.2	0.4	33.9	5	4.8	0.6
3.8	1.5	0.3	0.1	12.1	32	5.3	2.3
1.6	0.7	0.3	0.1	12.8	17	5.1	1.9
1.9	0.6	0.6	0.1	13.1	14	5.3	0.5
0.5	0.9	1.4	0.2	17.0	15	5.3	0.5
1.4	1.8	2.3	0.2	11.6	33	5.2	0.4
2.6	3.4	3.0	0.2	5.9	61	6.2	0.5
2.6	0.4	0.2	0.2	8.0	30	6.2	1.3
1.8	0.4	0.2	0.1	8.2	23	6.0	0.9
1.1	0.7	0.2	0.1	11.9	15	5.1	0.5
1.1	1.0	0.2	0.1	8.7	22	5.1	0.3
0.4	1.5	0.3	0.1	14.1	14	5.1	0.2
0.4	1.8	0.4	0.1	13.6	17	5.2	0.3
2.9	1.1	0.2	0.4	14.5	24	5.4	3.4
2.3	0.9	0.1	0.2	9.5	27	5.6	1.9
1.1	0.8	0.1	0.2	9.8	18	5.4	0.7
1.3	0.9	0.2	0.3	10.1	21	5.1	0.5
0.7	0.6	0.2	0.3	12.0	13	5.0	0.5
0.8	0.7	0.1	0.3	11.9	14	5.0	0.3
1.5	0.4	0.1	0.1	6.6	24	5.3	2.5
1.2	0.4	0.2	0.1	5.7	25	4.9	0.9
1.2	0.5	0.1	0.1	10.8	15	5.0	0.7
0.5	0.5	0.2	0.1	12.9	9	4.6	0.4
23.3	3.5	0.3	0.8	3.3	89	7.5	1.7
(1)	5.0	0.4	0.8	(1)	(1)	7.6	1.2
25.5	4.3	0.4	0.8	4.8	87	7.3	1.3
17.5	3.1	0.3	0.5	3.3	87	7.3	0.9
16.0	3.1	0.3	0.5	3.0	87	7.2	0.4

TABLE 11.—*Physical and chemical*

Soil, sample number, and depth in inches	Horizon	Particle-size distribution (smaller than 2.0 mm)					
		Very coarse through medium sand (2.0–0.25 mm)	Fine sand (0.25–0.10 mm)	Very fine sand (0.10–0.05 mm)	Total sand (2.0–0.05 mm)	Silt (0.05–0.002 mm)	Clay (0.002 mm)
		Pct	*Pct*	*Pct*	*Pct*	*Pct*	*Pct*
Morganfield silt loam:							
S68–Ark–36–16							
0–7	Ap	----------	3	27	30	60	10
7–14	A12	----------	1	19	20	71	9
14–30	C1	----------	14	37	51	43	6
30–41	C2	----------	2	32	34	60	6
41–58	Ab	----------	1	13	14	71	15
58–72	IIC	----------	2	22	24	67	9
Nella gravelly fine sandy loam:							
S70–Ark–36–3							
0–3	A1	2	18	10	30	59	11
3–7	A2	3	19	11	33	55	12
7–16	B1	2	18	10	30	52	18
16–29	B21t	2	17	9	28	49	23
29–36	B22t	1	19	10	30	43	27
36–44	B23t	1	22	9	32	34	34
44–54	B24t	1	23	10	34	29	37
54–72	B25t	1	28	10	39	27	34
Pickwick silt loam:							
S68–Ark–36–6							
0–6	Ap	4	18	11	33	57	10
6–12	B1	5	11	9	25	55	20
12–22	B21t[2]	2	11	7	20	53	27
22–35	B21t[2]	4	9	9	22	51	27
35–52	B22t	2	10	7	19	43	38
52–72	B23t	3	8	8	19	42	39
Spadra fine sandy loam:							
S68–Ark–36–7							
0–8	Ap	7	13	19	39	51	10
8–21	B21t	3	15	13	31	44	25
21–39	B22t	10	16	16	42	37	21
39–55	B3	10	36	14	60	26	14
55–72	C	27	28	16	71	21	8
Taft silt loam:							
S70–Ark–36–8							
0–4	Ap	2	11	9	22	70	8
4–8	A2	1	9	9	19	62	19
8–19	B2	1	8	8	17	58	25
19–20	A′2	----------	----------	----------	----------	----------	----------
20–40	B′x	1	7	7	15	51	34
40–56	B′2t[2]	3	8	7	18	42	40
56–72	B′2t[2]	2	7	6	15	45	40

[1] Contains calcium carbonate.

General Nature of the County

Johnson County is in western Arkansas. It is bounded on the south by the Arkansas River. To the north of the river flood plain, the terrain consists of broken hills separated by creeks. This terrain gives way to more distinctly mountainous terrain in the northern part of the county. The northern part of the county lies within the Ozark National Forest.

Farming, physiography and drainage, and climate in Johnson County are discussed in the following paragraphs.

Farming

Farming in Johnson County began on soils that had good natural drainage. These soils were in higher positions near the flood plain of the Arkansas River and on the hills and in the valleys in the southern part of the county. Cotton was the main cash crop. Most areas of the better drained soils were cleared for farming, and the areas of steep, stony, or wetter soils were left in woodland.

Farming has since become more diversified and generally less intensive. In the areas of ridges and val-

analyses of selected soils—Continued

Milliequivalents per 100 grams of soil					Base saturation	Reaction (1:1 soil-water ratio)	Organic matter
Exchangeable bases				Extractable acidity			
Calcium	Magnesium	Sodium	Potassium				
					Pct	*pH*	*Pct*
8.3	0.9	0.2	0.4	0.9	92	7.5	1.2
9.6	0.7	0.2	0.2	0.7	94	7.9	0.6
5.9	0.5	0.2	0.1	0.5	93	7.9	0.3
5.2	0.6	0.2	0.1	0.5	92	7.8	0.5
9.6	1.7	0.8	0.2	0.8	94	8.1	1.1
6.5	1.5	0.7	0.2	----------	100	8.2	0.4
5.5	1.0	0.2	0.4	11.5	38	5.7	3.6
3.2	0.7	0.2	0.2	8.8	33	5.7	2.5
3.1	0.7	0.1	0.2	6.9	37	5.9	1.5
3.5	0.7	0.2	0.3	6.5	42	6.0	0.7
2.3	1.2	0.2	0.5	9.1	32	5.6	0.5
0.6	0.6	0.1	0.5	14.4	11	4.9	0.4
0.6	0.5	0.1	0.6	16.3	10	5.0	0.3
0.6	0.5	0.1	0.6	16.3	10	5.1	0.3
3.1	0.8	0.2	0.1	3.5	55	5.6	1.9
3.8	1.3	0.2	0.1	3.1	64	6.1	0.4
2.8	1.4	0.2	0.1	5.5	45	5.2	0.2
0.9	1.5	0.2	0.1	7.1	28	4.9	0.1
0.6	1.4	0.2	0.2	9.6	20	4.8	0.1
0.4	1.1	0.2	0.2	10.5	15	4.7	----------
2.2	0.5	0.1	0.1	3.9	43	5.4	1.2
3.1	1.1	0.2	0.1	5.2	47	5.5	0.6
1.3	0.8	0.2	0.1	6.7	26	5.2	0.4
0.6	0.4	0.2	0.1	5.5	19	5.2	0.3
0.5	0.4	0.1	0.1	4.8	19	5.2	0.2
3.6	0.8	0.2	0.2	7.4	39	5.3	3.3
0.9	0.6	0.2	0.1	8.3	18	4.6	1.2
1.0	0.7	0.3	0.2	9.4	19	4.8	0.5
0.4	0.7	0.7	0.1	14.7	11	5.2	0.5
1.3	2.5	2.4	0.2	14.2	31	5.2	0.4
1.0	1.7	2.3	0.2	15.3	25	5.3	0.5

[2] Thick horizons, subdivided for sampling purposes.

leys, dairying, the raising of beef cattle, hogs and pigs, and poultry, including turkeys, broiler chickens, and laying hens, now provide most of the farm income. Some of the farms have a small acreage of orchards and vineyards.

On the bottom lands along the Arkansas River, flood control, use of improved crop varieties, and other improved management techniques have led to the expansion of cropland into nearly all of the flood plain. Most of the woodland on the bottom lands along the river has been cleared, and the natural drainage has been improved for more reliable crop production on wet soils.

On these bottom land farms, soybeans is the main crop, but corn, cotton, and winter small grains are other field crops grown. Some farms grow truck crops, such as spinach, okra, green beans, and melons.

Table 12 shows the acreage of principal crops and pasture grown, and Table 13 gives the kinds and number of livestock in 1964 and 1969.

At the time of the 1969 Census of Agriculture, about 29 percent of the land area in the county was in farms. The rest was mainly in cities and built-up

TABLE 12.—*Acreage of principal crops and pasture in Johnson County in 1964 and 1969*[1]

Crops	1964	1969
	Acres	*Acres*
Cropland pastured	7,808	25,516
Woodland pastured	9,098	11,899
Hay crops	11,875	12,037
Soybeans (for beans)	4,416	6,233
Cotton	807	791
Field corn (for all purposes)	838	273
Wheat	1,645	596
Truck crops (including potatoes)	217	972
Orchards and vineyards	1,572	985

[1] A large acreage of pasture and range is not differentiated in the Census but is included in the census under "All other land." In addition, the 1964 Census and observations during the fieldwork for this survey indicate that most of the privately owned woodland is grazed.

TABLE 13.—*Number of livestock in Johnson County in 1964 and 1969*

Livestock	1964	1969
All cattle and calves on farms and sold	27,533	28,344
Milk cows (Inventory)	1,206	605
Hogs and pigs on farms and sold	8,756	9,130
Chickens more than 3 months old on farms and sold	218,960	316,865
Broilers sold	4,316,750	4,565,899

areas, transportation facilities, and federally owned land within the Ozark National Forest.

Farms in Johnson County are decreasing in number and increasing in size. Between 1964 and 1969, the number of farms decreased from 920 to 695, and the average size increased from about 153 to 178 acres.

Farms larger than 500 acres decreased from 45 in 1964 to 37 in 1969, and farms smaller than 500 acres decreased from 875 in 1964 to 658 in 1969. Of the net decrease of 225 farms, 166 farms, or 74 percent, were smaller than 100 acres. Of the farm operators in the county in 1969, 466 were full owners, 170 were part owners, and 59 were tenants. Of the operators, 339 worked off the farm for 100 days or more.

Physiography and Drainage

The Arkansas River flows eastward and forms the southern boundary of the county. Its remaining flood plain is a relatively narrow strip that parallels the course of the river. Much of the former flood plain is inundated by Dardanelle Reservoir, one of the series of pools that were formed when the Arkansas River was made navigable by a series of locks and dams. The most fertile soils in the county, those of the Caspiana and Morganfield series, are in this area. The flow of the Arkansas River is regulated by major flood control impoundments upstream and by a series of locks and dams that form navigable pools. The Arkansas River is navigable to barge traffic all year round. The river provides recreational facilities for fishing, boating, and waterfowl hunting.

The northern half of Johnson County is in the Boston Mountains. In this area steep, stony mountains rise from the Arkansas Valley. They are drained by Mulberry River, Horsehead Creek, Spadra Creek, Little Piney Creek, and Big Piney Creek. These mountains are capped by sandstone, and the mountainsides consist of interbedded sandstone and shale. Slope ranges from 3 to 65 percent, and elevation ranges from about 700 feet in the stream valleys to about 2,250 feet on the top of Brushy Ridge.

The Arkansas Valley, which makes up most of the remainder of the county, consists of rolling, flat-topped hills, long narrow ridges, and broad valleys. The hilltops and ridges have hard sandstone caps. The hillsides and valleys are mostly underlain by shale. Slope ranges from 1 to 30 percent, and elevation ranges from about 420 to about 1,000 feet. This area is drained by streams such as Little Piney Creek, Spadra Creek, and Horsehead Creek.

The main soils on the mountains and hills are Nella, Enders, and Mountainburg soils. Linker and Mountainburg soils are the main soils on the ridges; Cane, Leadvale, and Taft soils are the main soils in the broad valleys. Ground water is insufficient for large-scale irrigation. Domestic water is supplied mainly by dug wells and drilled wells; livestock water is supplied mainly by ponds and creeks.

Climate

The climate of Johnson County, like that of most of Arkansas, generally consists of warm summers and mild winters. Although the county is within reach of cold arctic outbreaks, they generally are of short duration. The Boston Mountains in the northern part of the county, mainly 1,500 to 2,250 feet in elevation, provide a barrier that retards the penetration of cold air from the north in winter. Winters, therefore, are relatively free of severe cold, and outdoor work can be done during most of the winter.

Summer temperatures, especially in the valleys, occasionally rise to uncomfortable heights on the hottest days. The mountainous areas, however, afford some relief. Table 14 is a climate summary of temperature and precipitation at Clarksville, the county seat, and is representative for most of the county.

Clarksville recorded an all-time high reading of 112° F in July 1954. The all-time low reading of −5° F was recorded in January 1962.

The earliest freezing temperature in fall was recorded on October 16, and the latest in spring, on April 18.

Precipitation is ample for most crops. Spring is the wettest season; May generally receives the most rainfall. Winter normally is the driest season, although August commonly exhibits a significant minimum in precipitation. The mean annual precipitation is about 46 inches.

Snowfall averages several inches annually in the southern part of the county and somewhat more in the mountainous areas of the northern part.

TABLE 14.—*Temperature and precipitation*

[All data from Clarksville during the period 1954–72]

Month	Average daily temperature	Average monthly precipitation
	°F	*Inches*
January	39.2	2.5
February	43.7	3.2
March	50.6	3.9
April	62.7	4.5
May	69.9	5.5
June	77.0	3.9
July	81.4	4.1
August	80.2	3.2
September	74.1	3.9
October	62.9	3.4
November	50.7	3.5
December	42.3	4.0
Year	61.2	45.6

Evaporation rates in summer are as much as a third of an inch per day. As a result, periods that have abundant sunshine and high temperature may experience the loss of a considerable amount of soil moisture.

The bottom lands are fertile and produce large amounts of soybeans, cotton, hay, and small grains. The uplands, although not so fertile as the lowlands, provide grazing throughout most of the year because of the mild winter temperature and adequate rainfall.

The climate is suited to growing vegetables and fruit. Among the principal crops are peaches and grapes. The mild winters and abundant rainfall are conducive to plant growth.

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Glossary

ABC soil. A soil that has a complete profile, including an A, B, and C horizon.

AC soil. A soil that has an A horizon and a C horizon but no B horizon. Commonly such soils are immature, as those developing from alluvium or those on steep, rocky slopes.

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

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern.

Available water 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 capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Base saturation. The degree to which material that has base-exchange properties is saturated with exchangeable cations other than hydrogen, expressed as a percentage of the cation-exchange capacity.

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

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Chiseling. Tillage of soil with an implement having one or more soil penetrating points that loosen the subsoil and brings *clods* to the surface. A form of emerging tillage to control soil blowing.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex, soil. A mapping unit consisting of different kinds of soils that occur in such small individual areas or in such an intricate pattern that they cannot be shown separately on a publishable soil map.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found 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 and brittle; little affected by moistening.

Decreaser. Any of the climax range plants most heavily grazed. Because they are the most palatable, they are first to be destroyed by overgrazing.

Deferred grazing. The practice of delaying grazing until range plants have reached a definite stage of growth, in order to increase the vigor of the forage and to allow the desirable plants to produce seed. Contrasts with continuous grazing and rotation grazing.

Diversion, or diversion terrace. A ridge of earth, generally a terrace, that is built to divert runoff from its natural course and, thus, to protect areas downslope from the effects of such runoff.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, 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 different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low available water capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Fallow. Cropland left idle in order to restore productivity, mainly through accumulation of water, nutrients, or both. Summer fallow is a common stage before cereal grain in regions of limited rainfall. The soil is tilled for at least one growing season to control weeds, to aid decomposition of plant residues, and to encourage the storage of moisture for the succeeding grain crop.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the oven-dry weight, after the gravitational, or free, water has been allowed to drain away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Fragipan. A loamy, brittle, subsurface horizon that is very low in organic-matter content and clay but is rich in silt or very fine sand. The layer is seemingly cemented. When dry, it is hard or very hard and has a high bulk density in comparison with the horizon or horizons above it. When moist, the fragipan tends to rupture suddenly if pressure is applied, rather than to deform slowly. The layer is generally mottled, is slowly or very slowly permeable to water, and has few or many bleached fracture planes that form polygons. Fragipans are a few inches to several feet thick; they generally occur below the B horizon, 15 to 40 inches below the surface.

Genesis, soil. The manner in which a soil originates. Refers especially to the processes initiated by climate and organisms that are responsible for the development of the solum, or true soil, from the unconsolidated parent material, as conditioned by relief and age of landform.

Gleization. The reduction, translocation, and segregation of soil compounds, notably of iron, usually in the lower horizons, as a result of waterlogging with poor aeration and drainage; expressed in the soil by mottled colors dominated by gray. The soil-forming processes leading to the development of a gley soil.

Gleyed soil. A soil in which waterlogging and lack of oxygen have caused the material in one or more horizons to be neutral gray in color. The term "gleyed" is applied to soil horizons with yellow and gray mottling caused by intermittent waterlogging.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rains. The distinction between gully and rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by normal tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage. V-shaped gullies result if the material is more difficult to erode with depth; whereas U-shaped gullies result if the lower material is more easily eroded than that above it.

Gypsum. Calcium sulphate.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

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 some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

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

Increasers. Species in the climax vegetation that increase in relative amount as the more desirable plants are reduced by close grazing; increasers commonly are shorter than decreasers, and some are less palatable to livestock.

Invaders. On range, plants that come in and grow after the climax vegetation has been reduced by grazing. Generally, invader plants are those that follow disturbance of the surface. (Most weeds are "invaders").

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

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

Basin.—Water is applied rapidly to relatively level plots surrounded by levees or dikes.

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

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops, or in orchards, to confine the flow of water to one direction.

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

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

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

Wild flooding.—Irrigation water, released at high points, flows onto the field without controlled distribution.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state. In engineering, a high liquid limit indicates that the soil has a high content of clay and a low capacity for supporting loads.

Loess. Fine-grained material, dominantly of silt-sized particles, that has been deposited by wind.

Miscellaneous land type. A mapping unit for areas of land that have little or no natural soil; or that are too nearly inaccessible for orderly examination; or that occur where, for other reasons, it is not feasible to classify the soil.

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

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of 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 these: *fine*, less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium*, ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse*, more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

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

Parent material. Disintegrated and partly weathered rock from which soil has formed.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow*, *slow*, *moderately slow*, *moderate*, *moderately rapid*, and *very rapid*.

Phase, soil. A subdivision of a soil series, or other unit in the soil classification system made because of differences in the soil that affect its management but do not affect its classification in the natural landscape. A soil series, for example, may be divided into phases because of differences in slope, stoniness, thickness, or some other characteristic that affect its management but not its behavior in the natural landscape.

pH value. A numerical means for designating acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

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

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

Plowpan. A compacted layer formed in the soil immediately below the plowed layer.

Poorly graded. A soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles in poorly graded soil material, density can be increased only slightly by compaction.

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

Range condition. The state of health or productivity of both soil and forage in a given range, in terms of what productivity could or should be under normal climate and the best practical management. Condition classes generally recognized are—*excellent*, *good*, *fair*, and *poor*. The classification is based on the percentage of original, or climax, vegetation on the site, as compared to what ought to grow on it if management were good.

Range site. An area of range where climate, soil, and relief are sufficiently uniform to produce a distinct kind of climax vegetation.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	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

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock. Only the upper part of this, modified by organisms and other soil-building forces, is regarded by soil scientists as soil. Most American engineers speak of the whole regolith, even to great depths, as "soil."

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

Rill. A steep-sided channel resulting from accelerated erosion. A rill normally is a few inches in depth and width and is not large enough to be an obstacle to farm machinery.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. If two sequa are present in a single soil profile, it is said to have a bisequum.

Series, soil. A group of soils developed from a particular type of parent material and having genetic horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the profile.

Silica. Silica is a combination of silicon and oxygen. The mineral form is called quartz.

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

Site index. A numerical means of expressing the quality of a forest site that is based on the height of the dominant stand at an arbitrarily chosen age; for example, the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on relatively steep slopes and in swelling clays, where there is marked change in moisture content.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *Very coarse sand* (2.0 to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter). The separates recognized by the International Society of Soil Science are as follows: I (2.0 to 0.2 millimeter); II (0.2 to 0.02 millimeter); III (0.02 to 0.002 millimeter); IV (less than 0.002 millimeter).

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes 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 characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. 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 together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically, the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

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 may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

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

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil. A presumed fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Type, soil. A subdivision of the soil series that is made on the basis of differences in the texture of the surface layer.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In places an upper, or perched, water table may be separated from a lower one by a dry zone.

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

Wilting point (or permanent wilting point). The moisture content of soil, on an oven-dry basis, at which plants (specifically sunflower) wilt so much that they do not recover when placed in a dark, humid atmosphere.

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 the mapping unit belongs. The suitability of the soils for use as cropland and pasture is discussed in the soil descriptions. For information about the capability grouping, refer to page 29. For information about the suitability of the soils as woodland or for wildlife habitat, read the introduction to that section and refer to the table in each section.

Map symbol	Mapping unit	Page	Capability unit	Pasture and hayland group		Woodland suitability group	Range site
			Symbol	Symbol	Page	Symbol	Name
Br	Bruno loamy fine sand	6	IIIs-1	3B	33	2s5	----------
CaB	Cane fine sandy loam, 1 to 3 percent slopes	7	IIe-1	8A	33	3o7	----------
CaC	Cane fine sandy loam, 3 to 8 percent slopes	8	IIIe-1	8A	33	3o7	----------
Cp	Caspiana silt loam	8	I-1	2A	33	2o4	----------
Cy	Ceda cobbly fine sandy loam	9	VIIs-1	2B	33	3x9	----------
EnD	Enders gravelly fine sandy loam, 5 to 15 percent slopes	10	VIe-1	8C	33	4o1	Clay Break, Shale
EMD	Enders-Mountainburg association, rolling	10	------	---	--	---	----------
	Enders soils	--	VIIs-2	8D	33	4x2	Clay Break, Shale
	Mountainburg soils	--	VIIs-3	14B	34	5x3	Sandstone Ridge
EME	Enders-Mountainburg association, steep	10	------	---	--	---	----------
	Enders soils	--	VIIs-2	8D	33	4x2	Clay Break, Shale
	Mountainburg soils	--	VIIs-3	14B	34	5x3	Sandstone Ridge
Ge	Guthrie silt loam	11	IVw-1	8F	34	2w9	----------
LeB	Leadvale silt loam, 1 to 3 percent slopes	12	IIe-1	8A	33	3o7	----------
LeC	Leadvale silt loam, 3 to 8 percent slopes	12	IIIe-1	8A	33	3o7	----------
LBD	Leesburg association, rolling	13	VIe-2	8B	33	3o7	----------
LBE	Leesburg association, steep	14	VIIe-1	8B	33	3r8	----------
LEE	Leesburg-Enders association, steep	14	------	---	--	---	----------
	Leesburg soils	--	VIIe-1	8B	33	3r8	----------
	Enders soils	--	VIIs-2	8D	33	4x2	Clay Break, Shale
LEF	Leesburg-Enders association, very steep	14	------	---	--	---	----------
	Leesburg soils	--	VIIe-1	8B	33	3r9	----------
	Enders soils	--	VIIs-2	8D	33	5r3	Clay Break, Shale
LnB	Linker fine sandy loam, 1 to 3 percent slopes	15	IIe-1	8A	33	4o1	Loamy Upland
LnC	Linker fine sandy loam, 3 to 8 percent slopes	15	IIIe-1	8A	33	4o1	Loamy Upland
LnD	Linker fine sandy loam, 8 to 12 percent slopes	15	IVe-1	8A	33	4o1	Loamy Upland
LKD	Linker association, rolling	15	IVe-1	8A	33	4o1	Loamy Upland
LMD	Linker-Mountainburg association, rolling	16	------	---	--	---	----------
	Linker soils	--	VIe-2	8B	33	4o1	Loamy Upland
	Mountainburg soils	--	VIIs-3	14B	34	5x3	Sandstone Ridge
McC	McKamie silt loam, 3 to 8 percent slopes	17	IVe-2	8C	33	3c2	----------
Md	Moreland clay	18	IIw-1	1A	31	2w6	----------
Mg	Morganfield silt loam	19	I-1	2A	33	2o4	----------
MoD	Mountainburg gravelly fine sandy loam, 3 to 12 percent slopes	20	IVe-3	14D	34	5d2	Sandstone Ridge
MsD	Mountainburg stony fine sandy loam, 1 to 12 percent slopes	20	VIs-1	14C	34	5x3	Sandstone Ridge
MsF	Mountainburg stony fine sandy loam, 12 to 65 percent slopes	20	VIIs-3	14B	34	5x3	Sandstone Ridge
MED	Mountainburg-Enders association, rolling	20	------	---	--	---	----------
	Mountainburg soils	--	VIIs-3	14B	34	5x3	Sandstone Ridge
	Enders soils	--	VIIs-2	8D	33	4x2	Clay Break, Shale
MEE	Mountainburg-Enders association, steep	21	------	---	--	---	----------
	Mountainburg soils	--	VIIs-3	14B	34	5x3	Sandstone Ridge
	Enders soils	--	VIIs-2	8D	33	4x2	Clay Break, Shale
MEF	Mountainburg-Enders association, very steep	21	------	---	--	---	----------
	Mountainburg soils	--	VIIs-3	14B	34	5x3	Sandstone Ridge
	Enders soils	--	VIIs-2	8D	33	5r3	Clay Break, Shale

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit	Pasture and hayland group		Woodland suitability group	Range site
			Symbol	Symbol	Page	Symbol	Name
MRF	Mountainburg-Rock outcrop association, very steep	21	------	---	--	---	----------
	Mountainburg soils	--	VIIs-3	14B	34	5x3	Sandstone Ridge
	Rock outcrop	--	------	---	--	---	----------
MzB	Muskogee silt loam, 1 to 3 percent slopes	22	IIe-1	8A	33	3o7	----------
NaB	Nella gravelly fine sandy loam, 1 to 3 percent slopes	23	IIe-1	8A	33	3o7	----------
NaC	Nella gravelly fine sandy loam, 3 to 8 percent slopes	23	IIIe-1	8A	33	3o7	----------
NaD	Nella gravelly fine sandy loam, 8 to 12 percent slopes	23	IVe-1	8A	33	3o7	----------
NED	Nella-Enders association, rolling	23	------	---	--	---	----------
	Nella soils	--	VIe-2	8B	33	3o7	----------
	Enders soils	--	VIIs-2	8D	33	4x2	Clay Break, Shale
NEE	Nella-Enders association, steep	24	------	---	--	---	----------
	Nella soils	--	VIIe-1	8B	33	3r8	----------
	Enders soils	--	VIIs-2	8D	33	4x2	Clay Break, Shale
NEF	Nella-Enders association, very steep	24	------	---	--	---	----------
	Nella soils	--	VIIe-1	8B	33	3r9	----------
	Enders soils	--	VIIs-2	8D	33	5r3	Clay Break, Shale
NMD	Nella-Mountainburg association, rolling	24	------	---	--	---	----------
	Nella soils	--	VIe-2	8B	33	3o7	----------
	Mountainburg soils	--	VIIs-3	14B	34	5d2	Sandstone Ridge
NME	Nella-Mountainburg association, steep	25	------	---	--	---	----------
	Nella soils	--	VIIe-1	8B	33	3r8	----------
	Mountainburg soils	--	VIIs-3	14B	34	5x3	Sandstone Ridge
NMF	Nella-Mountainburg association, very steep	25	------	---	--	---	----------
	Nella soils	--	VIIe-1	8B	33	3r9	----------
	Mountainburg soils	--	VIIs-3	14B	34	5x3	Sandstone Ridge
NSD	Nella soils, rolling	25	VIe-2	8B	33	3o7	----------
NSE	Nella soils, steep	25	VIIe-1	8B	33	3r8	----------
PcB	Pickwick silt loam, 1 to 3 percent slopes	26	IIe-1	8A	33	3o7	----------
PcC	Pickwick silt loam, 3 to 8 percent slopes	26	IIIe-1	8A	33	3o7	----------
Ro	Roellen clay	27	IIIw-1	1A	31	2w6	----------
SpB	Spadra fine sandy loam, 1 to 3 percent slopes	28	IIe-2	8A	33	2o7	----------
Ta	Taft silt loam	28	IIIw-2	8F	34	3w8	----------
Ud	Udorthents	29	VIIs-4	17B	34	5r9	----------

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