

SOIL SURVEY OF

Vernon County, Missouri



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

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in the period 1969-73. Soil names and descriptions were approved in 1973. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1973. This survey was made cooperatively by the Soil Conservation Service and the Missouri Agricultural Experiment Station. It is part of the technical assistance furnished to the Vernon County Soil and Water Conservation District.

Soil maps in this survey may be copied without permission, but any enlargement of these maps could cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and woodland; 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 in Vernon 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. The guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification of each.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For

example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

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

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

Game managers and others can find information about soils and wildlife in the section "Wildlife."

Community planners and others concerned with recreational development can read about the soil properties that affect the choice of sites for parks, picnic areas, and other recreational uses in the section "Recreation Development."

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

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

Newcomers in Vernon 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 "Environmental Factors Affecting Soil Use."

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SOIL SURVEY OF VERNON COUNTY, MISSOURI

By George D. Preston, Soil Conservation Service

Fieldwork by George D. Preston, Harold E. Hughes, William M. Knight, and Billy E. Sparkman, Soil Conservation Service, United States Department of Agriculture

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

VERNON COUNTY is in the west-central part of Missouri (fig. 1). It has a total area of 838 square miles or 536,320 acres. Nevada, the largest city and county seat, is near the center of the county. In 1970 the population of Nevada was 9,736 and that of the county was 19,065.

Most of Vernon County is nearly level to gently sloping. The topography is more rolling along the major streams and in the northwestern and southeastern corners of the county. In the more rolling areas and in the southeastern corner, the soils formed under forest vegetation. Soils in the rest of the county formed under tall prairie vegetation. In the northwest corner of the county the topography is more rolling because of the Fort Scott escarpment. There are also several, conspicuous, high mounds in the county which are outlying members of the Fort Scott escarpment.

Farming is the principal enterprise in the county. In 1969, about 87 percent of the land area was in farms, mainly cash-grain and livestock farms. The principal field crops are corn, soybeans, and grain sorghum, but alfalfa, fescue, and other grasses and legumes are

grown for pasture and hay. The principal livestock are cattle and hogs.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Vernon County, where they are located, and how they can be used. The soil scientists went into the county knowing they were likely to 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 downward into the parent material that has not been changed much by leaching or by the action of plant roots.

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

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Bolivar and Bronaugh, 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 soil 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, Bolivar fine sandy loam, 2 to 5 percent slopes, is one of several phases within the Bolivar series.

After a guide for classifying and naming the soils

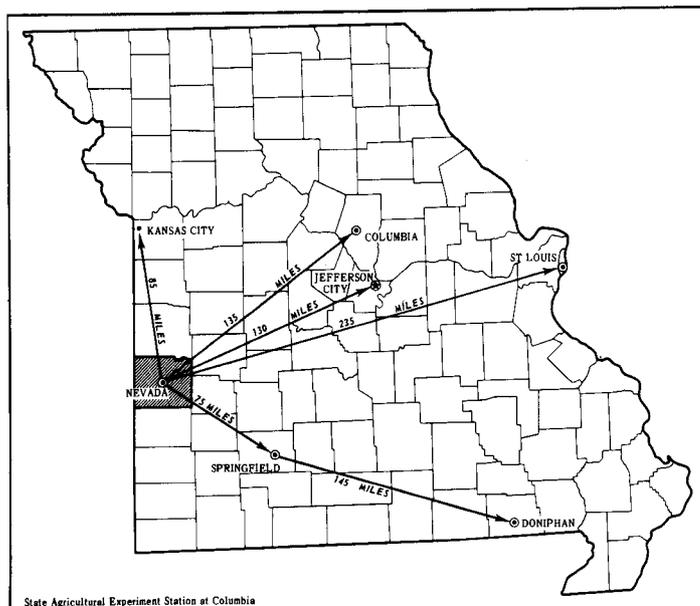


Figure 1.—Location of Vernon County in Missouri.

had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodland, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map in the back of this publication was prepared from the 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 other 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 Vernon County: soil complexes and undifferentiated groups.

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

An undifferentiated group is made up of two or more soils that could be mapped separately 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. The name of an undifferentiated group consists of the names of the dominant soils, joined by "and." Radley, Parsons, and Barden soils, 0 to 25 percent slopes, severely eroded, is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be 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. Mine pits and dumps is a land type in Vernon County.

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

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way as to be readily useful to different groups of users, among them farmers, managers of woodland and range, and engineers.

On the basis of yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. Then they 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 present methods of use and management.

General Soil Map

The General Soil Map at the back of this survey shows, in color, the soil associations in the survey area. A soil association is a landscape that has a distinctive pattern of soils in defined proportions. It typically consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in an association can occur in other associations; but in different patterns.

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

The soil associations in this survey area are described on the pages that follow.

1. Zaar-Barden-Liberal association

Deep, gently sloping and moderately sloping, moderately well drained and somewhat poorly drained soils that have a surface layer of silt loam or silty clay and a subsoil of silty clay or silty clay loam; on uplands

This association (fig. 2) is on gently sloping wide ridgetops and moderately wide divides and on gently sloping to moderately sloping side slopes and high mounds. Slopes are generally long but are shorter with increased steepness.

This association makes up about 11 percent of the county. It is about 31 percent Zaar soils, 20 percent Barden soils, and 13 percent Liberal soils. Minor soils of the Lula, Balltown, Parsons, and Barco series make up the rest.

Zaar soils are mainly gently sloping on the divides along drainageways and are gently sloping and moderately sloping on side slopes and mounds. These soils are somewhat poorly drained. They formed in material weathered from shale and thin bedded limestone. The surface layer is black silty clay. The subsoil is black, very dark gray, and very dark grayish-brown silty clay.

Barden soils are gently sloping. They are on the divides. These soils are moderately well drained. They formed in material weathered from gray clay shale. The surface layer is very dark grayish-brown silt loam. The subsoil is mottled dark-brown, yellowish-brown, reddish-brown, and grayish-brown silty clay loam.

Liberal soils are gently sloping and moderately slop-

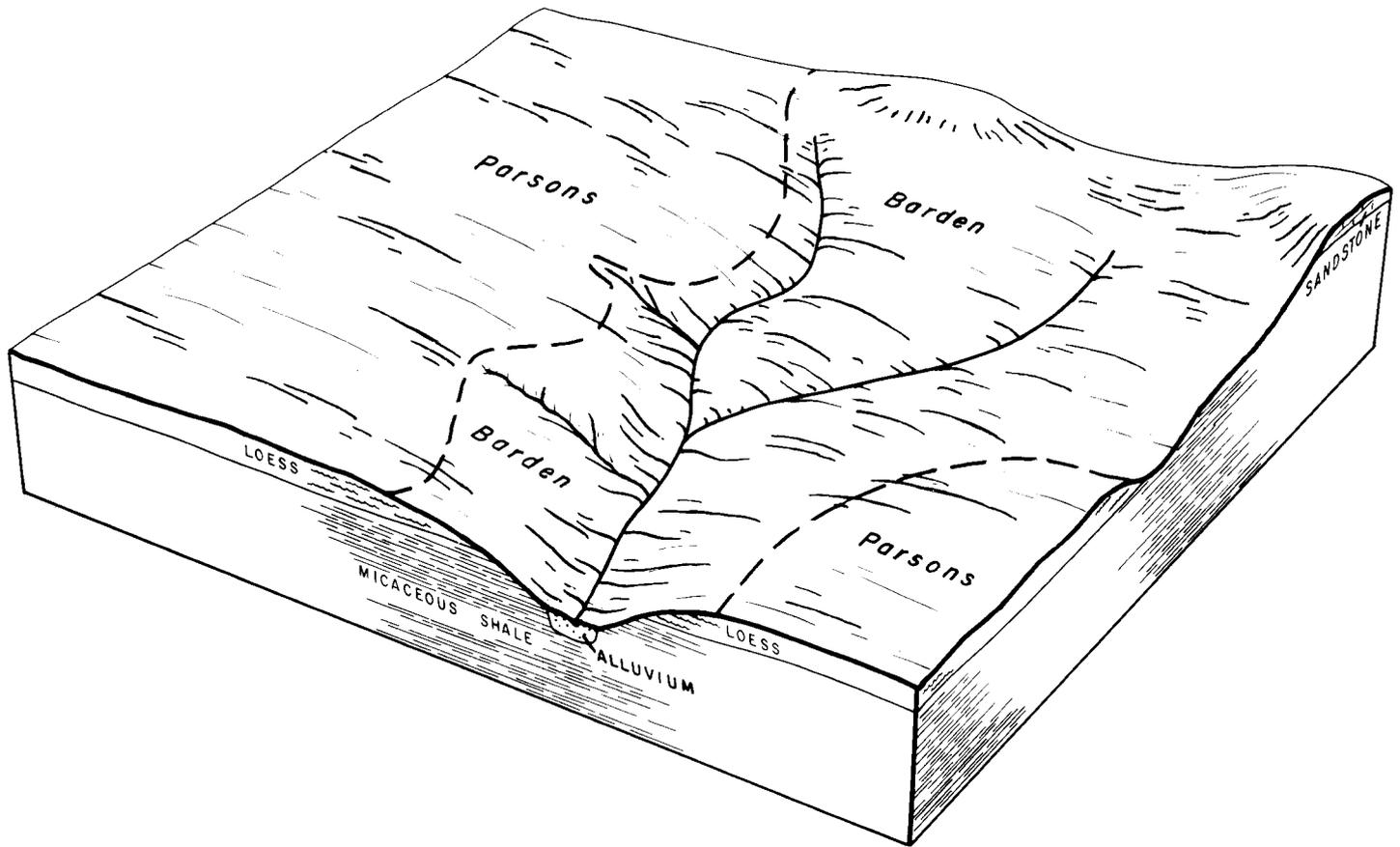


Figure 3.—Typical pattern of the soils in Barden-Parsons association.

Hepler soils that occur in intricate patterns with Radley soils. Hepler soils are on low stream terraces, and Radley soils are on narrow bottom lands. The upper reaches of the drainageways are narrow, U-shaped, and entrenched. Small, continuous, severely eroded areas of Parsons, Barden, and Barco soils are on upland breaks that have scarped edges, and areas of Hepler and Radley soils are on narrow bottom lands.

Controlling erosion, seasonal droughtiness, and, to a lesser degree, seasonal wetness, are limitations to the use of the soils in this association. Under highly specialized management, row crops can be grown year after year in the nearly level areas. Barden and Parsons soils have potential for irrigation.

This association is well suited to farming. It is farmed in large tracts and with large machinery. Most of the acreage is intertilled row crops and small grain that are marketed as cash-grain. Tame grasses for pasture, hay, and seed are grown on much of the remaining acreage. A small acreage is used for native prairie grass that is mowed for hay.

3. Barco-Barden-Coweta association

Shallow to deep, gently sloping to strongly sloping, well drained and moderately well drained soils that have a surface layer of fine sandy loam to silt loam and a subsoil of loam to silty clay loam; on uplands

This association (fig. 4) is on gently sloping divides,

benches, ridgetops, and knobs and on strongly sloping side slopes and breaks along drainageways.

This association makes up about 25 percent of the county. It is about 47 percent Barco soils, 24 percent Barden soils, and 14 percent Coweta soils. Minor soils mainly of the Parsons, Liberal, Verdigris, and Cleora series make up the rest.

Barco soils are gently sloping and moderately sloping. They are on ridgetops, knobs and side slopes. These soils are well drained. They formed in material weathered from sandstone interbedded with thin layers of shale. The surface layer is very dark brown loam. The subsoil is brown and yellowish-brown loam and clay loam.

Barden soils are gently sloping. They are on divides and side slopes. These soils are moderately well drained. They formed in gray clay shale. The surface layer is very dark grayish-brown silt loam. The subsoil is mottled yellowish-brown and gray silty clay loam.

Coweta soils are gently sloping to strongly sloping. They are on narrow ridgetops and knobs and on gently sloping to strongly sloping side slopes. They are well drained. The surface layer is dark-brown fine sandy loam. The underlying material is soft sandstone bedrock at a depth of 10 to 20 inches.

Parsons soils are on nearly level divides and benches. Liberal soils are on knobs and side slopes. Verdigris and Cleora soils are on nearly level, narrow bottom lands.

Fertility is medium to low, and the organic-matter

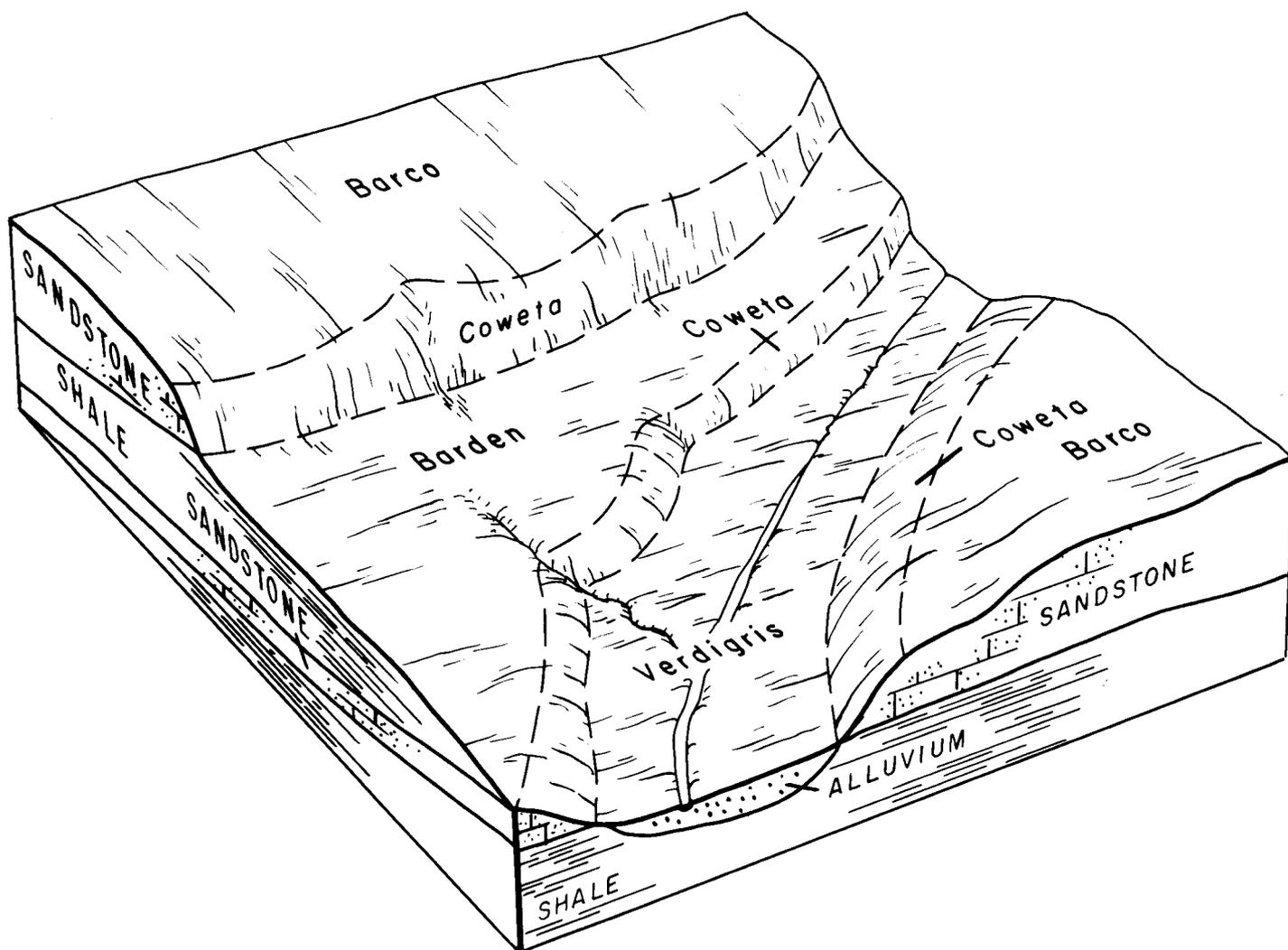


Figure 4.—Typical pattern of the major soils in Barco-Barden-Coweta association.

content is moderate to low. The available water capacity is high to low. The major concerns of management are controlling erosion and droughtiness and maintaining tilth and fertility.

This association is used for general livestock farming. Most of the acreage is used for pasture, hay, small grain, and sorghum. Corn and soybeans are grown in some of the gently sloping areas.

4. Hector-Bolivar association

Shallow and moderately deep, gently sloping to steep, well drained soils that have a surface layer of fine sandy loam and a subsoil of fine sandy loam or sandy clay loam; on uplands

This association (fig. 5) is on gently sloping and moderately sloping ridgetops, points, and foot slopes and on moderately sloping to steep side slopes.

This association makes up about 12 percent of the county. It is about 40 percent Hector soils and 35 percent Bolivar soils. Minor soils, mainly of the Dubbs, Hepler, Verdigris, and Cleora series, make up the rest.

Hector soils are moderately sloping to steep. They are

on ridgetops, points, breaks, and hillsides. These soils are well drained. They are stony in some places and have many rock outcrops. The surface layer is very dark grayish-brown and dark-brown fine sandy loam. The subsoil is yellowish-brown fine sandy loam. Sandstone bedrock is at a depth of 8 to 20 inches.

Bolivar soils are gently sloping. They are on ridgetops, points and foot slopes and on moderately sloping side slopes. These soils are well drained. They formed in material weathered from sandstone interbedded with thin layers of shale. The surface layer is dark-brown to yellowish-brown fine sandy loam. The subsoil is yellowish-red to brown sandy clay loam.

Dubbs soils are on gently sloping foot slopes in uplands. Hepler, Verdigris, and Cleora soils are on narrow, nearly level bottom lands.

Fertility, organic-matter content, and the available water capacity are low or very low. The major concerns of management on the upland soils are controlling erosion and droughtiness and the presence of stones and Rock outcrop. Occasional or frequent overflow is a hazard on the bottom land soils.

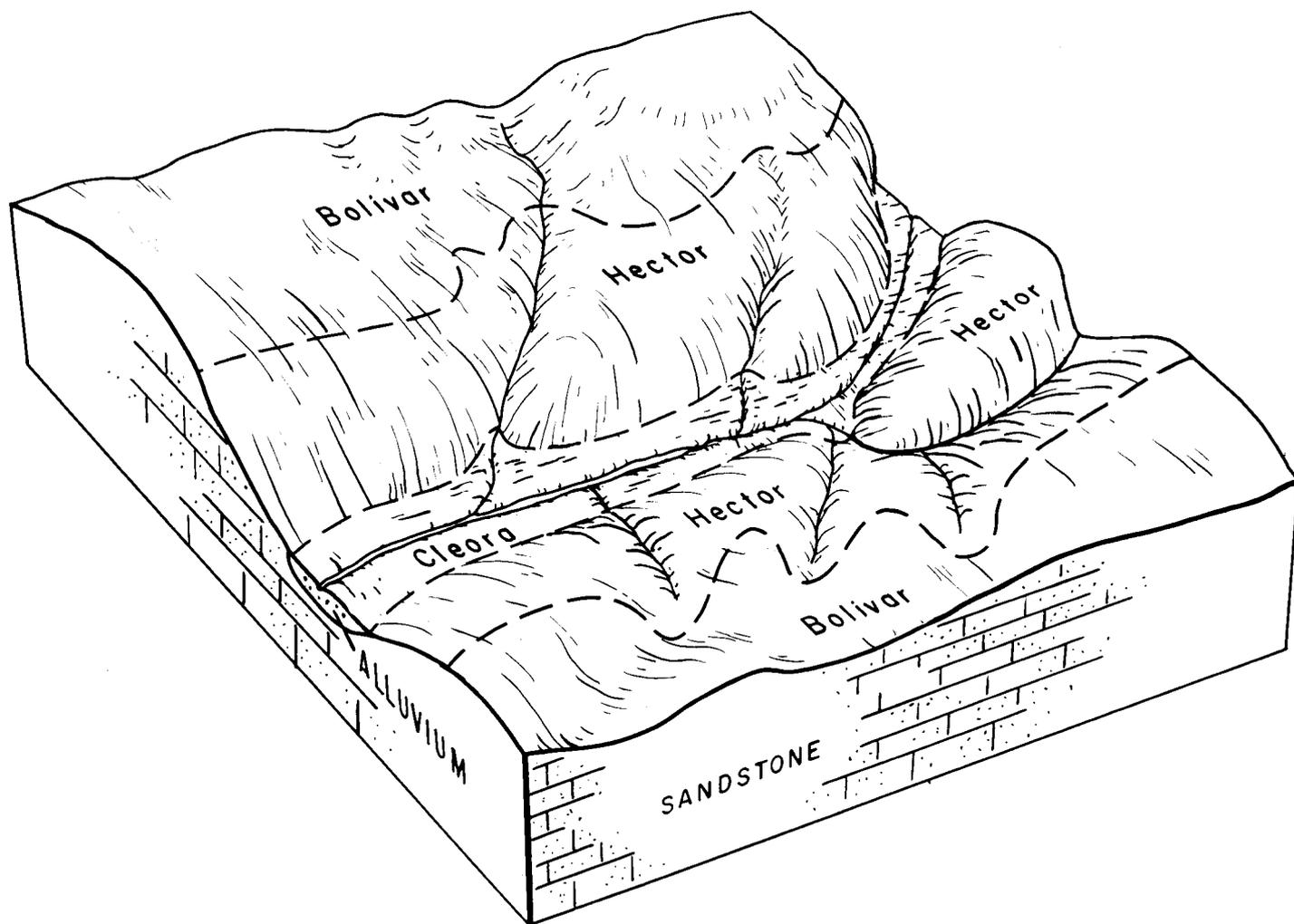


Figure 5.—Typical pattern of the major soils in Hector-Bolivar association.

Most of the acreage in this association is in timber and brush. Oaks and hickory predominate. The acreage not in timber is mainly in grass and legumes. Small grain and sorghum are grown on some of the gently sloping soils. These soils are suited to grasses and legumes, woodland, and wildlife. Some small grain can be grown.

5. Osage-Lanton-Hepler association

Deep, nearly level, poorly drained and somewhat poorly drained soils that have a surface layer of silt loam to silty clay and a subsoil of silty clay loam or silty clay; on bottom lands and low stream terraces

This association (fig. 6) is on flood plains of the major streams in the county.

This association makes up about 13 percent of the county. It is about 42 percent Osage soils, 17 percent Lanton soils, and 15 percent Hepler soils. Minor soils, mainly of the Radley and Verdigris series, make up the rest.

Osage soils are nearly level. They are on wide flood plains. These soils are poorly drained. They formed in clayey alluvium. The surface layer is dark-brown and

black silty clay. The subsoil is very dark gray and dark gray silty clay.

Lanton soils are nearly level. They are on moderately wide flood plains. These soils are poorly drained. They formed in silty clay loam alluvium. The surface layer is black and very dark gray silty clay loam. The underlying material is dark-gray silty clay loam.

Hepler soils are nearly level. They are on low stream terraces. These soils are somewhat poorly drained. They formed in silty alluvium. The surface layer is very dark grayish-brown silt loam. The subsurface layer is grayish-brown and light brownish-gray silt loam. The subsoil is dark-gray silty clay loam.

Radley and Verdigris soils are on old natural levees along the major streams. They are moderately well drained.

Fertility is medium in Hepler soils but high in the other soils. Organic-matter content is moderate in Hepler soils, but high in the others. The available water capacity is moderate in Osage soils but high in the others. The major concern of management is wetness caused by slow runoff, ponding, flooding, and slow internal drainage.

This association is used mainly for cash-grain farm-

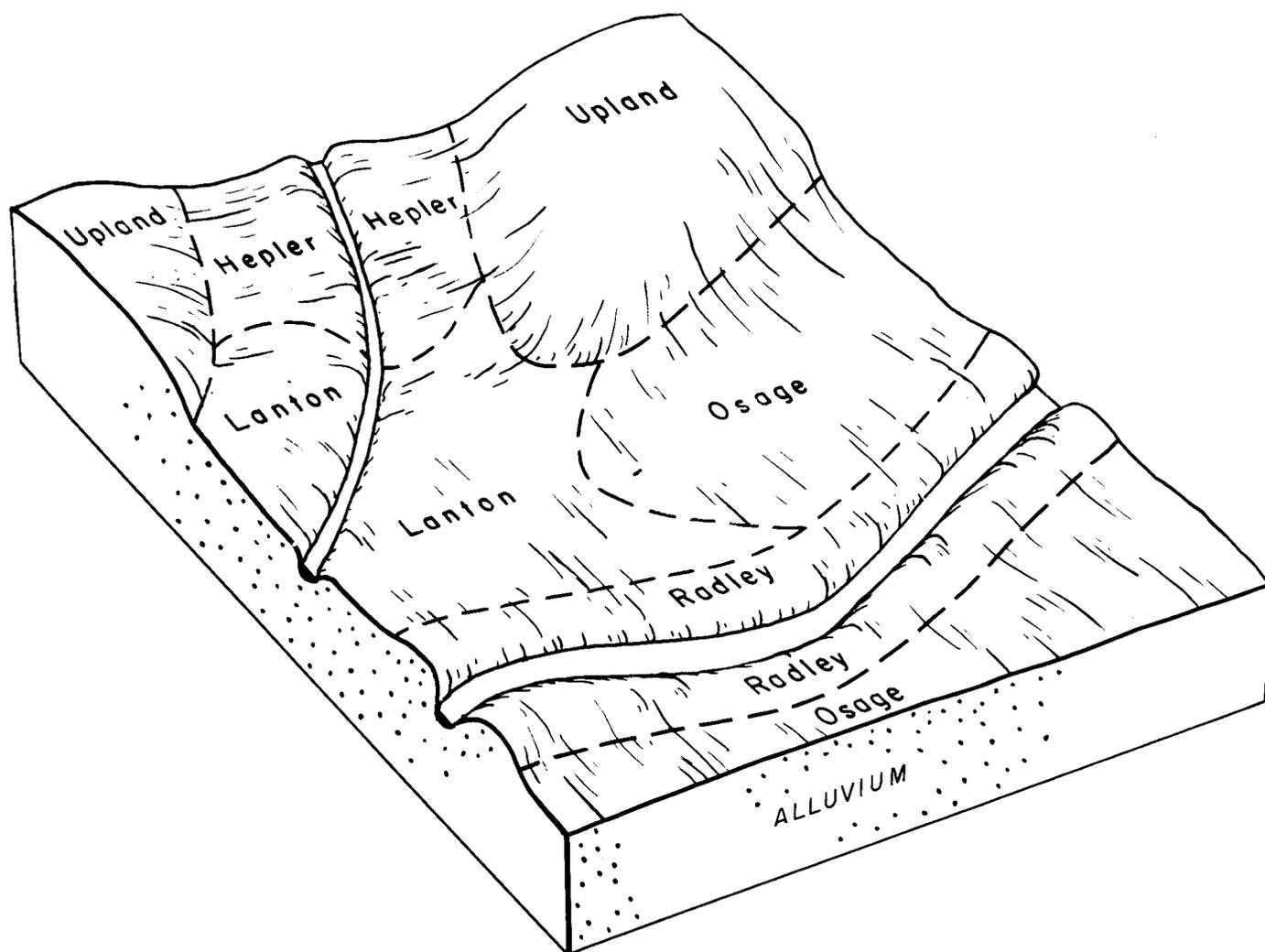


Figure 6.—Typical pattern of the major soils in Osage-Lanton-Hepler association.

ing. Most of the acreage is in corn, soybeans, and sorghum.

Descriptions of the Soils

This section describes the soil series and mapping units in Vernon County. Each soil series is described in detail, and then, briefly, each mapping unit in that series. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

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

those who need to make thorough and precise studies of soils. Color terms are for moist soil, unless otherwise stated. The profile described in the series is representative for mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are stated in describing the mapping unit, or they are differences that are apparent in the name of the mapping unit.

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

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

The acreage and proportionate extent of each map-

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

Soil	Area		Soil	Area	
	Acres	Percent		Acres	Percent
Balltown flaggy silty clay loam, 9 to 20 percent slopes -----	3,675	0.7	Hepler silt loam -----	9,270	1.7
Barco loam, 2 to 5 percent slopes -----	57,295	10.7	Hepler silt loam, overwash -----	2,250	.4
Barco loam, 2 to 5 percent slopes, eroded -----	16,160	3.0	Hepler-Radley complex -----	6,400	1.2
Barco loam, 5 to 9 percent slopes -----	2,145	.4	Lanton silty clay loam -----	11,720	2.2
Barco loam, 5 to 9 percent slopes, eroded -----	2,235	.4	Liberal silt loam, 2 to 5 percent slopes -----	6,680	1.3
Barden silt loam, 1 to 5 percent slopes -----	112,730	21.0	Liberal silty clay loam, 2 to 9 percent slopes, eroded -----	8,170	1.5
Barden silt loam, 1 to 5 percent slopes, eroded -----	18,965	3.5	Liberal-Coweta-Barco complex, 2 to 14 percent slopes -----	5,105	1.0
Bolivar fine sandy loam, 2 to 5 percent slopes -----	17,460	3.3	Lula silt loam, 2 to 5 percent slopes -----	3,715	.7
Bolivar fine sandy loam, 2 to 5 percent slopes, eroded -----	4,375	.8	Mayes silty clay loam -----	5,535	1.0
Bolivar fine sandy loam, 5 to 9 percent slopes -----	3,470	.7	Mine pits and dumps -----	4,210	.8
Bolivar fine sandy loam, 5 to 9 percent slopes, eroded -----	2,350	.4	Osage silty clay -----	30,650	5.7
Bronaugh silt loam, 2 to 5 percent slopes -----	2,180	.4	Parsons silt loam -----	88,540	16.5
Cleora loamy fine sand -----	5,455	1.0	Radley silty clay loam -----	9,200	1.7
Coweta fine sandy loam, 2 to 14 percent slopes -----	17,130	3.2	Radley, Parsons, and Barden soils, 0 to 25 percent slopes, severely eroded -----	9,335	1.7
Coweta stony fine sandy loam, 5 to 14 percent slopes -----	2,310	.4	Verdigris silt loam -----	10,970	2.1
Dubbs loam, 2 to 5 percent slopes -----	2,660	.5	Zaar silty clay, 2 to 5 percent slopes -----	21,300	4.0
Eldon cherty loam, thin solum variant, 5 to 14 percent slopes -----	290	.1	Zaar silty clay, 5 to 9 percent slopes -----	1,800	.3
Hector fine sandy loam, 5 to 14 percent slopes -----	13,000	2.4	Water that covers 3 acres or more -----	2,740	.5
Hector stony fine sandy loam, 5 to 14 percent slopes -----	11,530	2.2	Miscellaneous, including limestone quarries, made land, borrow pits -----	445	.1
Hector stony fine sandy loam, 14 to 30 percent slopes -----	2,870	.5	Total -----	536,320	100.0

ping 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 (6).¹

Balltown Series

The Balltown series consists of shallow, somewhat excessively drained soils that have a moderately fine textured surface layer and, at a depth of 5 to 20 inches, hard limestone bedrock. These soils are on upland divides and side slopes and have a slope of 9 to 20 percent. They formed in material weathered from limestone interbedded with thin layers of shale. The native vegetation was tall prairie grasses.

In a representative profile the surface layer is very dark grayish-brown flaggy silty clay loam about 10 inches thick. Below this the underlying material is dark-brown, firm flaggy silty clay loam about 6 inches thick. Limestone bedrock is at a depth of about 16 inches.

Natural fertility is medium. Organic-matter content is moderate. The available water capacity is very low. Surface runoff is medium to very rapid, and permeability is moderate. The chief limitation to the use of these soils is droughtiness, but stoniness, rockiness, and susceptibility to erosion are also limitations.

Balltown soils are used mainly for pasture. A small acreage has been seeded to tame grass, and the rest is in native grass. About half of it is covered with brush.

Representative profile of Balltown flaggy silty clay loam, 9 to 20 percent slopes, in a pasture, 660 feet east

and 40 feet south of the northwest corner of sec. 7, T. 37 N., R. 33 W.

A1—0 to 10 inches, very dark grayish-brown (10YR 3/2) flaggy silty clay loam; moderate, fine, granular structure; friable; many roots; 50 percent limestone fragments; mildly effervescent; mildly alkaline; clear, smooth boundary.

C—10 to 16 inches, dark-brown (10YR 3/3) flaggy silty clay loam; weak, fine, subangular blocky structure; firm; few roots; 80 percent limestone fragments; strongly effervescent; mildly alkaline; abrupt, smooth boundary.

R—16 inches, gray limestone bedrock.

The A horizon and the C horizon, if any, range from black (10YR 2/1) to dark brown (7.5YR 3/2 and 10YR 3/3). Depth to hard limestone bedrock ranges from 5 to 20 inches. The soil is 35 to 80 percent coarse fragments throughout. It is slightly acid to moderately alkaline.

Balltown soils are near Barden, Lula, and Zaar soils. They are not as deep to bedrock as those soils.

BaD—Balltown flaggy silty clay loam, 9 to 20 percent slopes. This soil is strongly sloping to moderately steep. It is on convex ridgetops and side slopes. This soil is commonly at a higher elevation than Zaar soils, and in many places is in narrow bands between Lula and Zaar soils. It is in long and narrow areas of 10 to 40 acres or more.

Included with this soil in mapping are small areas of Zaar and Lula soils and a soil that is similar to Balltown in thickness, color, and texture, but that is not flaggy. Also included are a few rock outcrops and wet seepy spots, and areas that have slopes of less than 9 percent, or areas that have slopes of more than 20 percent.

This soil is droughty because it is shallow to limestone bedrock and there are flagstones on the surface and throughout the soil. Because this soil is droughty

¹ Italic numbers in parentheses refer to Literature Cited, p 60.

and susceptible to erosion, it is not suitable for cultivation. Poor response to management can be expected. The use of this soil is limited largely to pasture, meadow, or wildlife food and cover. This soil is best suited to close-growing grass and legumes. Capability unit VII_s-8.

Barco Series

The Barco series consists of moderately deep, well-drained soils that have a medium-textured surface layer and mainly a moderately fine textured subsoil. These soils are on upland divides and mounds and have a slope of 2 to 9 percent. They formed in material weathered from sandstone interbedded with thin layers of shale. Sandstone fragments are on the surface and throughout the soil. Sandstone bedrock is at a depth of 20 to 40 inches. The native vegetation was tall prairie grass.

In a representative profile the surface layer is very dark brown and very dark grayish-brown loam about 13 inches thick. The subsoil is dark brown and dark yellowish-brown, firm, and about 18 inches thick. The upper part of the subsoil is loam and clay loam, and the lower part is gravelly clay loam. The underlying material, to a depth of about 35 inches, is brown gravelly loam and partly weathered sandstone fragments. Sandstone bedrock is at a depth of 35 inches.

Natural fertility is medium. The available water capacity is moderate or low. Barco soils in the northwestern part of the county have a greater capacity to hold and release some plant nutrients than Barco soils in other parts of the county. Surface runoff is medium or rapid, and permeability is moderate. Because they are moderately deep to sandstone bedrock, these soils are somewhat droughty, but susceptibility to erosion is the main limitation to their use.

More than half the acreage of Barco soils is used for cultivated crops, mainly small grain, corn, sorghum, and soybeans. The rest of the acreage is mainly in grass and legumes for hay and pasture. A small acreage is still in native tall prairie grasses.

Representative profile of Barco loam, 2 to 5 percent slopes, in a meadow, 1,260 feet north and 400 feet east of the southwest corner of the NW $\frac{1}{4}$ sec. 17, T. 35 N., R. 29 W.

- A11—0 to 9 inches, very dark brown (10YR 2/2) loam; moderate, fine, granular structure; friable; many roots; few worm holes and casts; few small brownish-yellow sandstone fragments; neutral; clear, smooth boundary.
- A12—9 to 13 inches, very dark grayish-brown (10YR 3/2) loam; moderate, medium, granular structure; friable; many roots; few small sandstone fragments; acid; clear, smooth boundary.
- B1—13 to 16 inches, dark-brown (10YR 4/3) loam; very dark grayish brown (10YR 3/2) in old worm channels; weak, fine, subangular blocky structure; friable; many roots; strongly acid; clear, smooth boundary.
- B21t—16 to 20 inches, dark yellowish-brown (10YR 4/4) clay loam; moderate, fine, subangular blocky structure; firm; many roots; thin clay films on faces of peds; few, dark reddish-brown, soft sandstone fragments; strongly acid; gradual, smooth boundary.
- B22t—20 to 27 inches, dark-brown (7.5YR 4/4) clay loam; moderate, fine, subangular blocky structure; firm; many roots; thin clay films on faces of peds; few red sandstone fragments; strongly acid; clear, smooth boundary.

- B3—27 to 31 inches, dark yellowish-brown (10YR 4/4) gravelly clay loam; weak, fine, subangular blocky structure; firm; many roots; approximately 35 percent partly weathered sandstone fragments; strongly acid; clear, smooth boundary.
- C—31 to 35 inches, brown (10YR 5/3) gravelly loam; massive; firm; few roots; approximately 35 percent partly weathered sandstone fragments; strongly acid; abrupt irregular boundary.
- R—35 inches, sandstone bedrock.

The thickness of the solum and depth to bedrock are 20 to 40 inches. In uneroded areas the A horizon is 7 to 15 inches thick and very dark brown (10YR 2/2) to dark brown (10YR 3/3). In eroded areas it is about 6 inches thick and mainly dark brown.

The B horizon is 10 to 30 inches thick and medium acid to strongly acid. The Bt horizons and the B3 horizon are dark-brown (10YR 4/3) to yellowish-brown (10YR 5/4) loam, clay loam, and sandy clay loam. The Bt horizon also contains 5 to 35 percent coarse fragments that are less than 3 inches in diameter.

The C horizon is loam, clay loam, or sandy clay loam and 5 to 35 percent coarse fragments that are less than 3 inches in diameter.

Barco soils are near Parsons, Barden, Coweta, Bolivar, and Hector soils. They are not so deep, and they have more sand and less clay throughout the profile than Parsons and Barden soils. They are deeper than Coweta and Hector soils. They have a darker colored or thicker A horizon than Bolivar and Hector soils.

BcB—Barco loam, 2 to 5 percent slopes. This soil is gently sloping. It is on convex knobs, side slopes, and rounded ridgetops. Areas are generally long and moderately wide and 10 to 80 acres or more. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Liberal, Coweta, and Barden soils. Liberal soils are on the knobs; Coweta soils are on the knobs and breaks of the side slopes; and Barden soils are below the breaks and in saddles that cross the ridgetops. Also included are a few small stony spots, eroded spots, and small areas that have a slope of more than 5 percent.

The available water capacity is moderate. Surface runoff is medium. Organic-matter content is moderate.

A good response to management can be expected. Because the soil is susceptible to erosion and is somewhat droughty, the choice of crops is limited or moderate conservation practices are needed. This soil is suited to corn, soybeans, sorghum, small grain, grass, and alfalfa and other legumes. Capability unit II_e-4.

BcB2—Barco loam, 2 to 5 percent slopes, eroded. This soil is gently sloping. It is near the slope breaks on convex knobs, ridgetops, and side slopes. The areas are long and narrow and about 5 to 80 acres or more.

This soil has a profile similar to the one described as representative of the series, but the surface layer is about 6 inches of dark-brown loam. Part of the original surface layer has been mixed with part of the subsoil. In erosion scars and gullies, the browner, somewhat finer textured subsoil is exposed in many places. Depth to sandstone bedrock is commonly 24 to 30 inches.

Included with this soil in mapping are small areas of Coweta and Barden soils. Coweta soils are on the breaks of side slopes and Barden soils are below the breaks and in saddles that cross the ridgetops. Also included are small areas of a soil that has a surface layer of fine sandy loam, areas of uneroded Barco soils, areas that have slopes of more than 5 percent, and small stony spots.

The available water capacity is low. Surface runoff is

medium. Organic-matter content is low. A good response to management can be expected. Because this soil is susceptible to further erosion and is droughty, the choice of crops is limited, or special conservation practices are needed, or both. This soil is best suited to small grain, grass, and legumes. Corn, soybeans, or sorghum can be safely grown in rotations that include hay or pasture crops. Capability unit IIIe-7.

BcC—Barco loam, 5 to 9 percent slopes. This soil is moderately sloping. It is on convex breaks and side slopes. Areas are long and narrow and 5 to 20 acres.

This soil has a profile similar to the one described as representative of the series, but depth to sandstone bedrock is generally about 24 to 30 inches.

Included with this soil in mapping are small areas of Coweta soils and Bolivar soils, and areas of soils that have a surface layer of sandy loam. Coweta soils are on breaks, and Bolivar soils are in the steeper wooded draws between Barco soils and Hector soils. Also included are a few rock outcrops, stony spots, and small eroded areas.

The available water capacity is moderate. Surface runoff is rapid. Organic-matter content is moderate. A fair response to management can be expected. Because this soil is highly susceptible to erosion and is droughty, the choice of crops is restricted and careful management is needed. This soil is suited to grass and legumes. Small grain, and occasionally a cultivated crop, can be grown in rotations that include several years of hay or pasture. Capability unit IIIe-4.

BcC2—Barco loam, 5 to 9 percent slopes, eroded. This soil is moderately sloping. It is on convex breaks and side slopes. This soil is in long and narrow areas of 5 to 20 acres.

This soil has a profile similar to the one described as representative of the series, but the surface layer is about 6 inches of dark-brown loam. Part of the original surface layer has been mixed with part of the subsoil. In scarred and gullied areas, the browner, somewhat finer textured subsoil is exposed in many places. Depth to sandstone bedrock is generally 20 to 26 inches.

Included with this soil in mapping are small areas of Coweta soils and Bolivar soils, and areas of a soil that has a surface layer of fine sandy loam. Coweta soils are on breaks and Bolivar soils are between the Barco soils and the steeper wooded draws. Also included are a few rock outcrops, stony spots, and areas where little or no erosion has taken place.

The available water capacity is low. Surface runoff is rapid. Organic-matter content is low.

A fair response to management can be expected. Because this soil is highly susceptible to further erosion and is droughty, its use is severely limited. This soil is suited to grass and legumes. Small grain and occasionally a cultivated crop can safely be grown in a rotation that includes several years of pasture or hay. Capability unit IVE-7.

Barden Series

The Barden series consists of deep, moderately well drained soils that have a medium-textured surface layer and a moderately fine textured subsoil. These soils are on upland divides and have a slope of 1 to 5 percent. They formed in material weathered from silty and

clayey shales. They are thinly mantled with loess, and depth to shale bedrock is more than 50 inches. The native vegetation was tall prairie grasses.

In a representative profile the surface layer is very dark grayish-brown silt loam about 12 inches thick. The subsoil is about 36 inches thick. In sequence from the top, the upper 6 inches is dark-brown and dark yellowish-brown, friable silty clay loam; the next 7 inches is dark-brown and dark grayish-brown, firm silty clay loam that has prominent mottles; the next 10 inches is mottled grayish-brown and reddish-brown, firm silty clay loam; and the lower 13 inches is distinctly mottled dark-gray, firm clay loam. The underlying material, to a depth of 55 inches, is distinctly mottled, gray, firm clay loam. Shale bedrock is at a depth of 55 inches.

Natural fertility is medium. The available water capacity is high. Barden soils in the northwestern part of the county have a greater capacity to hold and release some plant nutrients than Barden soils in other parts of the county. Surface runoff is medium, and permeability is slow. In some places these soils tend to be wet and seepy, but susceptibility to erosion is the major limitation to their use.

More than half the acreage of Barden soils is used for row crops and small grain. The important crops are corn, small grain, soybeans, and sorghum. The soils are worked with large machines, and the crops are marketed as cash-grain. Most of the remaining acreage is in tame grass, legumes, and native tall prairie grasses that are used for pasture and hay.

Representative profile of Barden silt loam, 1 to 5 percent slopes, in a pasture, 150 feet west and 75 feet south of the northeast corner of the SE $\frac{1}{4}$ sec. 21, T. 36 N., R 31 W.

A1—0 to 12 inches, very dark grayish-brown (10YR 3/2) silt loam; moderate, fine, granular structure; friable; many roots; many small pores; many small brown iron stains; strongly acid; gradual, smooth boundary.

B1—12 to 18 inches, dark-brown (10YR 4/3) and dark yellowish-brown (10YR 4/4) silty clay loam; few fine, prominent, dark-red (2.5YR 3/6) mottles; moderate, fine, subangular blocky structure; friable; many roots; strongly acid; gradual, smooth boundary.

B21t—18 to 25 inches, dark-brown (10YR 3/3) and dark grayish-brown (10YR 4/2) heavy silty clay loam; few, fine, prominent, dark-red (2.5YR 3/6) and yellowish-red (5YR 4/6) mottles; strong, fine and very fine, subangular blocky structure; firm; few roots; thin, continuous clay films; strongly acid; clear, smooth boundary.

B22t—25 to 35 inches, mottled grayish-brown (10YR 5/2), yellowish-brown (10YR 5/6), and dark reddish-brown (2.5YR 3/4) heavy silty clay loam; moderate, medium and fine, subangular blocky structure; firm; thin, continuous clay films; strongly acid; gradual, smooth boundary.

B3t—35 to 48 inches, dark-gray (10YR 4/1) clay loam; many, medium, distinct, yellowish-brown (10YR 5/6) and strong-brown (7.5YR 5/6) mottles; weak, fine and medium, subangular blocky structure; firm; thin, patchy clay films; few black stains; slightly acid; gradual, smooth boundary.

C1—48 to 55 inches, gray (10YR 6/1) clay loam; few, medium, distinct, yellowish-brown (10YR 5/8) mottles; massive; firm; old root channels filled with gray (10YR 5/1) clay; neutral; abrupt, smooth boundary.

C2—55 to 60 inches, gray clay shale interbedded with thin layers of sandstone.



Figure 7.—A tall fescue pasture on Barden silt loam, 1 to 5 percent slopes.

The solum is from 40 to 60 inches thick, and depth to bedrock is more than 50 inches.

The A horizon is 5 to 15 inches thick. It is very dark gray (10YR 3/1) to very dark brown (10YR 2/2). Except where lime has been applied, this horizon is strongly acid to medium acid.

The B1 horizon is brown (10YR 4/3) or dark-brown to yellowish-brown (10YR 5/4) silty clay loam or clay loam. It ranges from slightly acid to very strongly acid. The B2t horizon is dark brown (10YR 3/3) and dark grayish brown (10YR 4/2) to yellowish brown (10YR 5/6) and has dark-gray (10YR 4/1) to red (2.5YR 4/8) mottles. It is silty clay loam, clay loam, or silty clay. It ranges from slightly acid to strongly acid. B2t horizon is 15 to 30 inches thick. The B3 horizon and C1 horizon are mottled, grayish and yellowish-brown silty clay loam, clay loam, or silty clay.

Barden soils are near Parsons, Barco, Liberal, and Bronaugh soils. Barden soils do not have the abrupt textural change from the A to the B2t horizon that Parsons soils have. They are deeper than the Barco and Liberal soils. They are less red throughout than Bronaugh soils.

BdB—Barden silt loam, 1 to 5 percent slopes. This soil is gently sloping. It is on convex ridgetops and side slopes. Areas are long and moderately wide and 10 to 100 acres or more. These areas are well shaped for farm operations. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Parsons, Barco, and Liberal soils. Parsons soils are on ridgetops and benches near drainageways. Barco and Liberal soils are on knobs and on the steeper, somewhat broken side slopes. Also included are areas of eroded Barden soils, bands of seepage on foot slopes, and a few areas that have a slope of more than 5 percent.

The available water capacity is high. Surface runoff is medium. Organic-matter content is moderate. Susceptibility to erosion is a limitation to the use of this soil.

A good response to management can be expected. The

choice of crops is limited, or moderate conservation practices are needed. This soil is well suited to corn, soybeans, sorghum, small grain, grass (fig. 7), and legumes. The better drained areas are suited to alfalfa. If the soil is irrigated, it has a good potential for growing vegetables and field crops, but the acreage that could be irrigated is limited because an adequate water supply is not always available. Capability unit IIe-5.

BdB2—Barden silt loam, 1 to 5 percent slopes, eroded. This soil is gently sloping. It is near slope breaks on slightly concave ridgetops and side slopes. Areas are generally long and narrow and 5 to 40 acres or more.

This soil has a profile similar to the one described as representative of the series, but the surface layer is about 6 inches of very dark grayish-brown or dark-brown silt loam. Part of the original surface layer has been mixed with part of the subsoil. In erosion scars and in a few small gullies, the browner, finer textured subsoil is exposed in some places. Loamy material eroded from higher areas is accumulating in flatter downslope areas.

Included with this soil in mapping are small areas of Parsons, Barco, and Liberal soils. Parsons soils are near drainageways. Barco and Liberal soils are near slope breaks on knobs and side slopes. Also included are areas where little or no erosion has taken place, and areas where the slope is more than 5 percent.

The available water capacity is high. Surface runoff is medium. Organic-matter content is moderate. Susceptibility to further erosion severely limits the use of this soil. A good response to management can be expected. The choice of crops is limited, or special conservation practices are needed, or both. This soil is suited to sorghum, small grain, grass, legumes, corn, or soybeans. Capability unit IIIe-5.

Bolivar Series

The Bolivar series consists of moderately deep, well-drained soils that have a moderately coarse textured surface layer and a moderately fine textured subsoil. These soils are on upland divides and have a slope of 2 to 9 percent. They formed in material weathered from sandstone interbedded with thin layers of shale. Sandstone fragments are on the surface and throughout the soil. Sandstone bedrock is at a depth of from 20 to 40 inches. The native vegetation was mixed hardwood trees.

In a representative profile the surface layer is brown fine sandy loam about 7 inches thick. The subsurface layer is yellowish-brown fine sandy loam about 5 inches thick. The subsoil is about 15 inches thick. The upper 10 inches is yellowish-red, firm sandy clay loam, and the lower 5 inches is strong-brown, firm sandy clay loam. The underlying material, to a depth of about 35 inches, consists of layers of brown and red, highly weathered sandstone interbedded with thin layers of gray shale. Sandstone bedrock is at a depth of 35 inches.

Natural fertility and the available water capacity are low. Surface runoff is medium to rapid, and permeability is moderate. Because they are moderately deep to sandstone bedrock, these soils are somewhat droughty, but susceptibility to erosion is the major limitation to their use.

More than half of the acreage of Bolivar soils is in timber, predominantly oak and hickory. About half the remaining acreage is in grass and legumes used for pasture and hay. The main cultivated crops are small grain and sorghum.

Representative profile of Bolivar fine sandy loam, 2 to 5 percent slopes, in a meadow, 2,460 feet south and 100 feet west of the northeast corner of sec. 2, T. 34 N., R. 30 W.

- Ap—0 to 7 inches, brown (10YR 4/3) fine sandy loam; moderate, very fine, granular structure; very friable; many roots; few, 5- to 10-millimeter, soft sandstone fragments; medium acid; abrupt, smooth boundary.
- A2—7 to 12 inches, yellowish-brown (10YR 5/4) fine sandy loam; moderate, very fine, granular structure; very friable; many roots; few, 5- to 10-millimeter, soft sandstone fragments; slightly acid; clear, smooth boundary.
- B1—12 to 17 inches, yellowish-red (5YR 4/8) sandy clay loam; weak, fine, subangular blocky structure; firm; few roots; few, 10- to 20-millimeter, soft sandstone fragments; medium acid; gradual, smooth boundary.
- B2t—17 to 22 inches, yellowish-red (5YR 4/8) sandy clay loam; few, fine, distinct, red (2.5YR 4/8) mottles; moderate, fine, subangular blocky structure; firm; few roots; thin clay films on faces of peds; few small soft sandstone fragments; very strongly acid; gradual, smooth boundary.
- B3—22 to 27 inches, strong-brown (7.5YR 5/6) sandy clay loam; common, fine, prominent, dark-red (2.5YR 3/6) mottles; moderate, medium, subangular blocky structure; firm; few roots; few, small, soft sandstone fragments; very strongly acid; clear, smooth boundary.
- C—27 to 35 inches, strong-brown (7.5YR 5/8), yellowish-red (5YR 5/8), and dark-red (2.5YR 3/6) sandy clay loam; soft, highly weathered layers of sandstone interbedded with thin layers of light brownish-gray (10YR 6/2) clay shale; massive; firm; very strongly acid; abrupt, wavy boundary.
- R—35 inches, sandstone bedrock; massive.

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

The A horizon is 4 to 12 inches thick. The A1 horizon in uneroded areas is very dark grayish brown (10YR 3/2) or dark brown (10YR 3/3) and is 1 to 3 inches thick. The Ap or A2 horizon is dark brown (10YR 4/3) to light yellowish brown (10YR 6/4). In many places the A2 horizon has been removed through erosion or mixing that results from deep plowing.

The B horizon is 10 to 30 inches or more thick. The B1 horizon ranges from yellowish red (5YR 4/8) to yellowish brown (10YR 5/8) or dark yellowish brown (10YR 4/4) and is 3 to 8 inches thick. It is fine sandy loam to sandy clay loam. The B2t horizon ranges from friable sandy clay loam to firm clay loam. It ranges from brown (10YR 4/3) to red (2.5YR 4/8) and is 5 to 18 inches thick. In most places where the depth to sandstone is as much as 30 inches, a B3 horizon occurs. The B horizon ranges from medium acid to very strongly acid. Thick, grayish clay films or flows occur in the C horizon in some places.

Bolivar soils are near Barco, Hector, Coweta, and Dubbs soils. Bolivar soils have a lighter colored or thinner A horizon than Barco soils. They are deeper to sandstone bedrock than Hector and Coweta soils. Bolivar soils are not so deep as Dubbs soils.

BoB—Bolivar fine sandy loam, 2 to 5 percent slopes. This soil is gently sloping. It is on convex ridgetops, side slopes, and foot slopes. Areas are longer than they are wide and are 5 to 40 acres or more. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Hector, Dubbs, Barden, and Barco soils. Hector soils are on breaks of side slopes, and Dubbs soils are on foot slopes. Barden soils are at the head of drainageways, and Barco soils are in the transitional area between timber and prairie. Also included are a few eroded spots and areas that have a slope of more than 5 percent.

The available water capacity is low. Surface runoff is medium. Organic-matter content is low. Susceptibility to erosion and droughtiness are limitations to the use of this soil. A good response to management can be expected. The choice of crops is limited, or special conservation practices are needed, or both. This soil has some potential for alfalfa. It is suited to sorghum, corn, and soybeans, but it is best suited to small grain, grass, and legumes. A large acreage, once cleared for farming



Figure 3.—Native grasses and scattered oak and hickory trees on Bolivar fine sandy loam, 2 to 5 percent slopes.

is now covered by native grasses (fig. 8) and oak and hickory trees. Capability unit IIIe-7.

BoB2—Bolivar fine sandy loam, 2 to 5 percent slopes, eroded. This soil is gently sloping. It is near breaks on ridgetops, points, side slopes, and foot slopes. The slope is convex. This soil is in long and narrow areas of 5 to 40 acres or more.

This soil has a profile similar to the one described as representative of the series, but because it is eroded, the surface layer is about 6 inches of brown fine sandy loam. It is a combination of part of the original surface layer and some of the material below. In erosion scars and gullies, the reddish finer textured subsoil is exposed in many places. Sandstone bedrock is generally at a depth of 24 to 30 inches.

Included with this soil in mapping are small areas of Hector, Barco, and Barden soils. Hector soils are on slope breaks, and Barco soils are in the transitional area between timber and prairie. Barden soils are at the head of drainageways. Also included are small spots of uneroded and severely eroded Bolivar soils, and areas that have a slope of more than 5 percent.

The available water capacity is low. Surface runoff is medium. Organic-matter content is low.

A fair response to management can be expected. Because this soil is highly susceptible to erosion and is droughty, the choice of crops is limited. This soil is best suited to grass and legumes. Small grain and occasionally a cultivated crop can safely be grown in a long-term rotation that includes several years of hay and pasture. Capability unit IVe-7.

BoC—Bolivar fine sandy loam, 5 to 9 percent slopes. This soil is moderately sloping. It is on convex side slopes and foot slopes. Areas are long and narrow and 5 to 20 acres or more.

This soil has a profile similar to the one described as representative of the series, but depth to sandstone bedrock is generally 24 to 30 inches.

Included with this soil in mapping are small areas of Hector, Dubbs, and Cleora soils. Hector soils are on breaks of side slopes, and Dubbs soils are on foot slopes. Cleora soils are in the bottoms of narrow upland drainageways. Also included are a few rock outcrops and stony spots and areas that are moderately eroded.

The available water capacity is low. Surface runoff is rapid. Organic-matter content is low. A fair response to management can be expected. Because this soil is highly susceptible to erosion and is droughty, the choice of crops is restricted and very careful management is needed. This soil is suited to small grain, and occasionally a sorghum crop can be grown, but it is best suited to close-growing grass and legumes. Capability unit IIIe-7.

BoC2—Bolivar fine sandy loam, 5 to 9 percent slopes, eroded. This soil is moderately sloping. It is on convex side slopes and foot slopes. The areas are long and narrow and 5 to 20 acres or more.

This soil has a profile similar to the one described as representative of the series, but the surface layer is about 6 inches of brown fine sandy loam. Part of the original surface layer has been mixed with part of the subsoil. In erosion scars and gullies, the red, finer textured subsoil is exposed in many places. Depth to sandstone bedrock is generally 20 to 26 inches.

Included with this soil in mapping are small areas of

Hector, Dubbs, and Cleora soils. Hector soils are on breaks of side slopes, and Dubbs soils are on foot slopes. Cleora soils are on the bottoms of narrow upland drainageways. Also included are few rock outcrops and stony spots.

The available water capacity is low. Surface runoff is rapid. Organic-matter content is low.

A fair response to management can be expected. Because this soil is highly susceptible to further erosion and to droughtiness, the choice of crops is restricted and careful management is needed. This soil is best suited to close-growing grass and legumes. Occasionally small grain or sorghum also can be grown. Capability unit IVe-7.

Bronaugh Series

The Bronaugh series consists of deep, well-drained soils that have a medium-textured surface layer and mainly a moderately fine textured subsoil. These soils are on upland divides and mounds and have a slope of 2 to 5 percent. They formed in material weathered from silty or clayey and sandy shale. Depth to sandstone bedrock is more than 50 inches. The native vegetation was tall prairie grasses.

In a representative profile the surface layer is dark-brown silt loam about 7 inches thick. The subsoil is about 35 inches thick. The upper 6 inches is dark reddish-brown, friable silty clay loam; the next 21 inches is dark-red, firm silty clay and silty clay loam, and the lower 8 inches is red, firm silty clay loam. The underlying material, to a depth of about 52 inches, is yellowish-red, firm silty clay loam. Sandstone bedrock is at a depth of 52 inches.

Natural fertility is medium. The available water capacity is high. Surface runoff is medium, and permeability is moderate. Susceptibility to erosion is the major limitation to use.

Bronaugh soils are used mainly for corn, soybeans, sorghum, and small grain. Grass and legumes, especially alfalfa, are also grown.

Representative profile of Bronaugh silt loam, 2 to 5 percent slopes, in a cultivated field, 290 feet west and 825 feet south of the northeast corner of the NW $\frac{1}{4}$ sec. 14, T. 34 N., R. 32 W.

- Ap—0 to 7 inches, dark-brown (7.5YR 3/2) silt loam; moderate, fine, granular structure; friable; many roots; medium acid; clear, smooth boundary.
- B1—7 to 13 inches, dark reddish-brown (5YR 3/3) silty clay loam; moderate, medium, granular structure; friable; few roots; few, small, black concretions; medium acid; clear, smooth boundary.
- B21t—13 to 22 inches, dark-red (2.5YR 3/6) light silty clay; weak, medium, subangular blocky structure; firm; thin clay films on faces of peds; many, small, black concretions; medium acid; gradual, smooth boundary.
- B22t—22 to 34 inches, dark-red (2.5YR 3/6) silty clay loam; moderate, fine, subangular blocky structure; firm; thin clay films on faces of peds; many, fine, black concretions of iron and manganese; medium acid; gradual, smooth boundary.
- B3t—34 to 42 inches, red (2.5YR 4/6) silty clay loam; weak, medium, subangular blocky structure; firm; thin patchy clay films; many, fine, black concretions of iron and manganese; medium acid; gradual, smooth boundary.
- C—42 to 52 inches, yellowish-red (5YR 4/6) silty clay loam;

massive; firm; many, medium, black concretions of iron and manganese; medium acid.
R—52 inches, sandstone bedrock.

The solum is 40 to 60 inches or more thick, and depth to bedrock is more than 50 inches. The surface layer is mainly dark brown (7.5YR 3/2) but ranges from dark reddish brown (5YR 3/3) to very dark brown (10YR 2/2). In areas where lime has not been applied, it is medium acid or strongly acid.

The B1 horizon is dark brown (7.5YR 3/2) to dark reddish brown (5YR 3/4). The Bt horizon has hue of 5YR or 2.5YR, value of 3 through 5, and chroma of 4 through 8. It is normally heavy silty clay loam or silty clay but ranges to heavy clay loam. This horizon is medium acid to strongly acid.

The C horizon is brownish or yellowish-red silty clay loam or clay loam and has concretions of iron and manganese. It commonly has gray mottles.

Bronaugh soils are near Barden, Parsons, Barco, and Liberal soils. Bronaugh soils are redder throughout than any of these soils. They are deeper than Barco soils and typically are deeper than Liberal soils. They lack the abrupt textural change from the A horizon to the B2it horizon, which the Parsons soils have.

BsB—Bronaugh silt loam, 2 to 5 percent slopes. This soil is gently sloping. It is on convex ridgetops and knobs. The soil areas are long and narrow or circular and 5 to 20 acres.

Included with this soil in mapping are small areas of Barco and Barden soils. Barco soils are on knobs, and Barden soils are on broad divides. Both soils are at a lower elevation than Bronaugh soils. Also included are small eroded areas that are redder and, in many places, are silty clay loam instead of silt loam. Other inclusions are areas that have a slope of more than 5 percent.

The available water capacity is high. Surface runoff is medium. Organic-matter content is moderate.

A good response to management can be expected. Because this soil is susceptible to erosion, the choice of crops is limited or moderate conservation practices are needed. This soil is well suited to corn, soybeans, sorghum, small grain, grass, and alfalfa and other legumes. Areas of this soil are generally so small that they are managed with surrounding soils. Capability unit IIe-1.

Cleora Series

The Cleora series consists of deep, nearly level, well-drained soils that have coarse-textured surface layer and coarse-textured to medium-textured underlying material. These soils are on bottom lands. They formed in coarse sediments washed from fine sandy loam soils of nearby uplands. The native vegetation was mixed hardwood forest and an understory of tall prairie grasses.

In a representative profile the surface layer is very dark grayish-brown loamy fine sand about 10 inches thick. Below that is about 27 inches of yellowish-brown and dark grayish-brown, very friable loamy very fine sand. The next layer is about 10 inches of brown, friable loam. The next layer, to a depth of about 60 inches, is brown, very friable fine sandy loam.

Natural fertility is medium. The available water capacity is moderate. Air and water move through these soils at a moderately rapid rate. Surface runoff is slow. Flooding is the major limitation to use of these soils.

Cleora soils are mainly in grass, brush, or forest. In cultivated areas, row crops, small grain, grass, and legumes are grown. These soils have a good potential for walnut trees, other valuable trees, and alfalfa.

Representative profile of Cleora loamy fine sand, in a pasture, 825 feet east and 60 feet south of the north-west corner of the NE ¼ sec. 17, T. 35 N., R. 30 W.

A1—0 to 10 inches, very dark grayish-brown (10YR 3/2) loamy fine sand; weak, fine and very fine, granular structure; very friable; many roots; medium acid; clear, smooth boundary.

C1—10 to 25 inches, yellowish-brown (10YR 5/4) loamy very fine sand; massive; very friable; common roots; medium acid; gradual, smooth boundary.

C2—25 to 37 inches, dark grayish-brown (10YR 4/2) loamy very fine sand; massive; very friable; few large roots; medium acid; clear, smooth boundary.

C3—37 to 47 inches, brown (10YR 4/3 and 10YR 5/3) loam; massive; friable; few large roots; medium acid; clear, smooth boundary.

C4—47 to 60 inches, brown (10YR 5/3) fine sandy loam; massive; very friable; faintly stratified; medium acid.

Cleora soils are medium acid to neutral. The A horizon is 10 to 16 inches thick. It is very dark grayish brown (10YR 3/2) to very dark brown (10YR 2/2). The C horizon is dark grayish-brown (10YR 4/2) to yellowish-brown (10YR 5/6) and dominantly loamy very fine sand, but it ranges from loamy very fine sand to loam. In places coarser textures or finer textures are below a depth of 40 inches.

Cleora soils are near Hepler, Verdigris, Radley, and Dubbs soils. Cleora soils have more sand and less clay throughout than any of those soils.

Ce—Cleora loamy fine sand. This soil is nearly level. It is on flood plains of small streams or near the channels of larger streams. The slope is 0 to 2 percent. Areas of this soil are long and narrow and 5 to 40 acres or more.

Included with this soil in mapping are small areas of Verdigris, Radley, and Hepler soils. Verdigris and Radley soils are on natural levees close to the stream channel or to old meanders. Hepler soils are between natural levees and uplands. Also included are areas that have a thinner, dark-colored surface layer.

The available water capacity is moderate. Surface runoff is slow. Organic-matter content is moderate.

A good response to management can be expected. Because of seasonal droughtiness and frequent flooding, the choice of crops is limited or special conservation practices are needed. Many areas of this soil are small and poorly shaped for farming. This soil is suited to alfalfa, small grain, grass, and legumes. It is less suited to sorghum, corn, and soybeans. It has a good potential for walnut trees. Capability unit IIw-2.

Coweta Series

The Coweta series consists of shallow, well-drained soils that have a moderately coarse textured surface layer and sandstone at a depth of less than 20 inches. These soils are on upland divides and mounds near streams and have a slope of 2 to 14 percent. They formed in material weathered from sandstone interbedded with thin layers of shale. Sandstone fragments are on the surface and throughout the soil. The native vegetation was tall prairie grasses.

In a representative profile the surface layer is fine sandy loam about 14 inches thick. The upper 6 inches is very dark grayish brown, and the lower 8 inches is dark brown. The underlying material is strong-brown and yellowish-red, soft sandstone about 21 inches thick. Hard sandstone is at a depth of 35 inches.

Natural fertility is low, and available water capacity is very low. Surface runoff is medium to rapid, and per-



Figure 9.—Native grasses growing on Coweta fine sandy loam, 2 to 14 percent slopes.

meability is moderate. Droughtiness is the major limitation to use. Erosion, stoniness, and rockiness are also limitations.

Most of these soils are in native grasses (fig. 9) that are used for hay or pasture. A small acreage is in tame grass, legumes, small grain, and sorghum. In most places, cultivated areas of Coweta soils are near Barco soils.

Representative profile of Coweta fine sandy loam, 2 to 14 percent slopes, in a native prairie meadow, 150 feet west and 125 feet north of the southeast corner of sec. 22, T. 34 N., R. 31 W.

- A11—0 to 6 inches, very dark grayish-brown (10YR 3/2) fine sandy loam; moderate, fine and very fine, granular structure; very friable; many roots; 5 percent soft and hard sandstone fragments; medium acid; abrupt, smooth boundary.
- A12—6 to 14 inches, dark-brown (10YR 3/3) fine sandy loam; very dark grayish-brown (10YR 3/2) coatings on peds; moderate, fine and very fine, granular structure; very friable; many roots; 5 percent soft and hard sandstone fragments; medium acid; abrupt, smooth boundary.
- C—14 to 35 inches, strong-brown (7.5YR 5/6) and yellowish-red (5YR 5/6) soft sandstone interbedded with thin layers of shale; few roots in upper 7 inches; strongly acid; abrupt, smooth boundary.
- R—35 inches, brown sandstone bedrock; hard.

The solum is 10 to 20 inches thick. The A horizon is very dark brown (10YR 2/2) to dark brown (7.5YR 3/2). It is 4 to about 20 inches thick and strongly acid to slightly acid. A B horizon, which occurs in many places, is brown (10YR 4/3) to strong brown (7.5YR 5/6) and slightly acid to strongly acid. The C horizon is soft acid sandstone, commonly interbedded with shale. Hard sandstone is at a depth of 24 to 45 inches.

Coweta soils are near Barden, Barco, Bolivar, and Hector soils. They are shallower and contain less clay than Barden, Barco, and Bolivar soils. Coweta soils have a darker colored or thicker A horizon than Bolivar or Hector soils.

CoC—Coweta fine sandy loam, 2 to 14 percent slopes.

This soil is gently sloping to strongly sloping. It is on convex breaks, ridgetops, and side slopes. The soil areas are long and relatively wide and 10 to 100 acres or more. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Barco, Hector, and Liberal soils. Barco soils are on crests of ridgetops and between slope breaks. Hector soils are along drainageways that were originally wooded. Liberal soils are generally on knobs. Also included are stony spots, rock outcrops, and narrow bottoms where the soil is Cleora loamy fine sand.

The available water capacity is very low. Surface runoff is medium to rapid. Organic-matter content is moderate.

A poor response to management can be expected. Because this soil is droughty, susceptible to erosion, is stony in spots, and has rock outcrops, it is not suited to cultivation. It is best suited to grass and legumes, but it is also suited to woodland or wildlife food and cover. Capability unit VI_s-6.

CrD—Coweta stony fine sandy loam, 5 to 14 percent slopes. This soil is moderately sloping and strongly sloping. It is on convex breaks, side slopes, and narrow ridgetops. The soil areas are longer than they are wide and 5 to 80 acres or more.

This soil has a profile similar to the one described as representative of the series, but the surface layer is stony and somewhat thinner. Stones, 1 to 4 feet across, cover about 5 to 10 percent of the surface. Stones also make up about 15 to 30 percent, by volume, of the soil profile.

Included with this soil in mapping are small areas of Coweta fine sandy loam and of Hector and Barco soils. Coweta fine sandy loam occurs between the stony areas. Hector soils are along drainageways that were occasionally wooded, and Barco soils are between slope breaks. Also included are numerous rock outcrops and narrow bottoms where the soil is Cleora loamy fine sand. Other inclusions are areas that have a slope of less than 5 percent.

Because of the stones on the surface and in the surface layer (fig. 10) and the rocky spots, this soil is not suited to cultivation. Poor response to management can be expected. All use of farm machinery is impractical, and only the small, scattered, nonstony included areas can be mowed or worked for hay or pasture. These are very severe limitations that restrict the use of this soil to grazing, woodland, or wildlife. It is better suited to pasture or wildlife than to other uses. Capability unit VII_s-6.

Dubbs Series

The Dubbs series consists of deep, well-drained soils that have a medium-textured surface layer and a moderately fine textured subsoil. These soils are on stream terraces and foot slopes and have a slope of 2 to 5 percent. They formed in loamy material deposited by streams or moved downslope from higher upland areas. The native vegetation was mixed hardwood trees and tall prairie grasses.

In a representative profile the surface layer is brown loam about 11 inches thick. The subsoil is about 32 inches thick. In sequence from the top, the upper 4



Figure 10.—Rocks on the surface of Coweta stony fine sandy loam, 5 to 14 percent slopes, can impede the use of farm machinery.

inches is dark-brown, friable clay loam; the next 15 inches is reddish-brown, firm clay loam; and the lower 13 inches is red clay loam that has light brownish-gray mottles. The underlying material, to a depth of 49 inches, is mottled light yellowish-brown and yellowish-red clay loam. Below this, to a depth of 60 inches, it is mottled light yellowish-brown and dark-red loam.

Natural fertility is medium. The available water capacity is high. Surface runoff is medium, and permeability is moderate. Susceptibility to erosion is the major limitation to the use of these soils.

Dubbs soils are used mainly for sorghum, small grain, corn, soybeans, hay, and pasture. A small acreage is wooded. Wheat and sorghum are the most important crops.

Representative profile of Dubbs loam, 2 to 5 percent slopes, in a pasture, 1,200 feet west and 100 feet north of the center of sec. 26, T. 26 N., R. 29 W.

- Ap—0 to 7 inches, brown (10YR 4/3) loam; moderate, fine, granular structure; friable; many roots; few worm holes; neutral; abrupt, smooth boundary.
- A2—7 to 11 inches, brown (10YR 5/3) loam; weak, fine, granular structure; friable; many roots; common worm holes and casts; neutral; clear, smooth boundary.
- B1—11 to 15 inches, dark-brown (7.5YR 4/4) clay loam; weak, fine, subangular blocky structure; friable; common roots; neutral; clear, smooth boundary.
- B21t—15 to 23 inches, reddish-brown (5YR 4/4) clay loam; moderate, fine and medium, subangular blocky structure; firm; common roots; thin clay films on faces of peds; neutral, gradual, smooth boundary.
- B22t—23 to 30 inches, reddish-brown (5YR 4/3) clay loam; few, fine, distinct, brown (10YR 5/3) mottles; moderate, medium, subangular blocky structure; firm; few roots; thin clay films on faces of peds; few, medium, black (10YR 2/1) stains of iron; strongly acid; clear, smooth boundary.
- B3t—30 to 43 inches, red (2.5YR 4/6) clay loam; common, medium, distinct, light brownish-gray (10YR 6/2) mottles; weak, medium, subangular blocky struc-

ture; friable; thin patchy clay films on faces of peds; few, fine, black stains of iron; strongly acid; clear, wavy boundary.

- C1—43 to 49 inches, mottled light yellowish-brown (10YR 6/4) and yellowish-red (5YR 4/6) clay loam; massive; friable; strongly acid; clear, smooth boundary.
- C2—49 to 60 inches, mottled light yellowish-brown (10YR 6/4) and dark-red (2.5YR 3/6) loam; massive; friable; pale-brown (10YR 6/3) very fine coatings of sand on some pressure faces; strongly acid.

Dubbs soils are very strongly acid through medium acid, except where lime has been applied. The Ap or A horizon is 4 to 12 inches thick and brown (10YR 4/3) to grayish brown (10YR 5/2). In undisturbed areas, the A1 horizon is very dark grayish brown (10YR 3/2) or dark brown (10YR 4/3) and 1 to 4 inches thick. The B horizon is 20 to 40 inches thick. The B1 horizon is dark brown (7.5YR 4/2) to yellowish brown (10YR 5/4). The Bt horizon is red (2.5YR 4/6) to pale-brown (10YR 6/3) loam to silty clay loam and is mottled in the lower part. The C horizon is dark-red (2.5YR 3/6) to light brownish-gray (10YR 6/2) loam to silty clay loam.

These soils contain more fine sand in the B horizon than is defined as the range for the series, but the difference does not alter their usefulness and behavior.

Dubbs soils are near Hepler, Cleora, and Bolivar soils. They are at a higher elevation and have a lighter-colored or thinner A horizon than Hepler or Cleora soils. They are deeper than Bolivar soils.

DuB—Dubbs loam, 2 to 5 percent slopes. This soil is gently sloping. It is on convex stream terraces, natural levees, and foot slopes. The soil areas are irregularly shaped and 5 to 20 acres or more.

Included with this soil in mapping are small areas of soil in which part of the original surface layer has been mixed with part of the subsoil, and small areas of Bolivar and Cleora soils. Bolivar soils are on side slopes above Dubbs soils, and Cleora soils are on bottom lands. Also included are areas of a soil that has a surface layer of fine sandy loam. Other inclusions are seepy spots and a few areas of a soil that has a darker colored surface layer.

The available water capacity is high. Surface runoff is medium. Organic-matter content is low. Good response to management can be expected. Because this soil is susceptible to erosion the choice of crops is reduced or special conservation practices are needed, or both. The soil is suited to corn, soybeans, small grain, sorghum, grass, and legumes. Capability unit IIe-1.

Eldon Variant

This variant of the Eldon series consists of deep, well-drained soils that have a cherty, medium-textured surface layer and a cherty, fine textured and moderately fine textured subsoil. It is on upland divides and side slopes and has a slope of 5 to 14 percent. It formed in material weathered from cherty limestone. Limestone bedrock is at a depth of 45 to 70 inches. The native vegetation was tall prairie grasses.

In a representative profile the surface layer is very dark brown and very dark grayish-brown cherty and very cherty loam about 14 inches thick. The subsoil is about 20 inches thick. In sequence from the top, the upper 4 inches is reddish-brown, friable very cherty silty clay loam; the next 10 inches is dark-red, firm cherty silty clay; the lower 6 inches is yellowish-brown, firm silty clay that has dark-red mottles. The underlying material, to a depth of about 51 inches, is mottled

gray and brownish-yellow, firm silty clay loam. Limestone bedrock is at a depth of 51 inches.

Natural fertility is medium. The available water capacity is low. Surface runoff is medium, and permeability is moderate. Droughtiness is the major limitation to use, but erosion and angular chert fragments in the soil and on the surface are also limitations.

These soils are mainly in grass and legumes and are used for pasture. More than half the acreage is covered with brush and scrub trees. These soils have a good potential for walnut trees.

Representative profile of Eldon cherty loam, thin solum variant, 5 to 14 percent slopes, in a pasture, 550 feet west and 2,320 feet south of the northeast corner of sec. 25, T. 36 N., R. 29 W.

- A11—0 to 8 inches, very dark brown (10YR 2/2) cherty loam; moderate, fine and very fine, granular structure; friable; many roots; about 30 percent chert fragments; medium acid; clear, smooth boundary.
- A12—8 to 14 inches, very dark grayish-brown (10YR 3/2) very cherty loam; moderate, medium, granular structure; friable; common roots; about 65 percent chert fragments; slightly acid; clear, wavy boundary.
- B1—14 to 18 inches, reddish-brown (5YR 4/4) very cherty silty clay loam; weak, fine, subangular blocky structure; friable; few roots; about 60 to 70 percent chert fragments; slightly acid; clear, wavy boundary.
- B2t—18 to 28 inches, dark-red (2.5YR 3/6) cherty silty clay; moderate, fine and medium, subangular blocky structure; firm; few roots; about 30 percent chert fragments; grayish-brown (10YR 5/2) clay films on surfaces of peds; medium acid; clear, smooth boundary.
- B3—28 to 34 inches, yellowish-brown (10YR 5/6) silty clay; common, fine, prominent, dark-red (2.5YR 3/6) mottles; weak, medium, subangular blocky structure; firm; about 5 percent chert fragments; neutral; clear, smooth boundary.
- C—34 to 51 inches, mottled light-gray (10YR 6/1), grayish-brown (10YR 5/2), and brownish-yellow (10YR 6/6) silty clay loam; massive; firm; about 10 percent chert fragments; organic stains in old root channels; neutral.
- R—51 inches, limestone bedrock.

The solum is 30 to 60 inches thick, and depth to bedrock is 50 to 60 inches. The A horizon is 10 to 15 inches thick and ranges from very dark brown (10YR 2/2) to dark brown (7.5YR 3/2). It is 30 to 65 percent chert and is slightly acid to strongly acid. The B1 and B2t horizons are yellowish-red (5YR 4/6) to dusky-red (10YR 3/3) cherty or very cherty silty clay loam, clay loam, or silty clay. They are 30 to 75 percent chert and are slightly acid to strongly acid. The B3 horizon is strong-brown (7.5YR 5/6) or yellowish-brown (10YR 5/6) silty clay or silty clay loam and is 5 to 15 percent chert.

Eldon variant soils are near Coweta, Barco, and Barden soils. They are deeper than the Coweta and Barco soils. They have a redder B horizon and more chert fragments on the surface and throughout the profile than Barco and Barden soils.

EdD—Eldon cherty loam, thin solum variant, 5 to 14 percent slopes. This soil is moderately sloping and strongly sloping. It is on convex ridgetops and side slopes. The soil areas are long and moderately wide and 15 to 100 acres.

Included with this variant in mapping are small areas of Coweta, Barco, and Barden soils. Coweta soils are on breaks either above or below Eldon soils. Barden and Barco soils are below breaks or near the head of draws on low slopes. Also included are areas where the surface layer is dark grayish brown and brown.

Chert fragments on and throughout the soil, droughtiness, and susceptibility to erosion severely limit the use of this soil.

A good response to management can be expected. The choice of crops is restricted, and careful management is needed. This soil is best suited to grass, legumes, and small grain. Occasionally, sorghum or another row crop may be grown in a cropping system that includes several years of hay or pasture. Capability unit IVs-6.

Hector Series

The Hector series consists of shallow, well-drained soils that have a moderately coarse textured surface layer and a thin moderately coarse textured subsoil. These soils are on low upland divides near streams and have a slope of 5 to 30 percent. They formed in material weathered from sandstone. In places the sandstone is interbedded with thin layers of shale. Sandstone fragments are on the surfaces and throughout the soil. Sandstone bedrock is at a depth of less than 20 inches. The native vegetation was deciduous hardwood trees.

In a representative profile the surface layer is very dark grayish-brown and dark-brown fine sandy loam about 6 inches thick. The subsoil is about 8 inches of yellowish-brown, very friable, fine sandy loam. Sandstone bedrock is at a depth of about 14 inches.

Natural fertility is very low. The available water capacity is very low. Surface runoff is medium to rapid, and permeability is moderately rapid. Droughtiness, resulting from shallowness and moderately coarse texture, is the major limitation. Susceptibility to erosion and stoniness and rockiness are also limitations.

More than half of the acreage is in forest stands and brush. Blackjack oak, post oak, and hickory are the dominant trees. Most cleared areas are in tame grass, lespedeza, and broom sedge, but a few acres are in small grain and sorghum. Most cultivated areas are close to Bolivar soils.

Representative profile of Hector fine sandy loam, 5 to 14 percent slopes, in a wooded area, 740 feet north and 125 feet east of the center of sec. 16, T. 35 N., R. 29 W.

- A1—0 to 3 inches, very dark grayish-brown (10YR 3/2) fine sandy loam; weak, very fine, granular structure; very friable; many roots; common small sandstone fragments; medium acid; clear, smooth boundary.
- A2—3 to 6 inches, dark-brown (10YR 4/3) fine sandy loam; weak, fine, granular structure; very friable; many roots; common small sandstone fragments; very strongly acid; clear, smooth boundary.
- B2—6 to 14 inches, yellowish-brown (10YR 5/4) fine sandy loam; weak, medium, subangular blocky structure; very friable; common roots; common small sandstone fragments; very strongly acid; abrupt, wavy boundary.
- R—14 to 16 inches, yellowish-brown sandstone; hard, massive.

The thickness of the solum and depth to bedrock are 8 to 20 inches.

The A horizon is 4 to 15 inches thick and ranges from very strongly acid to slightly acid. The A1 horizon is very dark grayish brown (10YR 3/2) to dark brown or brown (10YR 4/3) and 1 to 5 inches thick. The Ap and A2 horizons are dark brown (10YR 4/3) to light yellowish brown (10YR 6/4).

The B horizon and the C horizon that occur in places are dark brown (10YR 4/3) to strong brown (7.5YR 5/8). The B horizon is strongly acid or very strongly acid. The C horizon is structureless.

Hector soils are near Bolivar, Coweta, Barco, Barden, and Dubbs soils. They are not so deep as and have more sand and less clay than Bolivar, Barco, Barden, and Dubbs soils. They have a lighter colored or thinner A horizon than Coweta, Barco, and Barden soils.

In Vernon County, Hector stony fine sandy loams contain more stones throughout the profile than is defined as the range for the series.

HcD—Hector fine sandy loam, 5 to 14 percent slopes.

This soil is moderately sloping and strongly sloping. It is on convex breaks, narrow ridgetops, and side slopes. The soil areas are long and narrow and 10 to 80 acres or more. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Coweta and Bolivar soils. Coweta soils are away from the wooded draws in areas where they are under tall prairie grasses. Bolivar soils are on ridgetops and below breaks. Also included are small stony spots and rock outcrops, narrow bottom lands where Cleora soils occur, and areas that have a slope of less than 5 percent.

The available water capacity is very low. Surface runoff is medium. Organic-matter content is low.

A poor response to management can be expected. Because of droughtiness, susceptibility to erosion, stony spots, and rock outcrops this soil is not suited to cultivation. These features limit the use of this soil to pasture, woodland, and wildlife food and cover. The soil is best suited to grass and legumes. Capability unit VI-4.

HeD—Hector stony fine sandy loam, 5 to 14 percent slopes. This soil is moderately sloping and strongly sloping. It is on convex ridgetops, breaks, and side slopes. The soil areas are longer than they are wide and 10 to 100 acres or more.

This soil has a profile similar to the one described as representative of the series, but there are stones on and in the soil. Stones, 1 to 4 feet across, cover about 10 to 20 percent of the surface. Stones make up more than 35 percent, by volume, of the soil profile.

Included with this soil in mapping are small areas of Coweta soils and other Hector soils. Coweta soils are away from the wooded draws in areas where they are under tall prairie grasses. Hector fine sandy loam is in small areas between stony areas. Also included are numerous rock outcrops and narrow bottoms of Cleora soils.

Surface runoff is medium. Organic-matter content is low.

A poor response to management can be expected. Because of the stones on and in the surface layer, rocky spots, and droughtiness, this soil is not suited to cultivation. All use of farm machinery is impractical, and only scattered nonstony included areas of other soils can be mowed or worked for pasture or hay. Cleared areas are best suited to pasture. The steeper, broken slopes have limited suitability for woodland. All areas of this soil are suited to wildlife. Capability unit VII-6.

HeE—Hector stony fine sandy loam, 14 to 30 percent slopes. This stony soil is moderately steep and steep. It is on convex side slopes. The soil areas are long and narrow and 10 to 80 acres or more.

This soil has a profile similar to the one described as representative of the series, but stones are on and in the soil. The stones are 1 to 4 feet across and cover about 10 to 20 percent of the surface. More than 35 percent, by volume, of the soil profile is stones.

Included with this soil in mapping are small areas of Hector fine sandy loam that is on narrow ridgetops in some places, above the slope breaks in some places, and below the slope breaks in other places. Also included are numerous rock outcrops and areas of narrow bottom lands where soils are in the Cleora series.

Surface runoff is rapid. Organic-matter content is low.

Poor response to management can be expected. Because of stones on the surface and in the surface layer, rocky spots, steepness, and droughtiness, this soil is not suited to cultivation. All use of farm machinery is impractical. These soil features are very severe limitations that restrict use of this soil to pasture, woodland, or wildlife habitat. This soil is best suited to wildlife habitat, but to a limited degree, it is also suitable for grazing or woodland. Capability unit VII-6.

Hepler Series

The Hepler series consists of deep, somewhat poorly drained soils that have a medium-textured surface layer and a moderately fine textured subsoil. These soils are on low stream terraces and have a slope of less than 2 percent. They formed in silty alluvium washed from nearby uplands. The native vegetation was tall prairie grasses and scattered hardwood trees.

In a representative profile the surface layer is very dark grayish-brown silt loam about 9 inches thick. The subsurface layer is silt loam about 16 inches thick. The upper part of this layer is grayish brown, and the lower part is light brownish gray. Both parts have brown mottles. The subsoil is about 25 inches thick. It is dark-gray, firm, light silty clay loam that has many brownish and yellowish mottles. The underlying material, to a depth of about 70 inches, is dark-gray light silty clay loam that has many brownish mottles.

Natural fertility is medium. The available water capacity is very high. Surface runoff is slow, and permeability is moderately slow. The use of these soils is limited, because they are seasonally wet and subject to occasional flooding.

Hepler soils are used mainly for sorghum, small grain, corn, soybeans, grass, and legumes. The acreage not in crops is mainly in pasture, brush, and woodland.

Representative profile of Hepler silt loam, in a cultivated field, 100 feet north and 200 feet east of the southwest corner of sec. 28, T. 35 N., R. 31 W.

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2) silt loam; moderate, medium, granular structure; friable; many worm holes and casts; neutral; abrupt, smooth boundary.

A12—6 to 9 inches, very dark grayish-brown (10YR 3/2) silt loam; moderate, medium, granular structure; friable; many roots; many worm holes and small pores; slightly acid; gradual, smooth boundary.

A21—9 to 17 inches, grayish-brown (10YR 5/2) silt loam; many, medium, faint, brown (10YR 4/3) mottles; moderate, medium, granular structure; friable; many roots; many small pores; medium acid; gradual, smooth boundary.

A22—17 to 25 inches, light brownish-gray (10YR 6/2) silt loam; many, medium, faint, brown (10YR 4/3) mottles; moderate, medium, granular structure; friable; common roots; many small pores; strongly acid; clear, smooth boundary.

B21t—25 to 32 inches, dark-gray (10YR 4/1) light silty clay loam; many, medium, faint, pale-brown (10YR 6/3) and dark yellowish-brown (10YR 4/4) mot-

bles; moderate, fine, subangular blocky structure; firm; few roots; thin clay films on some faces of peds; many old root channels filled with dark-colored material; medium acid; gradual, smooth boundary.

B2t—32 to 42 inches, dark-gray (10YR 4/1) light silty clay loam; many, medium, faint, pale-brown (10YR 6/3) and few, fine, distinct, dark yellowish-brown (10YR 4/4) mottles; weak, medium, subangular blocky structure; firm; few roots; thin clay films on faces of peds; few old root channels filled with dark-colored material; strongly acid; gradual, smooth boundary.

B3—42 to 50 inches, dark-gray (10YR 4/1) light silty clay loam; many, medium, faint, brown (10YR 4/3) and many, small, faint, pale-brown (10YR 6/3) mottles; weak, medium, subangular blocky structure; firm; few roots; medium acid; gradual, smooth boundary.

C—50 to 70 inches, dark-gray (10YR 4/1) light silty clay loam; many, medium, faint, yellowish-brown (10YR 5/6) and light brownish-gray (10YR 6/2) mottles; massive; firm; few roots; few large black stains; slightly acid.

Hepler soils are medium acid to very strongly acid, except where lime has been applied. They are 60 to 100 inches or more thick.

The A horizon is 16 to about 30 inches thick. The Ap and A1 horizons are mainly very dark grayish-brown (10YR 3/2) or dark-brown (10YR 3/3) silt loam about 6 to 9 inches thick. In some places they are very dark gray (10YR 3/1). The A horizon in some overwash areas is lighter colored silt loam 10 to 20 inches thick. The A2 horizon ranges from gray (10YR 5/1) to dark grayish brown (10YR 4/2).

The B2t horizon ranges from dark gray (10YR 4/1) to grayish brown (10YR 5/2). It has many mottles that have colors of higher chroma.

Hepler soils are near Dubbs, Verdigris, Cleora, and Radley soils. They have a darker colored or thicker A horizon than that of Dubbs soils and a thinner, dark-colored A horizon than that of Lanton or Verdigris soils. They are finer textured throughout the profile than Cleora soils. Hepler soils are grayer below the A horizon than Radley, Verdigris, Dubbs, and Cleora soils.

Hm—Hepler silt loam. This soil is level or nearly level. It is on low terraces along the larger streams (fig. 11) or old meanders between uplands and natural levees. The slope is 0 to 2 percent. This soil is in long and generally wide areas of 20 to 100 acres or more. It has the profile described as representative of the series.

Included with this soil in mapping are small areas of Hepler silt loam, overwash, and of Verdigris and Radley soils. Hepler silt loam, overwash, is close to natural levees, and Verdigris and Radley soils are in long narrow strips on natural levees.

The available water capacity is very high. Surface runoff is slow. Organic-matter content is moderate. This soil is wet because of seasonal ponding and overflow.

A good response to management can be expected. Crops should be chosen carefully, and special conservation practices are needed. The soil is suited to corn, soybeans, sorghum, small grain, grass, and legumes. Capability unit IIw-1.

Hp—Hepler silt loam, overwash. This soil is level or nearly level. It is on low stream terraces generally between areas of Hepler silt loam and the natural levees. The slope is 0 to 2 percent. This soil is in long and narrow areas of about 10 to 60 acres or more. It has a profile similar to the one described as representative of the series, but it has a layer of light-colored overwash as much as 20 inches thick on the surface.

Included with this soil in mapping are small areas of

Hepler silt loam and Verdigris and Radley soils. Hepler silt loam is between this soil and the uplands, and Verdigris and Radley soils are on natural levees. Also included are a few areas where the overwash is more than 20 inches thick.

The available water capacity is very high. Surface runoff is slow. Organic-matter content is moderate. This soil is wet because of seasonal flooding and slow runoff. Overwash material slightly improves drainage and natural fertility and speeds runoff.

Farm operations can begin earlier in the spring and sooner after rains on this soil than on Hepler silt loam. A good response to management can be expected. The choice of crops is limited or moderate conservation practices are needed. This soil is suited to corn, soybeans, sorghum, small grain, grass, and legumes. Capability unit IIw-1.

Hr—Hepler-Radley complex. This complex is in the narrow bottoms of upland drainageways where the slope is 0 to 2 percent. It is about 50 percent Hepler soils, 35 percent Radley soils, and 15 percent other soils. Hepler soil is between the uplands and natural levees, and Radley soil is on natural levees. Upstream areas of this complex are generally long, narrow, and dissected by intermittent streams. Downstream areas are wider and better shaped for farming. This complex is in areas of about 10 to 80 acres or more.

Included with this complex in mapping are small areas of Verdigris and Cleora soils and Hepler silt loam, overwash. Verdigris and Cleora soils are on natural levees, and Hepler silt loam, overwash, is at the edge of natural levees.

The available water capacity is very high. Seasonal wetness caused by ponding and overflow is the main limitation to use of these soils.

A good response to management can be expected. The choice of crops is limited, and special conservation practices are needed. In narrow areas dissected by intermittent streams, this complex is best suited to grass, legumes, and trees. In broader, less dissected areas it is best suited to sorghum, small grain, corn, soybeans, grass, and legumes. Capability unit IIw-1.

Lanton Series

The Lanton series consists of deep, poorly drained soils that have a thick, dark-colored, moderately fine textured surface layer and a moderately fine textured subsoil. These soils are on bottom lands and have a slope of less than 2 percent. They formed in silty clay loam sediments washed from nearby upland areas. The native vegetation was water-tolerant hardwood trees and an understory of water-tolerant grasses.

In a representative profile the surface layer is about 31 inches of black and very dark gray, firm silty clay loam. The underlying material, to a depth of about 60 inches, is dark-gray firm silty clay loam that has olive-brown and dark yellowish-brown mottles.

Natural fertility is high. The available water capacity is high. Surface runoff is slow, and permeability is slow. Because these soils are seasonally wet and subject to occasional overflow, their use is limited.

Lanton soils are used mainly for corn, soybeans, sorghum, small grain, grass, and legumes. A few areas



Figure 11.—Soybean stubble and pin oak trees growing on Hepler silt loam.

where access is limited are in brush and woodland, but the remaining acreage is in permanent pasture.

Representative profile of Lanton silty clay loam, in a cultivated field, 650 feet east and 60 feet north of the southwest corner, sec. 5, T. 37 N., A. 32 W.

- Ap—0 to 5 inches, black (10YR 2/1) silty clay loam; moderate, fine, granular structure; firm; many roots; slightly acid; abrupt, smooth boundary.
- A12—5 to 11 inches, very dark gray (10YR 3/1) silty clay loam; weak, medium, granular structure; firm; common roots; slightly acid; clear, smooth boundary.
- A13—11 to 21 inches, black (10YR 2/1) silty clay loam; moderate, medium and fine, subangular blocky structure; firm; common roots; few concretions of iron and manganese; slightly acid; gradual, smooth boundary.
- A14—21 to 31 inches, very dark gray (10YR 3/1) silty clay loam; few, fine, distinct, dark yellowish-brown (10YR 4/4) mottles; moderate, fine, angular blocky structure; firm; few roots; shiny faces on peds; common concretions of iron and manganese; slightly acid; gradual, smooth boundary.
- C1g—31 to 50 inches, dark-gray (5Y 4/1) silty clay loam; common, fine, distinct, olive-brown (2.5Y 4/4) mottles; weak, medium, subangular blocky structure;

firm; few roots; shiny faces on peds; common concretions of iron and manganese; neutral; gradual, smooth boundary.

- C2g—50 to 60 inches, dark-gray (10YR 4/1) silty clay loam; common, medium, distinct, dark yellowish-brown (10YR 4/4) and few, medium, faint, gray (5Y 5/1) mottles; massive; firm; few concretions of iron and manganese; neutral.

The A horizon is black (10YR 2/1), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2). It is from 24 to 40 inches thick. This horizon is slightly acid or neutral.

The matrix of the Cg horizon ranges from dark grayish brown (10YR 4/2) to gray (5Y 5/1) and the mottles are in shades of gray and brown. This horizon is silty clay loam but is commonly finer textured below a depth of 40 inches. It is slightly acid to neutral.

Lanton soils are near Verdigris, Osage, Radley, and Hepler soils. The Lanton soils have a C horizon that is grayer and contains more clay than Verdigris and Radley soils. Lanton soils have less clay throughout than Osage soils. They have a thicker, darker colored A horizon than Hepler soils.

La—Lanton silty clay loam. This soil is level or nearly level and is on stream bottoms. The slope is 0 to 2 percent. This soil is commonly between Verdigris or Radley



Figure 12.—Pecan trees on Lanton silty clay loam.

soils that are on natural levees and Osage soils that are adjacent to the uplands. It also occurs on the smaller bottoms and in upland drainageways. The soil areas generally are long and narrow, but some areas are long and broad. They are 10 to 80 acres or more.

Included with this soil in mapping are small areas of Verdigris, Radley, and Osage soils. Verdigris and Radley soils are on natural levees, and Osage soils are between Lanton soils and the uplands. Also included are areas of a soil that is similar to Lanton soils but has a dark-colored surface layer that is less than 24 inches thick.

The available water capacity is high. Surface runoff is slow. Organic-matter content is high.

A good response to management can be expected. Seasonal wetness caused by ponding and flooding limits the use of this soil. The choice of crops is limited, or moderate conservation practices are needed. This soil is suited to corn, soybeans, sorghum, small grain, grass, and legumes. It is also well suited to pecan trees (fig. 12). Capability unit IIw-1.

Liberal Series

The Liberal series consists of deep, moderately well drained soils that have a medium-textured surface layer and mainly a fine-textured subsoil. These soils are on divides and mounds and have a slope of 2 to 9 percent. They formed in material weathered from shale interbedded with thin layers of sandstone. Shale bedrock is at a depth of 40 to 60 inches. The native vegetation was tall prairie grasses.

In a representative profile the surface layer is very dark grayish-brown silt loam about 9 inches thick. The subsoil is 21 inches thick. The upper 11 inches is mottled dark-brown silty clay loam. The lower 10 inches is gray and yellowish-brown, firm silty clay that is mottled. The underlying material, to a depth of about 43 inches, is mottled gray, dark-gray, and very dark gray silty clay. Gray shale bedrock is at a depth of about 43 inches.

Natural fertility is medium. The available water capacity is moderate to low. Surface runoff is medium to rapid, and permeability is slow. Because of their moderate depth to shale, these soils tend to be seasonally wet or dry. Susceptibility to erosion is the major limitation to use.

More than half the acreage is in native tall prairie grasses or tame grasses that are used for hay or pasture. Most of the remaining acreage is cultivated. The principal crops are sorghum, wheat, grass, legumes, corn, and soybeans.

Representative profile of Liberal silt loam, 2 to 5 percent slopes, in a cultivated field, 2,310 feet east and 200 feet north of the southwest corner, sec. 31, T. 34 N., R. 33 W.

- Ap—0 to 9 inches, very dark grayish-brown (10YR 3/2) heavy silt loam; moderate, fine, granular structure; friable; many roots; strongly acid; abrupt, smooth boundary.
- B1t—9 to 13 inches, dark-brown (10YR 4/3) silty clay loam; many, fine, distinct, red (2.5YR 4/8) and strong-brown (7.5YR 5/8) mottles; moderate, fine, subangular blocky structure; friable; few roots; thin clay films on faces of pedis; few pebbles; strongly acid; clear, smooth boundary.
- B21t—13 to 20 inches, dark-brown (10YR 4/3) silty clay loam; many, fine, distinct, red (2.5YR 4/8) and strong-brown (7.5YR 5/8) mottles; weak, fine, subangular blocky structure; firm; few roots; thin, continuous clay films; few pebbles; strongly acid; gradual, smooth boundary.
- B22t—20 to 25 inches, mottled gray (10YR 5/1) and yellowish-brown (10YR 5/6) silty clay; weak, medium, angular blocky structure; firm; few roots; clay films on faces of pedis; few black concretions; old root channels filled with very dark grayish-brown material; medium acid; clear, smooth boundary.
- B3t—25 to 30 inches, gray (N 5/0) silty clay; few fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, coarse, subangular blocky structure; firm; few roots along cleavage planes; dark-gray (10YR 4/1), thick, patchy clay films on faces of some pedis; slightly acid; clear, smooth boundary.
- C1—30 to 43 inches, gray, dark-gray, and very dark gray (N 5/0, N 4/0, and N 3/0) silty clay; thin platy structure; firm; weathered shale; few roots along cleavage planes; common pressure faces; moderately alkaline; abrupt, smooth boundary.
- C2—43 to 50 inches, gray clay shale interbedded with thin layers of yellowish-brown sandstone; stratified; neutral.

The solum is 20 to 40 inches thick, and the depth to bedrock ranges from 40 to 60 inches.

The A horizon is silt loam and silty clay loam 6 to 10 inches thick. It is from medium acid to very strongly acid.

The B1t and B2t horizons are brown (10YR 4/3) to light olive brown (2.5Y 5/4), but the B2t horizon ranges to lighter colors and at a depth of more than 19 inches has grayish mottles. The B2t horizon is silty clay or clay. The B3t and C horizons are silty clay loam to clay in which medium or coarse, prominent, red mottles are common.

Liberal soils are near Barco, Coweta, Barden, Zaar, and Parsons soils. They are finer textured than Barco and Coweta soils and deeper than Coweta soils. They are not so deep as Barden, Zaar, and Parsons soils.

LeB—Liberal silt loam, 2 to 5 percent slopes. This soil is generally sloping. It is on convex knobs, ridgetops, and side slopes. The soil areas are irregularly shaped and 5 to 50 acres or more. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Barden, Parsons, Barco, and Coweta soils. Barden soils are on foot slopes or saddles that cross ridgetops. Parsons soils are on crests of the wider ridgetops. Barco soils are on knobs and above or below breaks. Coweta soils are on knobs and breaks. Also included are eroded Liberal soils and areas that have a slope of more than 5 percent.

The available water capacity is moderate. Surface runoff is medium. Organic-matter content is moderate.

A good response to management can be expected. Because this soil is susceptible to erosion and is seasonally wet or dry, the choice of crops is limited or special conservation practices are needed. This soil is best suited to small grain, grass, and legumes. Sorghum and other row crops can be safely grown in a crop rotation that includes hay and pasture crops. Capability unit IIe-2.

LmC2—Liberal silty clay loam, 2 to 9 percent slopes, eroded. This soil is gently sloping and moderately sloping. It is near the slope break on convex knobs, ridgetops, side slopes, and foot slopes. In some places areas are small and widely separated. In other places they are large and dissected by gullies and drainageways. They range from 5 to 100 acres or more.

Erosion has scarred the landscape and caused losses of soil material. Consequently, the surface layer is about 6 inches thick and very dark grayish-brown silty clay loam. Part of the original surface layer has been mixed with part of the subsoil. In the numerous erosion scars and gullies, the browner, finer-textured subsoil is exposed in many places.

Included with this soil in mapping are small areas of Barden, Barco, and Coweta soils. Barden soils are on foot slopes or saddles that cross ridgetops. Barco soils are above or below breaks, and Coweta soils are on breaks. Also included are some wet seepy spots and some areas of uneroded Liberal soils.

The available water capacity is low. Surface runoff is rapid. Organic-matter content is low.

A fair response to management can be expected. Because this soil is highly susceptible to further erosion and drought, the choice of crops is severely limited and careful management is needed. This soil is best suited to grass, legumes, and small grain. An occasional row crop can safely be grown in a cropping system that includes several years of hay or pasture. Capability unit IVe-2.

LoD—Liberal-Coweta-Barco complex, 2 to 14 percent slopes. This soil complex is gently sloping to strongly sloping. It is on mounds, narrow ridgetops, and side slopes. It consists of about 35 percent Liberal soils, 25 percent Coweta soils, and 20 percent Barco soils. These soils formed in alternating beds of shale and sandstone. Generally, Liberal soils are on foot slopes, Barco soils on tops of mounds and ridges, and Coweta soils on side slopes between Liberal and Barco soils.

Included with these soils in mapping are small areas of Barden and Zaar soils. Barden and Zaar soils are in narrow bands on foot slopes. Barden soils are also in saddles that cross ridgetops. Also included are a few

rock outcrops and stony areas. Seepy spots and eroded areas are common in the areas of Liberal soils.

The available water capacity is commonly low. Surface runoff is medium to rapid. These soils are droughty, and some areas are stony. Susceptibility to erosion is the major limitation to use.

This complex is generally not suited to cultivation. All but the stony areas can be mowed. Most of these soils are in native prairie grass or tame grass. A much smaller acreage is cultivated. These soils are best suited to grass and legumes. Capability unit VIe-2.

Lula Series

The Lula series consists of deep, well-drained soils that have a medium-textured surface layer and a moderately fine textured subsoil. These soils are on divides and mounds and have a slope of 2 to 5 percent. They formed in material weathered from limestone. In places they are thinly mantled with loess. Limestone bedrock is at a depth of 40 to 60 inches. The native vegetation was tall prairie grasses.

In a representative profile the surface layer is dark-brown silt loam about 12 inches thick. The subsoil is about 31 inches thick. The upper 8 inches is dark reddish-brown, friable silty clay loam; the next 23 inches is yellowish-red, firm silty clay loam. Limestone bedrock is at a depth of about 43 inches.

Natural fertility is high. The available water capacity is moderate. Surface runoff is medium, and permeability is moderate. Susceptibility to erosion is the major limitation to use.

Lula soils are mainly cultivated. The principal crops are corn, wheat, sorghum, and soybeans. A small acreage in grass and legumes is used for pasture and hay. This soil has a good potential for alfalfa.

Representative profile of Lula silt loam, 2 to 5 percent slopes, in an alfalfa field, 20 feet north and 400 feet west of the southeast corner of the SW $\frac{1}{4}$ sec. 34, T. 38 N., R. 33 W.

Ap—0 to 9 inches, dark-brown (7.5YR 3/2) silt loam; moderate, fine and medium, granular structure; friable; common roots; many worm casts; mildly alkaline; abrupt, smooth boundary.

A12—9 to 12 inches, dark-brown (10YR 3/3) heavy silt loam; moderate, fine and medium, granular structure; friable; common roots; medium acid; clear, smooth boundary.

B1—12 to 20 inches, dark reddish-brown (5YR 3/3) light silty clay loam; moderate, medium, subangular blocky structure; friable; few roots; medium acid; clear, smooth boundary.

B21t—20 to 28 inches, yellowish-red (5YR 4/6) silty clay loam; moderate, medium, subangular blocky structure; firm; few roots; thin clay films on faces of peds; slightly acid; gradual, smooth boundary.

B22t—28 to 42 inches, yellowish-red (5YR 4/6) silty clay loam; moderate, fine and medium, angular blocky structure; firm; clay films on faces of peds; many black concretions and stains; few small chert fragments; slightly acid; clear, smooth boundary.

B3t—42 to 43 inches, yellowish-brown (10YR 5/6) and dark reddish-brown (5YR 3/4) silty clay loam; moderate, fine, subangular blocky structure; firm; clay flows in old root channels; many black concretions; many small chert fragments; mildly alkaline; abrupt, smooth boundary.

R—43 inches, limestone bedrock.

The solum is more than 40 inches thick, and depth to bedrock is less than 60 inches. The A horizon ranges from dark reddish brown (5YR 3/3) to very dark brown (10YR 2/2).



Figure 13.—Alfalfa and corn on Lula silt loam, 2 to 5 percent slopes.

It is 10 to 18 inches thick, and in areas where lime has not been applied, it is slightly acid to medium acid. The B horizon is mainly silty clay loam, but in many places it is silty clay in the lower part. It ranges from slightly acid to strongly acid in the upper part and from medium acid to mildly alkaline in the lower part. The B1 horizon is dark brown (7.5YR 3/2) to dark reddish brown (5YR 3/3). The B2t horizon is dark reddish brown (2.5YR 3/4) to yellowish red (5YR 4/6). The B3 horizon is dark reddish brown (2.5YR 3/4) to yellowish brown (10YR 5/6).

Lula soils are near Zaar, Barden, Barco, and Liberal soils. Lula soils are redder than any of those soils. They are coarser textured throughout the profile than Zaar and Barden soils and deeper than Barco and Liberal soils.

LuB—Lula silt loam, 2 to 5 percent slopes. This soil is gently sloping. It is on convex ridgetops. The soil areas are either rounded or long and wide and 5 to 40 acres or more.

Included with this soil in mapping are small areas of Zaar soils near the downslope boundary. A few areas of soils similar to Lula are included, but they are less than 40 inches deep to limestone bedrock. Also included are a few rock outcrops and small eroded spots.

The available water capacity is moderate. Surface runoff is medium. Organic-matter content is moderate. Good response to management can be expected. Because this soil is susceptible to erosion, the choice of crops is limited or moderate conservation practices are needed. This soil is well suited to corn, soybeans, small grain,

grass, and legumes. It is especially well suited to alfalfa (fig. 13). Capability unit IIe-1.

Mayes Series

The Mayes series consists of deep, nearly level, somewhat poorly drained soils that have a moderately fine textured surface layer and a fine-textured subsoil. They are on broad upland divides. These soils formed in material weathered from clay and clayey shale. Shale bedrock is at a depth of more than 60 inches. The native vegetation was tall prairie grasses.

In a representative profile the surface layer is black and very dark gray silty clay loam about 19 inches thick. The subsoil is about 43 inches thick. The upper 23 inches is very dark gray, very firm, silty clay that has dark-brown and yellowish-brown mottles; the lower 20 inches is dark-gray, very firm silty clay that has yellowish-brown mottles. The underlying material is very dark gray silty clay that has grayish-brown and yellowish-brown mottles.

Natural fertility is medium. The available water capacity is moderate. Surface runoff is very slow, and permeability is very slow. Wetness is caused by slow internal drainage and runoff from adjoining soils. The use of these soils is limited.

Mayes soils are used mainly for row crops and small

grain. The principal crops are corn, soybeans, sorghum, and wheat. Most of the remaining acreage is in grass and legumes for pasture or hay.

Representative profile of Mayes silty clay loam, in a meadow, 330 feet south and 250 feet east of the northwest corner of sec. 13, T. 34 N., R. 33 W.

- A1—0 to 10 inches, black (10YR 2/1) silty clay loam; moderate, fine, granular structure; friable; many roots; slightly acid; clear, smooth boundary.
- A3—10 to 19 inches, very dark gray (10YR 3/1) silty clay loam; weak, medium, granular structure; firm; common roots; medium acid; clear, smooth boundary.
- B21tg—19 to 32 inches, very dark gray (10YR 3/1) silty clay; few, fine, distinct, dark-brown (7.5YR 4/4) mottles; moderate, medium, subangular blocky structure; very firm; common roots; thin clay films on faces of peds; few iron stains; neutral; clear, smooth boundary.
- B22tg—32 to 42 inches, very dark gray (10YR 3/1) silty clay; common, medium, distinct, dark yellowish-brown (10YR 4/4) and yellowish-brown (10YR 5/8) mottles; moderate, medium, subangular blocky structure; very firm; few roots; thin clay films on faces of peds; few concretions of iron and manganese; neutral; clear, smooth boundary.
- B3g—42 to 62 inches, dark-gray (10YR 4/1) silty clay; common, medium, faint, dark yellowish-brown (10YR 4/4 and 3/4) mottles and common, medium, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; very firm; many concretions of iron and manganese; neutral; gradual, smooth boundary.
- C—62 to 74 inches, dark-gray (10YR 4/1) silty clay; common, medium, distinct, grayish-brown (10YR 5/2) and dark yellowish-brown (10YR 4/4) mottles; massive; very firm; neutral.

The solum is 40 to 60 inches or more thick. The A horizon is black (10YR 2/1) to very dark grayish brown (10YR 3/2) and neutral to medium acid. In some places an A3 horizon is lacking.

The B horizon is silty clay loam, silty clay, or clay. The B2t horizon is mottled in shades of gray and brown and contains few to many iron and manganese concretions. The B21tg horizon is very dark gray (10YR 3/1), very dark grayish brown (10YR 3/2), or black (10YR 2/1) and medium acid to neutral. The B22tg horizon ranges from very dark gray (10YR 3/1) to dark grayish brown (10YR 2/4) and is neutral or slightly acid. The B3g horizon is dark gray (10YR 4/1) to dark grayish brown (2.5Y 4/2 and 10YR 4/2) and is neutral or mildly alkaline. It contains few to many iron and manganese concretions and gypsum crystals.

Mayes soils are near Parsons and Barden soils. They have a thicker, darker colored, finer textured A horizon than the Parsons soils. They lack an abrupt textural change from the A horizon to the B horizon, which is present in the Parsons soils. Mayes soils have a greater B horizon than Barden soils.

Ma—Mayes silty clay loam. This soil is nearly level. It is generally in concave basins and at the head of and along shallow concave drainageways. It is at a lower elevation than the surrounding soils and receives seepage and runoff from higher areas. The slope is 0 to 2 percent. The soil areas are rounded and 5 to 100 acres or more.

Included with this soil in mapping are small areas of Parsons and Barden soils. Both of these soils are at a slightly higher elevation than Mayes soils. Also included are a few seepy spots.

The available water capacity is moderate. Surface runoff is very slow. Organic-matter content is moderate.

A good response to management can be expected. Because this soil is seasonally wet, its use is limited. The choice of crops is limited or moderate conservation practices are needed. This soil is suited to corn, soy-

beans, sorghum, small grain, grass, and legumes. Under highly specialized management, row crops can be grown year after year. Capability unit IIw-1.

Mine Pits and Dumps

Mp—Mine pits and dumps. This land type consists of rough, irregularly shaped dumps of shale, sandstone, overturned earth, and pits that result from strip mining of coal. The pits are long and narrow, and most of the larger ones are filled with water. The areas are 5 to 200 acres or more.

The material is mixed, but it is mostly clayey and has large stone fragments throughout. The proportion of rock, shale, or soil on a particular site depends on the kind of underlying material and on the depth to which mining has taken place. The soil material is mainly strongly acid but ranges to moderately alkaline in some places; also, surface material and soil reaction vary greatly within short distances. Most of the larger strip mined areas have alternate rows of peaked ridges and steep V-shaped valleys, and there are deep pits along the side where mining stopped.

Included are a few small areas that have been leveled. Also included are small areas of Parsons, Barden, Liberal, Barco, and Coweta soils.

The available water capacity is low. Surface runoff is rapid on the ridges, and between ridges there is variable ponding. Air and water move through the soil material at a slow or very slow rate. The hazard of erosion is severe, and the present scanty cover of brush, weeds, trees, and grass offers little protection from erosion.

Because the slope is 20 to 65 percent, because large sandstones litter the surface in places, and because there are numerous pits and gullies, tilling this land is not practical. A poor response to management can be expected. Most areas of this land type are idle, except for a small amount of grazing. This land type is suited to wildlife food and cover and recreation (fig. 14). Capability unit VIIe-7.

Osage Series

The Osage series consists of deep, poorly drained soils that have a fine-textured, dark-colored surface layer and subsoil. They are on wide bottom lands and have a slope of less than 2 percent. These soils formed in clayey sediments washed from nearby upland soils. The native vegetation was water-tolerant hardwood trees and a considerable understory of water-tolerant grasses.

In a representative profile the surface layer is very dark brown and black silty clay about 15 inches thick. The subsoil is extremely firm silty clay 35 inches thick. The upper 27 inches is very dark gray, and the lower 8 inches is dark gray. The underlying material, to a depth of about 67 inches, is dark-gray extremely firm silty clay.

Natural fertility is high. The available water capacity is moderate. Organic-matter content is high. Surface runoff is very slow, and permeability is very slow. Wetness caused by ponding and occasional flooding limits the use of these soils.

More than half the acreage is used for row crops. The principal crops are corn, soybeans, and sorghum.

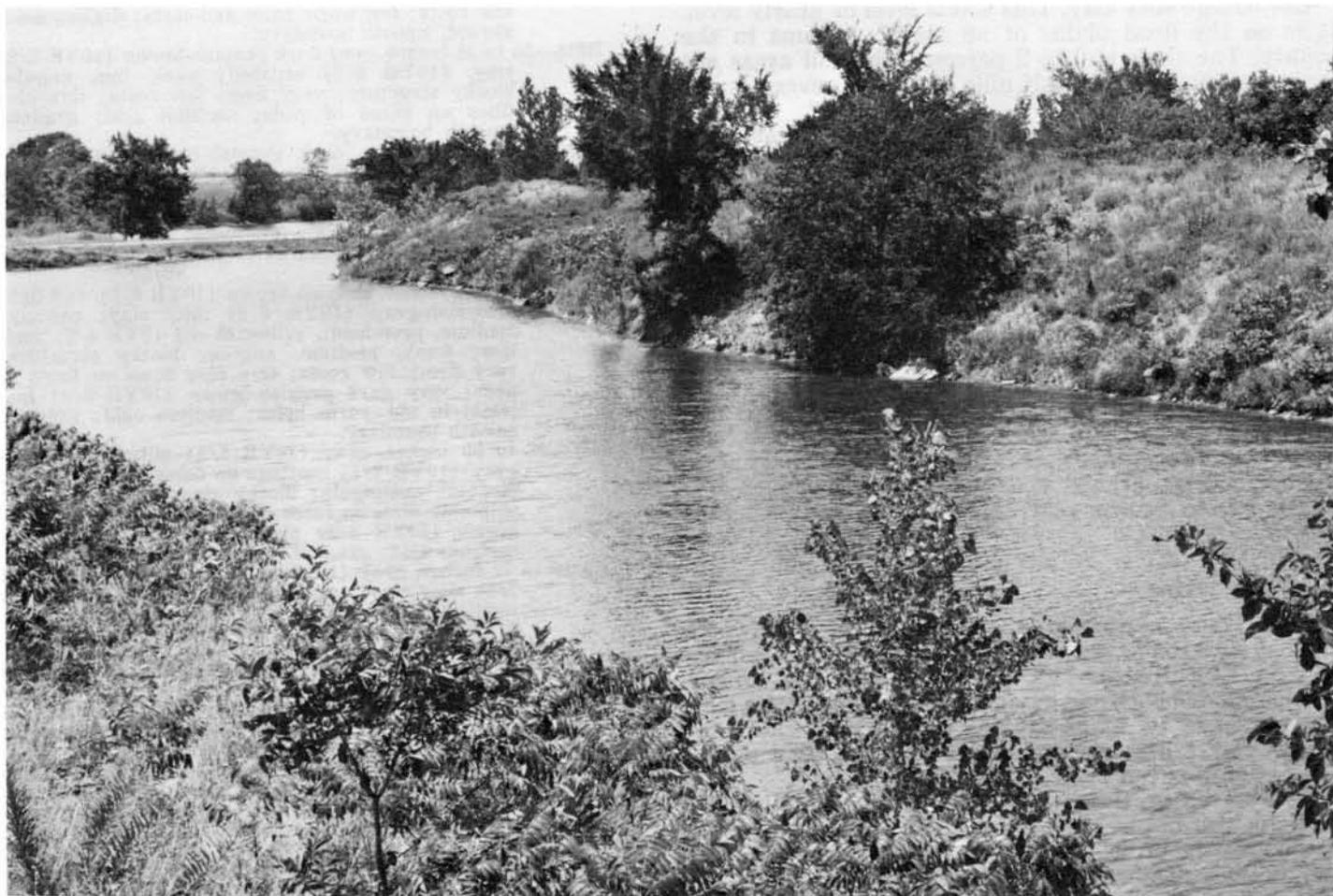


Figure 14.—Mine pits and dumps have a potential for wildlife habitat and recreational development.

Most of the remaining acreage is in water-tolerant grasses, but in places there are scattered hardwood trees. This acreage is used for pasture and hay. A small acreage is in native pecan trees or woodland.

Representative profile of Osage silty clay, in a cultivated field, 100 feet north and 100 feet east of the center of sec. 35, T. 38 N., R. 31 W.

Ap1—0 to 4 inches, very dark brown (10YR 2/2) silty clay; strong, very fine, granular structure; firm sticky and plastic; many roots; strongly acid; abrupt, smooth boundary.

Ap2—4 to 9 inches, black (10YR 2/1) silty clay; strong, fine, angular blocky structure; very firm, very sticky and plastic; many fine roots; strongly acid; gradual, smooth boundary.

A13—9 to 15 inches, black (10YR 2/1) silty clay; few, fine, faint, very dark gray (N 3/0) mottles; moderate, fine, angular blocky structure; extremely firm, very sticky and plastic; common fine roots; medium acid; gradual, smooth boundary.

B21g—15 to 27 inches, very dark gray (5Y 3/1) silty clay; many, fine, faint mottles of very dark grayish brown (2.5Y 3/2) and very dark gray (N 3/0); weak, fine and medium, angular blocky structure; extremely firm, very sticky and plastic; few fine roots; very few fine concretions of iron and manganese; few slickensides; slightly acid; gradual, smooth boundary.

B22g—27 to 42 inches, very dark gray (5Y 3/1) silty clay;

common, medium, distinct, olive-brown (2.5Y 4/4) mottles and few, fine, faint, dark-gray (5Y 4/1) mottles; dark grayish brown (2.5Y 4/2) rubbed; moderate, fine, angular blocky structure; extremely firm, very sticky and plastic; common, fine, soft concretions of iron and manganese and dark-brown iron-manganese stains; common slickensides; slightly acid; diffuse, smooth boundary.

B3g—42 to 50 inches, dark-gray (N 4/0) silty clay; common, medium, distinct, olive-brown (2.5Y 4/4) mottles; weak, medium, angular blocky structure; extremely firm, very sticky and plastic; common, fine, soft concretions of iron and manganese; common slickensides; slightly acid; gradual, smooth boundary.

Cg—50 to 67 inches, dark-gray (5Y 4/1) silty clay; common, medium, distinct, olive-brown (2.5Y 4/4) mottles; massive; extremely firm, very sticky and plastic; few concretions; common slickensides; moderately alkaline.

The A horizon is black (10YR 2/1) to very dark grayish brown (2.5Y 3/2) and very strongly acid to neutral.

The B horizon is heavy silty clay loam, silty clay, or clay. The upper part of this horizon is very dark grayish brown (10YR 3/2) to very dark gray (5Y 3/1) and medium acid to neutral. The lower part is very dark gray (N 3/0) to gray (5Y 5/1) and slightly acid to mildly alkaline.

Osage soils are near Verdigris, Radley, and Lanton soils. Osage soils have more clay throughout the profile than those soils.

Os—Osage silty clay. This soil is level or nearly level. It is on the flood plains of all major streams in the county. The slope is 0 to 2 percent. The soil areas are large, as much as one-half mile wide and several miles long.

Included with this soil in mapping are small areas of Verdigris, Radley, and Lanton soils. Verdigris and Radley soils are on natural levees near stream channels or old meanders. Lanton soils are between natural levees and Osage soils.

Because of the high clay content, very slow permeability, and wetness, this soil is difficult to till. The large soil areas are well suited to the use of large farm machinery. A good response to management can be expected. Seasonal wetness caused by ponding and flooding is a limitation to use. The choice of crops is limited, or special conservation practices are needed. This soil is well suited to corn, soybeans, sorghum, grass, and shallow-rooted legumes. It is also well suited to native pecans. Under highly specialized management, row crops can be grown year after year. Capability unit IIIw-14.

Parsons Series

The Parsons series consists of deep, somewhat poorly drained soils that have a medium-textured surface layer and fine-textured subsoil. These soils are on upland divides and benches and have a slope of 1 percent or less. They formed in material weathered from shale. In places they are thinly mantled with loess. The native vegetation was tall prairie grasses.

In a representative profile the surface layer is very dark grayish-brown silt loam about 8 inches thick. The subsurface layer is grayish-brown silt loam about 5 inches thick. The subsoil is about 46 inches thick and is very firm. The upper 15 inches is very dark grayish-brown clay; the next 10 inches is dark grayish-brown clay that is prominently mottled; the next 8 inches is mottled grayish-brown and brownish-gray silty clay, and the lower 13 inches is gray silty clay. The underlying material, to a depth of 71 inches, is gray silty clay.

Natural fertility is medium. The available water capacity is moderate. Surface runoff is slow, and permeability is very slow. A water table is perched over the clay subsoil in wet seasons. Susceptibility to erosion, seasonal droughtiness, and wetness limit the use of these soils.

Parsons soils are used mainly for row crops and small grain. They are economically worked with large farm machinery, and the crops are marketed as cash grain. A small acreage of tame grass and legumes, mostly tall fescue and lespedeza, is used for pasture and hay. Some tall fescue is combined for seed. A small acreage is in native tall prairie grasses that are mowed for hay.

Representative profile of Parsons silt loam, in a cultivated field, 1,370 feet east and 100 feet north of the southwest corner, sec. 14, T. 36 N., R. 32 W.

- Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) silt loam; moderate, fine, granular structure; friable; few roots; few worm holes and casts; mildly alkaline; abrupt, smooth boundary.
A2—8 to 13 inches, grayish-brown (10YR 5/2) silt loam; moderate, medium, granular structure; friable;

few roots; few worm holes and casts; slightly acid; abrupt, smooth boundary.

- B21t—13 to 28 inches, very dark grayish-brown (10YR 3/2) clay, (10YR 4/2) crushed; weak, fine, angular blocky structure; very firm; few roots; thin clay films on faces of peds; medium acid; gradual, smooth boundary.
B22t—28 to 38 inches, dark grayish-brown (10YR 4/2) clay; light brownish-gray (10YR 6/2) coatings on faces of peds; few, fine, prominent, dark-brown (7.5YR 4/4) mottles; weak, medium, angular blocky structure; very firm; few roots; thin clay films on faces of peds; medium acid; gradual, smooth boundary.
B23t—38 to 46 inches, grayish-brown (10YR 5/2) and light brownish-gray (10YR 6/2) silty clay; common, medium, prominent, yellowish-red (5YR 4/6) mottles; weak, medium, angular blocky structure; very firm; few roots; thin clay films on faces of peds; very dark grayish-brown (10YR 3/2) material in old worm holes; medium acid; gradual, smooth boundary.
B3t—46 to 59 inches, gray (10YR 5/1) silty clay; light-gray (10YR 7/1) coatings on faces of peds; weak, medium, subangular blocky structure; very firm; thin clay films on faces of peds; very dark grayish-brown (10YR 3/2) material in old worm holes; medium acid; gradual, smooth boundary.
C—59 to 71 inches, gray (10YR 5/1) and light-gray (10YR 7/1) silty clay; common, medium, prominent, dark reddish-brown (5YR 3/2) and reddish-brown (5YR 4/4) mottles; massive; very firm; medium acid.

Depth to bedrock is more than 60 inches. The A horizon is 6 to 16 inches thick.

The A1 and Ap horizons are very dark grayish-brown silt loam 6 to 10 inches thick. The A2 horizon is dark grayish brown (10YR 4/2) to light brownish gray (10YR 6/2). In some places this horizon has been removed by erosion or has been mixed with part of the subsoil by deep plowing.

The B2t horizon is 15 to 35 inches thick and mainly mottled with dark grayish brown (10YR 4/2), but the mottle colors range to very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2). The kneaded color is dark grayish brown (10YR 4/2) to dark brown (7.5YR 4/4). The B22t horizon is dark gray (10YR 4/1) to grayish brown (10YR 5/2) and has few to many, gray, brown, and red mottles. It ranges from medium acid to strongly acid. The B3t horizon is 10 to 30 inches thick and slightly acid to very strongly acid. The C horizon is silty clay loam, silty clay, or clay and is strongly acid to slightly acid.

Parsons soils are near Barden, Barco, Liberal, and Zaar soils. Parsons soils have an abrupt textural boundary between the surface layer and the subsoil, but none of those soils do. They are deeper than the Barco and Liberal soils. They have a thinner, dark-colored A horizon that contains less clay than that of Zaar soils.

Pa—Parsons silt loam. This soil is level or nearly level. It is on the tops of wide divides. The slope is 0 to 1 percent. The soil areas are generally large but range from 5 to several hundred acres. They are well shaped for farming.

Included with this soil in mapping are small areas of Barden, Barco, and Liberal soils. Barden soils are on narrow ridgetops and side slopes. Liberal and Barco soils are on knobs and slope breaks. Also included are areas of Parsons soils that have a slope of more than 1 percent, and small eroded spots.

The available water capacity is moderate. Surface runoff is slow. Organic-matter content is moderate.

A good response to management can be expected. Wetness in spring sometimes delays farming operations, but seasonal droughtiness is the major limitation to use of this soil. The choice of crops is limited, or moderate conservation practices are needed. This soil is



Figure 15.—Grain sorghum growing on Parsons silt loam.

suited to corn, soybeans, grain sorghum (fig. 15), small grain, grass, and legumes. Under highly specialized management, row crops can be grown year after year. Capability unit IIs-2.

Radley Series

The Radley series consists of deep, nearly level, moderately well drained soils that have a moderately fine textured surface layer and a medium-textured subsoil. These soils are on stream bottoms. They formed in stratified silty alluvium washed from nearby upland areas. The native vegetation was lowland hardwood trees.

In a representative profile the surface layer is very dark grayish-brown silty clay loam about 13 inches thick. The subsoil is brown, friable silt loam about 13 inches thick. The underlying material is brown and dark grayish-brown silt loam.

Natural fertility is high. The available water capacity is very high. Surface runoff is slow, and permeability is moderate. The small, irregular shape of the soil areas and the lack of easy access severely limit the use of these soils in some places. They are also subject to occasional flooding.

More than half of the acreage has been cleared of

brush and trees and is used for corn, sorghum, soybeans, grass, and legumes. These soils have a high potential for walnut, other valuable trees, and alfalfa.

Representative profile of Radley silty clay loam, in a cultivated field, 1,320 feet north and 320 feet west of southeast corner of NE $\frac{1}{4}$ sec. 13, T. 35 N., R. 33 W.

- Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) silty clay loam; weak, fine, granular structure; friable; many roots; many worm holes and casts; mildly alkaline; abrupt, smooth boundary.
- A12—7 to 13 inches, very dark grayish-brown (10YR 3/2) silty clay loam; moderate, medium, granular structure; friable; many roots; many worm holes and casts; neutral; gradual, smooth boundary.
- B2—13 to 26 inches, brown (10YR 4/3) silt loam; weak, fine, subangular blocky structure; friable; few roots; many small pores; neutral; clear, smooth boundary.
- C1—26 to 35 inches, brown (10YR 4/3) silt loam; massive; friable; few roots; weak stratification; neutral; gradual, smooth boundary.
- C2—35 to 62 inches, mixed dark grayish-brown (10YR 4/2) and grayish-brown (10YR 5/2) silt loam; massive; friable; few roots; faint brown stains; weak stratification; slightly acid.

Radley soils are medium acid to neutral and more than 50 inches deep. The A horizon is very dark grayish brown, dark brown (10YR 3/3), or very dark brown (10YR 2/2) silt loam or silty clay loam 10 to 24 inches thick. The B horizon is brown (10YR 4/3) or dark grayish brown (10YR 4/2)

and commonly mottled in the lower part. It is silt loam or silty clay loam. The B horizon and the C horizon have thin strata that are darker or lighter in color and finer or coarser textured in many places. Depth to gravel is more than 50 inches.

Radley soils are near Osage, Hepler, Lanton, Verdigris, and Cleora soils. They have a thinner, dark-colored surface layer than that of Osage, Lanton, and Verdigris soils. They are in lower position and are less acid than Hepler soils. They are not so gray and so wet as Hepler and Lanton soils. They are finer textured than Cleora soils.

Ra—Radley silty clay loam. This soil is level or nearly level. It is on the natural levees of the larger streams, between the stream channel and areas of Lanton, Osage, or Hepler soils, or on flood plains of the smaller streams. The slope is 0 to 2 percent. The soil areas are long and narrow and 10 to 50 acres or more.

Included with this soil in mapping are small areas of Hepler, Verdigris, and Lanton soils. Hepler and Lanton soils are between natural levees and the uplands, and Verdigris soils are on natural levees. Also included are areas that have a surface layer of silt loam.

The available water capacity is very high. Surface runoff is slow. Organic-matter content is moderate. Occasional flooding is the only limitation to use of this soil.

Good response to management can be expected. It is well suited to corn, soybeans, sorghum, small grain, grass, and alfalfa and other legumes. Under specialized management, row crops can be grown year after year. Areas that are small or poorly shaped for cultivation are best suited to walnut or other valuable trees. Capability unit IIw-1.

RpE3—Radley, Parsons, and Barden soils, 0 to 25 percent slopes, severely eroded. These soils are in upland drainageways. They are long, narrow, and nearly level in bottom lands and gently sloping to steep and narrow on adjacent side slopes. The areas of bottom land are about the same extent as areas of upland. Of the total acreage about 25 percent is Radley silty clay loam, 20 percent is Parsons soils, 20 percent is Barden soils, and 35 percent is included soils. Only two of the named soils are in some mapped areas, but all three are in others.

The Radley soil, which is on bottom lands, has a profile similar to the one described as representative of the series. The Parsons and Barden soils on the side slopes are severely eroded and the subsoil has been exposed in most places. The subsoil ranges from silty clay loam to clay. Available water capacity of the Parsons and Barden soils is moderate to low, and surface runoff is rapid.

Included with this complex in mapping are small areas of Hepler and Barco soils and small areas of un-eroded Parsons and Barden soils. Hepler silt loam makes up about half of the acreage of bottom lands. About 10 percent of the upland acreage is Barco soils.

These soils are not suited to cultivation. Response to management ranges from poor to good but is poor in most places. The operation of machinery is difficult because the side slopes are steep (fig. 16) and because on the bottom lands streams meander and wet spots are common. Erosion on uplands and flooding on bottom lands are the major limitations to use of these soils. Many farm ponds are on soils of this mapping unit. Most areas are used for grass and pasture. Capability unit VIe-5.



Figure 16.—Willow trees and water-tolerant plants on bottom lands and in seepy areas and native grasses on the side slopes in an area of Radley, Parsons, and Barden soils, 0 to 25 percent slopes, severely eroded.

Verdigris Series

The Verdigris series consists of deep, nearly level, moderately well drained soils that have a thick, medium-textured surface layer and underlying material. These soils are on stream bottoms. They formed in silty alluvium washed from nearby upland areas. The native vegetation was mixed hardwood trees and a thick understory of grasses.

In a representative profile the surface layer is silt loam about 40 inches thick. The upper 12 inches is very dark gray, and the lower 28 inches is very dark grayish brown and friable. The underlying material, to a depth of 60 inches, is dark grayish-brown silt loam that is faintly stratified.

Natural fertility is high. The available water capacity is very high. Organic-matter content is high. Surface runoff is slow, and permeability is moderate. The use of these soils is limited in some places because the areas are irregularly shaped or small and lack easy access. This soil is subject to occasional flooding.

More than half of the acreage has been cleared and cultivated. The principal crops are corn, soybeans, sorghum, grass, and legumes. These soils have a high potential for alfalfa, walnut, or other valuable trees.

Representative profile of Verdigris silt loam, in a wooded pasture, 1,155 feet north and 130 feet east of the southwest corner, sec. 16, T. 36 N., R. 33 W.

- A11—0 to 12 inches, very dark gray (10YR 3/1) silt loam; moderate, medium, granular structure; friable; common roots; neutral; clear, smooth boundary.
- A12—12 to 40 inches, very dark grayish-brown (10YR 3/2) silt loam; moderate, medium, granular structure; friable; few roots; some sand in upper 12 inches; slightly acid; clear, smooth boundary.
- C—40 to 60 inches, dark grayish-brown (10YR 4/2) silt loam; massive; friable; thin layers of lighter colored soil material; medium acid.

Verdigris soils are neutral to strongly acid and more than 50 inches deep. The thickness of dark-colored soil material ranges from 24 to 50 inches or more in some places. Dark grayish-brown (10YR 4/2) mottles are common at depths of more than 20 inches.

The A horizon is very dark grayish-brown (10YR 3/2), dark-brown (10YR 3/3), or very dark brown (10YR 2/2) silt loam or silty clay loam. An AC horizon occurs in many places. The C horizon is dark grayish-brown (10YR 4/2) to light yellowish brown (10YR 6/4) silt loam or silty clay loam that, at a depth of more than 50 inches in many places, contains some gravel or sand.

Verdigris soils are near Osage, Lanton, Hepler, and Radley soils. They have less clay throughout the profile and are not so gray and so wet as Osage and Lanton soils. They are not so gray and so wet as Hepler soils. Verdigris soils have a thicker, dark-colored A horizon than Hepler and Radley soils.

Ve—Verdigris silt loam. This soil is level or nearly level. It is on stream bottoms, on flood plains along smaller streams, and on natural levees along larger streams. The slope is 0 to 2 percent. The soil areas are long and narrow and 10 to 100 acres or more in size.

Included with this soil in mapping are small areas of Hepler, Lanton, and Osage soils. Hepler soils are at a slightly higher elevation. Lanton and Osage soils are between areas of Verdigris soils and the uplands. Also included are small areas of Radley and Cleora soils that are on natural levees.

Occasional flooding is the only limitation to use of this soil. A good response to management can be expected. This soil is well suited to corn, soybeans, sorghum, small grain, grass, alfalfa, and other legumes. Under highly specialized management, row crops can be grown year after year. Areas that are small or poorly shaped for cultivation are best suited to walnut or other valuable trees. Capability unit IIw-1.

Zaar Series

The Zaar series consists of deep, somewhat poorly drained soils that have a fine-textured surface layer and a fine-textured subsoil. These soils are on upland divides and have a slope of 2 to 9 percent. They formed in material weathered from clayey shale that was thinly interbedded with limestone. Shale or limestone bedrock is at a depth of more than 40 inches. The native vegetation was tall prairie grasses.

In a representative profile the surface layer is black silty clay about 13 inches thick. The subsoil is very firm silty clay about 35 inches thick. The upper 7 inches is black, the next 11 inches is very dark gray, and the lower 17 inches is very dark grayish brown and has common olive-brown mottles. The underlying material, to a depth of 70 inches, is mottled dark grayish-brown and olive-brown silty clay.

Natural fertility is high. The available water capacity is moderate. Surface runoff is medium to rapid, and permeability is very slow. In some places these soils tend to be wet and seepy, but susceptibility to erosion is the major limitation to use.

More than half of the acreage is used for row crops and small grain. The principal crops are corn, wheat, soybeans, and sorghum. Most of the remaining acreage is in grass and legumes used for pasture and hay.

Representative profile of Zaar silty clay, 2 to 5 percent slopes, in a pasture, 1,120 feet east and 35 feet north of the southwest corner, sec. 29, T. 38 N., R. 32 W.

- A1—0 to 9 inches, black (10YR 2/1) silty clay; moderate, fine, subangular blocky structure; firm; many roots; medium acid; gradual, smooth boundary.
- A12—9 to 13 inches, black (10YR 2/1) silty clay; moderate, medium, subangular blocky structure; firm; many roots; medium acid; gradual, smooth boundary.
- B21—13 to 20 inches, black (10YR 2/1) silty clay; moderate, fine, angular blocky structure; very firm; common roots; shiny faces on peds; slightly acid; gradual, smooth boundary.
- B22—20 to 31 inches, very dark gray (10YR 3/1) silty clay; moderate, medium, angular blocky structure; very firm; common roots; shiny faces on peds; neutral; clear, smooth boundary.
- B3—31 to 48 inches, very dark grayish-brown (2.5Y 3/2) silty clay; common, medium, faint, olive-brown (2.5Y 4/4) mottles; moderate, medium, angular blocky structure; very firm; clay flows; few small black concretions; neutral; gradual, smooth boundary.
- C1—48 to 56 inches, dark grayish-brown (2.5Y 4/2) silty clay; common, fine, faint, olive-brown (2.5Y 4/4) mottles; massive; firm; few small black concretions; neutral; gradual, smooth boundary.
- C2—56 to 70 inches, olive-brown (2.5Y 4/4) silty clay; common, medium, faint, olive-yellow (2.5Y 6/6) mottles; massive; firm; few small black concretions; neutral.

The solum is 30 to 50 inches thick, and depth to bedrock is more than 40 inches. The A horizon is black (10YR 2/1) to very dark grayish brown (10YR 3/2) and slightly acid to medium acid. The B21 horizon is black (10YR 2/1) to dark grayish brown (2.5Y 4/2), and the B22 horizon ranges from very dark gray (10YR 3/1) to olive brown (2.5Y 4/4). The B2 horizon is silty clay or clay. It is medium acid to neutral in the upper part and slightly acid to mildly alkaline in the lower part. The B3 horizon is very dark gray (10YR 3/1) to olive-brown (2.5Y 4/4) silty clay or clay. It is slightly acid to mildly alkaline. The C horizon is slightly acid to moderately alkaline.

Zaar soils are near Barden, Liberal, Lula, and Parsons soils. They have a finer textured A horizon than Barden soils, and dark colors extend deeper into the C horizon. They are deeper than Liberal soils. They are not so red as Lula soils. They do not have an abrupt boundary between the A horizon and the B horizon, that is characteristic of Parsons soils.

ZaB—Zaar silty clay, 2 to 5 percent slopes. This soil is on convex ridgetops, side slopes, and foot slopes. In some places it receives seepage and runoff from higher areas. The soil areas are long and narrow and 5 to 60 acres or more. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Parsons, Barden, and Balltown soils. Parsons soils are either on the ridgetops or on the foot slopes, Barden soils are on the foot slopes. Balltown soils are in narrow bands on slope breaks. Also included are a few seepy spots, areas where depth to bedrock is less than 40 inches, eroded spots, and small areas that have a slope of more than 5 percent.

The available water capacity is moderate. Surface

runoff is medium. Organic-matter content is high. Susceptibility to erosion limits the use of this soil. Good response to management can be expected. The choice of crops is limited, or special conservation practices are needed. This soil is well suited to corn, soybeans, sorghum, small grain, grasses, alfalfa, and other legumes. Capability unit IIIe-6.

ZaC—Zaar silty clay, 5 to 9 percent slopes. This soil is on convex side slopes. It is generally above Zaar silty clay loam, 2 to 5 percent slopes. The soil areas are either long and narrow or are small and irregularly shaped. They are from about 5 to 30 acres or more.

This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner and bedrock is generally at a depth of less than 60 inches.

Included with this soil in mapping are small areas of Liberal soils and areas where depth to bedrock is less than 40 inches. Also included are small eroded spots, a few seepy spots, and a few rock outcrops.

The available water capacity is moderate. Surface runoff is rapid. Organic-matter content is high. Susceptibility to erosion limits the use of this soil. Good response to management can be expected. The choice of crops is limited or special conservation practices are needed. This soil is suited to corn, soybeans, and sorghum, but it is best suited to small grain, grass, and legumes. Capability unit IVe-6.

Use and Management of the Soils

This section contains information about the use and management of the soils of Vernon County for crops, woodland, wildlife, recreation, and engineering. It explains the system of capability classification used by the Soil Conservation Service and groups the soils according to their management needs. It also contains a table showing predicted yields of the principal crops grown in the county under two levels of management.

Crops and Pasture

Most of the acreage in Vernon County is in crops and pasture. Corn, soybeans, wheat, and grain sorghum are the principal cultivated crops. Tall fescue, lespedeza, and alfalfa produce most of the forage. These crops respond well when commercial fertilizer, manure, and lime are added to the soil. The kind and amount of fertilizer needed for each crop is determined by field trials and soil tests.

The major limitations to use and management of the soils for field and pasture crops are the hazards of erosion, wetness, and droughtiness. All of the soils need management that help conserve water, maintain or increase the organic matter and fertility, and preserve good tilth. A good supply of organic matter is important because it improves soil structure, increases permeability, and helps reduce erosion.

To conserve cultivated soils, management should include a suitable cropping system, minimum tillage, and good use of fertilizer. A large amount of crop residue should be produced, left on the soil surface during critical periods, and eventually returned to the soils. This crop residue, as well as animal manure, helps maintain

or improve soil tilth and structure. More than half of Vernon County is sloping upland that is susceptible to erosion. Terracing, stripcropping, contour planting, and using grassed waterways are some of the practices that help reduce runoff and erosion on these soils. In most places a combination of both vegetative and mechanical erosion practices are needed. Wet bottom land needs drainage and flood control. Both bottom land and upland should be irrigated where water is available. Equally important and urgently needed is pasture seeding and renovation. Good management combines all of these practices.

Good management will increase yields and insure an adequate economic return to the owner and operator. A conservation cropping system combines suitable crop rotations with management practices that prevent soil deterioration. Technical assistance in planning the application of suitable practices for a particular field or farm can be obtained from the Soil Conservation Service through the Vernon County Soil and Water Conservation District.

On the pages that follow, the system of capability grouping used by the Soil Conservation Service is discussed; the soils in each capability unit are described; and management suited to the soils in each unit is suggested. Estimated yields per acre of the principal crops are also given for most of the soils in the county.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are used, and the way they 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 requiring 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 of groups of soils for range, for forest trees, or for engineering.

In the capability system, the kinds of soils are grouped at three levels: the capability class, the subclass, and the unit. These are discussed in the following paragraphs.

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

Class I soils have few limitations that can restrict their use.

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

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

Class IV soils have very severe limitations that reduce

the choice of plants, require very careful management, or both.

Class V soils are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife habitat.

Class VI soils have severe limitations that make them generally unsuitable for cultivation and limit their use largely to pasture or range, woodland, or wildlife habitat.

Class VII soils have very severe limitations that make them unsuitable for cultivation and that restrict their use largely to pasture or range, woodland, or wildlife habitat.

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife habitat, or water supply, or to esthetic purposes.

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

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, although they have other limitations that restrict their use largely to pasture, range, woodland, wildlife habitat, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-4 or IIIe-6. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

In the following pages the capability units in Vernon County are described.

CAPABILITY UNIT IIe-1

The soils in this capability unit are deep and gently sloping. They are on uplands and high terraces and are well drained. The surface layer is loam or silt loam, and the subsoil is silty clay loam, clay loam, or silty clay.

Natural fertility is medium or high. The available water capacity is moderate or high, and permeability is moderate. The organic-matter content is moderate to low. Surface runoff is medium. The main limitations are runoff and the hazard of erosion. Maintaining

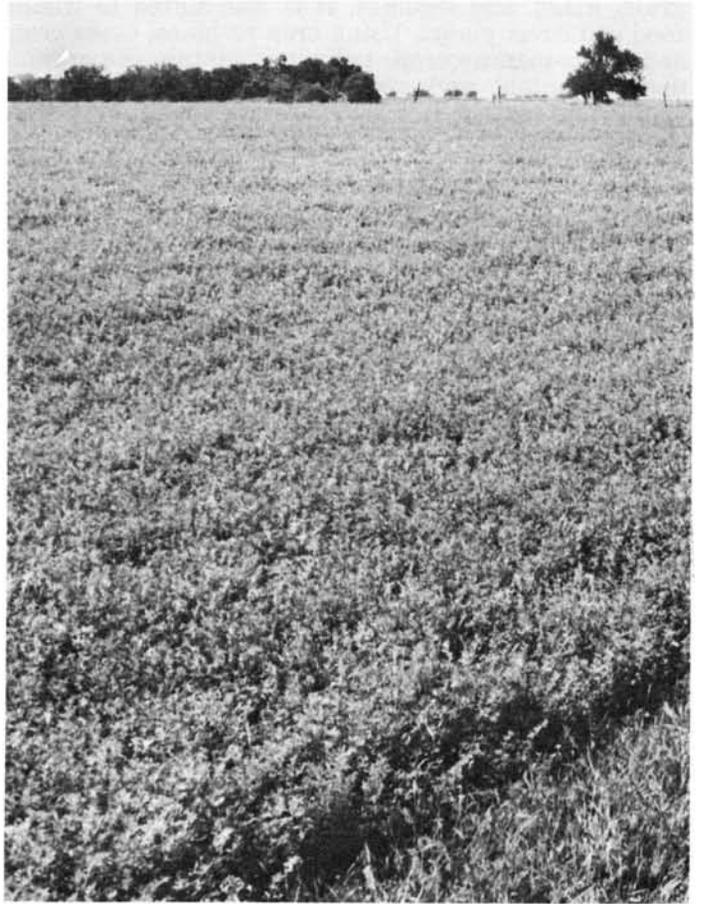


Figure 17.—Alfalfa growing in an area of Lula silt loam, 2 to 5 percent slopes.

organic-matter content and fertility, improving or maintaining tilth, and controlling erosion are good management practices.

These soils are suited to corn, soybeans, small grain, sorghum, grass, and alfalfa (fig. 17) and other legumes. They are also suited to trees and wildlife food and cover plants. Using crop residues, cover crops, and green-manure crops helps to maintain the organic-matter content and good tilth. Terracing, minimum tilling, and contour tilling help retard runoff and control erosion. If the soils are irrigated and lime and fertilizer are applied, yields are optimal.

CAPABILITY UNIT IIe-2

Liberal silt loam, 2 to 5 percent slopes, is the only soil in this capability unit. It is deep and moderately well drained. The surface layer is silt loam, and the subsoil is silty clay and silty clay loam.

Natural fertility is medium. The available water capacity is moderate, and permeability is slow. The organic-matter content is moderate. Surface runoff is medium. The main limitations are runoff and the hazard of erosion. Maintaining or improving organic-matter content, fertility, and tilth and controlling erosion are good management practices.

This soil is suited to corn, soybeans, sorghum, small

grain, grass, and legumes. It is also suited to wildlife food and cover plants. Using crop residues, cover crops, and green-manure crops helps to maintain the organic-matter content and good tilth. Terracing, minimum tilling, and contour tilling help retard runoff and control erosion.

CAPABILITY UNIT IIe-4

Barco loam, 2 to 5 percent slopes, is the only soil in this capability unit. It is moderately deep and well drained. The surface layer is loam, and the subsoil is clay loam.

Natural fertility is medium. The available water capacity is moderate, and permeability is moderate. The organic-matter content is moderate. Surface runoff is medium. The main limitations are runoff and the hazard of erosion. Maintaining organic-matter content and fertility, improving or maintaining tilth, and controlling erosion are good management practices.

This soil is suited to small grain, sorghum, corn, soybeans, grass, and legumes, including alfalfa. It is also suited to wildlife food and cover plants. Using crop residue, cover crops, and green-manure crops helps to maintain organic-matter content and good tilth. These practices and terracing, minimum tilling, and contour tilling help retard runoff and control erosion.

CAPABILITY UNIT IIe-5

Barden silt loam, 1 to 5 percent slopes, is the only soil in this capability unit. It is deep and moderately well drained. The surface layer is silt loam, and the subsoil is silty clay loam and clay loam.

Natural fertility is medium. The available water capacity is high, and permeability is slow. The organic-matter content is moderate. Surface runoff is medium. The main limitations are runoff and the hazard of erosion. Maintaining or improving organic-matter content, fertility, and tilth and controlling erosion are good management practices.

This soil is suited to corn, soybeans, sorghum, small grain, grass, and legumes, and is suited to alfalfa in the better-drained areas. Using crop residues, cover crops, and green-manure crops helps to maintain organic-matter content and good tilth. These practices and terracing, minimum tilling, and contour tilling help retard runoff and control erosion. If the soil is irrigated and lime and fertilizer are applied, yields are optimal.

CAPABILITY UNIT IIw-1

The soils in this capability unit are deep, nearly level, and level. They are on uplands and bottom lands and are moderately well drained, somewhat poorly drained, and poorly drained. The surface layer is silt loam or silty clay loam, and the subsoil is silt loam, silty clay loam, and silty clay.

Natural fertility is medium or high. The available water capacity is moderate to very high, and permeability is moderate to very slow. The organic-matter content is moderate or high. Surface runoff is slow or very slow. The main limitation is seasonal wetness caused by surface runoff, ponding, and occasional flooding.

These soils are suited to corn, soybeans, sorghum, small grain, grass, and legumes. Most of the acreage is in crops. Areas cut up by meandering stream chan-

nels are in trees and grasses. Using crop residues, green manure, and cover crops helps to maintain organic-matter content, tilth, and available water capacity. These practices as well as land grading, surface ditches, and in places tile drains, reduce scour and maintain or improve drainage. Fertilizer and lime must be applied for high yields.

CAPABILITY UNIT IIw-2

Cleora loamy fine sand is the only soil in this capability unit. It is deep and nearly level. It is on bottom lands. The surface layer is loamy fine sand, and the underlying material is loamy very fine sand, fine sandy loam, and loam.

Natural fertility is medium. The available water capacity is moderate, and permeability is moderately rapid. The organic-matter content is moderate. Surface runoff is slow. The main limitations are the hazards of occasional flooding and, to a lesser degree, seasonal droughtiness. Many areas are small and poorly shaped for farming.

Cleared areas are suited to corn, sorghum, grass, and legumes. Continuous row crops can be grown. This soil has good potential for alfalfa and walnut trees. Using crop residues, cover crops, and green-manure crops helps to maintain available water capacity. Land grading, channel improvement, and stream bank management reduce scour and improve drainage.

CAPABILITY UNIT IIe-2

Parsons silt loam is the only soil in this capability unit. It is on uplands. This soil is deep, nearly level, and somewhat poorly drained. The surface layer is silt loam, and the subsoil is clay and silty clay.

Natural fertility is medium. The available water capacity is moderate, and permeability is very slow. The organic-matter content is moderate. Surface runoff is slow. The main limitations are seasonal droughtiness, and, to a lesser degree, seasonal wetness.

This soil is suited to corn, soybeans, sorghum, small grain, grass, and legumes. Most areas are in crops. Under highly specialized management, row crops can be grown year after year. Using crop residues, cover crops, and green-manure crops helps to maintain or improve organic-matter content, tilth, and available water capacity. Irrigation supplements the water available to plants.

CAPABILITY UNIT IIIe-4

Barco loam, 5 to 9 percent slopes, is the only soil in this capability unit. It is moderately deep and well drained. The surface layer is loam, and the subsoil is clay loam.

Natural fertility is medium. The available water capacity is moderate, and permeability is moderate. The organic-matter content is moderate. Surface runoff is rapid. The main limitations are the hazards of erosion and, to a lesser extent, droughtiness. Maintaining or improving organic-matter content, fertility, and tilth and controlling erosion are good management practices.

This soil is moderately well suited to corn, soybeans, grain sorghum, and small grain. Using crop residues, cover crops, and green-manure crops helps to maintain organic-matter content and tilth. These practices and terracing, minimum tilling, and contour tilling help retard runoff and control erosion.

CAPABILITY UNIT IIIe-5

Only Barden silt loam, 1 to 5 percent slopes, eroded, is in this capability unit. This soil is deep, moderately well drained and has a surface layer of silt loam over a subsoil of silty clay loam or clay loam.

Natural fertility is medium. Available water capacity is high, and permeability is slow. The organic-matter content is moderate. Surface runoff is medium. The chief hazard is susceptibility to erosion. The main management needs are controlling erosion and maintaining or improving organic-matter content, fertility, and tilth.

This soil is suited to small grains, grasses, and legumes and is somewhat less suited to corn, soybeans, and grain sorghums. The use of crop residues, cover crops, and green manure crops helps to maintain organic-matter content and tilth. These practices and terracing, minimum tilling, and contour tilling help retard runoff and control erosion.

CAPABILITY UNIT IIIe-6

Zaar silty clay, 2 to 5 percent slopes, is the only soil in this capability unit. It is deep and somewhat poorly drained. The surface layer is silty clay, and the subsoil is silty clay.

Natural fertility is high. The available water capacity is moderate, and permeability is very slow. The organic-matter content is high. Surface runoff is medium. The main limitation is the hazard of erosion. Maintaining organic-matter content and fertility, maintaining or improving tilth, and controlling erosion are good management practices.

This soil is well suited to small grain, grass, and legumes, including alfalfa. It is moderately well suited to corn, soybeans, and grain sorghum. Using crop residues, cover crops, and green-manure crops helps to maintain organic-matter content and good tilth. These practices and terracing, minimum tilling, and contour tilling help retard runoff and control erosion.

CAPABILITY UNIT IIIe-7

The soils in this capability unit are gently sloping and moderately sloping. They are on uplands and are moderately deep and well drained. The surface layer is fine sandy loam or loam, and the subsoil is sandy clay loam and clay loam.

Natural fertility is low to medium. The available water capacity is low, and permeability is moderate. The organic-matter content is low. Surface runoff is medium to rapid. The main limitations are runoff and the hazard of erosion. Seasonal droughtiness is a minor hazard. Maintaining or improving organic-matter content, fertility, and tilth and controlling erosion are good management practices.

These soils are suited to small grain, grass (fig. 18), and legumes, and, to a lesser degree, to corn, soybeans, and grain sorghum. Using crop residues, cover crops, and green-manure crops helps to maintain organic-matter content and good tilth. These practices and terracing, minimum tilling, contour tilling, and controlling grazing help retard runoff and control erosion.

CAPABILITY UNIT IIIw-14

Osage silty clay is the only soil in this capability unit. It is deep and nearly level. It is on bottom lands and is



Figure 18.—An unimproved pasture in the foreground and an improved tall fescue pasture in an area of Bolivar fine sandy loam, 2 to 5 percent slopes.

poorly drained. The surface layer and subsoil are silty clay.

Natural fertility is high. The available water capacity is moderate, and permeability is very slow. The organic-matter content is high. Surface runoff is very slow. The main limitation is the hazard of wetness. Because this soil is wet at times and has a dry and hard surface at other times, it is difficult to till. Much of the acreage has inadequate outlets for surface drainage and is subject to flooding.

If adequate drainage is provided, this soil is suited to soybeans, corn, and some water-tolerant grasses. Marshgrass is the natural cover. This soil is not well suited to alfalfa. Using crop residues and cover crops and plowing in the fall help improve tilth. Where surface drainage is provided and outlets are adequate this soil is suitable for intensive row cropping.

CAPABILITY UNIT IVe-2

Liberal silt loam, 2 to 9 percent slopes, eroded, is the only soil in this capability unit. It is deep and moderately well drained. The surface layer is silt loam, and the subsoil is silty clay and silty clay loam.

Natural fertility is medium. The available water capacity is low, and permeability is slow. The organic-matter content is low. Surface runoff is rapid. The main limitations are runoff and the hazard of erosion. Droughtiness is also a hazard. Maintaining or improv-

ing organic-matter content, fertility, and tilth and controlling erosion are good management practices.

This soil is suited to grass and legumes. It is also suited to wildlife food and cover plants. Occasionally a sorghum crop or other row crop can be grown in long-term rotations that include several years of hay and pasture. Using crop residues, cover crops, and green-manure crops helps to maintain organic-matter content and tilth. These practices and minimum tilling and contour tilling help retard runoff and control erosion.

CAPABILITY UNIT IVe-6

Zaar silty clay, 5 to 9 percent slopes, is the only soil in this capability unit. It is deep and somewhat poorly drained. The surface layer and the subsoil are silty clay.

Natural fertility is high. The available water capacity is moderate, and permeability is very slow. The organic-matter content is high. Surface runoff is rapid. The main limitations are runoff and the hazard of erosion. Maintaining organic-matter content, maintaining or improving tilth, and controlling erosion are good management practices.

This soil is suited to grass and legumes, including alfalfa. Small grain and occasionally a row crop can be grown in long-term rotations that include several years of hay and pasture. Using plant residues, cover crops, and green-manure crops helps to maintain organic-matter content and tilth. These practices and terracing, minimum tilling, contour tilling, and controlling grazing help control erosion and retard runoff. Lime and fertilizer must be applied for optimum yields.

CAPABILITY UNIT IVe-7

The soils in this capacity unit are moderately deep, gently sloping and moderately sloping, and eroded. They are on uplands. The surface layer is loam or fine sandy loam, and the subsoil is clay loam or sandy clay loam.

Natural fertility is low to medium. The available water capacity is low, and permeability is moderate. The organic-matter content is low. Surface runoff is medium to rapid. The main limitations are runoff and the hazard of erosion. Seasonal droughtiness is also a limitation. Maintaining or improving organic-matter content and tilth and controlling erosion are good management practices.

The soils in this unit are suited to grass and legumes. Small grain and occasionally a row crop can be grown in long-term rotations that include several years of hay and pasture. Using plant residues, cover crops, and green-manure crops helps maintain organic-matter content, tilth, and available water capacity. These practices and terracing, minimum tilling, contour tilling, and controlling grazing help control erosion and retard runoff. Lime and fertilizer must be applied for good yields.

CAPABILITY UNIT IVe-6

Eldon cherty loam, thin solum variant, 5 to 14 percent slopes, is the only soil in this capability unit. It is deep and well drained. The surface layer is cherty loam, and the subsoil is very cherty silty clay loam, cherty silty clay, and silty clay.

Natural fertility is medium. The available water capacity is low, and permeability is moderated. The

organic-matter content is moderate. Surface runoff is medium. The main limitation is droughtiness caused by the many chert fragments throughout the soil. Erosion is a hazard. The cherty surface layer makes this soil difficult to till.

This soil is suited to grass and legumes and is less suited to small grain. Sorghums or other row crops can be grown occasionally in rotations that include several years of hay crops or pasture. Some areas are still wooded. Using crop residues, cover crops, and green-manure crops helps to maintain organic-matter content, good tilth, and available water capacity. These practices and minimum tilling and contour tilling help retard runoff and control erosion.

CAPABILITY UNIT VIe-2

Only Liberal-Coweta-Barco complex, 2 to 14 percent slopes, is in this capability unit. These soils are shallow to deep and are gently sloping to strongly sloping. They have a medium-textured to moderately coarse textured surface layer and a moderately fine textured to fine textured subsoil. Coweta soils have soft sandstone bedrock at a depth of less than 20 inches.

Natural fertility is medium to low. The available water capacity is moderate to very low. The organic-matter content is moderate. Surface runoff is medium to rapid. The main limitations are runoff and the hazard of erosion. Droughtiness is also a limitation.

A large part of this unit is unsuited to cultivation. All but the stony or brush areas can be mowed. The soils are suited to grass and legumes. Good management practices, such as contour tilling when renovating pastures and maintaining good quality plant cover, help reduce runoff and erosion. Lime and fertilizer must be applied for high forage yields. After grazing and haying a vigorous stand should remain to protect the soil from erosion.

CAPABILITY UNIT VIe-5

Only Radley, Parsons, and Barden soils, 0 to 25 percent slopes, severely eroded, is in this capability unit. This mapping unit consists of U-shaped, entrenched upland drainageways that have scarped edges, small severely eroded areas, and very narrow bottoms. It is moderately well drained to somewhat poorly drained.

Natural fertility ranges from medium to high. The available water capacity ranges from moderate to very slow. The organic-matter content ranges from moderate to high. Parts of this unit are wet and other parts are droughty. The main limitations are runoff and the hazard of erosion.

This unit is generally unsuited to cultivation. Use is largely limited to pasture, woodland, or wildlife food and cover. In many places this unit provides good sites for stock ponds, reservoirs, and grass waterways. Upland game birds and animals use many areas.

Using plant residues and cover crops helps to maintain organic-matter content, tilth, and available water capacity. These practices and ponds and reservoirs help control erosion and retard runoff.

CAPABILITY UNIT VIe-4

Hector fine sandy loam, 5 to 14 percent slopes, is the only soil in this capability unit. It is shallow and well drained. The surface layer and subsoil is fine sandy

loam over sandstone bedrock at a depth of less than 20 inches.

Natural fertility is very low. The available water capacity is very low, and permeability is moderately rapid. The organic-matter content is low. Surface runoff is medium. The main limitation is droughtiness. Erosion and runoff are lesser concerns.

This soil is generally unsuited to cultivation. It is better suited to woodland, pasture, and wildlife food and cover. Maintaining a good stand of quality grass and legumes increases hay and pasture yields. Proper grazing and haying help maintain vigorous plant growth and provide adequate cover to protect the soil from erosion. Removing undesirable trees, protecting from fire, and fencing to control or prevent grazing increase timber production.

CAPABILITY UNIT VI_a-6

Coweta fine sandy loam, 2 to 14 percent slopes, is the only soil in this capability unit. It is shallow and well drained. The surface layer and subsoil is fine sandy loam over sandstone bedrock at a depth of less than 20 inches.

Natural fertility is low. The available water capacity is very low, and permeability is moderate. The organic-matter content is moderate. Surface runoff is medium to rapid. The main limitation is droughtiness. Erosion and runoff are lesser concerns.

This soil is generally unsuited to cultivation. Most of the acreage is in native prairie grasses. Maintaining a good stand of high quality grass and legumes increases hay and pasture yields. Grazing must be controlled for sustained high production. Proper grazing and haying help maintain vigorous plant growth and provide adequate cover to protect the soil from erosion.

CAPABILITY UNIT VII_a-7

Mine pits and dumps is the only land in this capability unit. The steep irregular-shaped dumps are a mixture of shale, sandstone, and the original mantle of oil stripped from coal beds. The pits are long and narrow, and most of them are filled with water.

Steep slopes, a litter of large sandstones on the surface in places, and numerous pits and gullies make tilling this unit impractical. Surface runoff is rapid, and low areas are ponded or seepy. Except for some soil areas included with this mixture of materials, permeability is slow or very slow, and the available water capacity is low. The scanty cover of brush, weeds, trees, and grasses offers little protection from erosion. The hazard of erosion is severe, and erosion will continue if protective cover is not maintained.

The use of Mine pits and dumps is largely restricted to grazing, woodland, or wildlife. Most of the acreage is suited to woodland, wildlife food and cover, and recreation. The small scattered areas of undisturbed soils are better suited to grazing.

Clearing the brush, smoothing the dumps, and planting adapted grasses, trees, and shrubs increase the value of this unit for wildlife, recreation, grazing, Christmas tree production, and woodland.

CAPABILITY UNIT VII_b-6

The soils in this capability unit are stony and moderately sloping to steep. They are on uplands. They are

shallow and well drained. The surface layer and subsoil is fine sandy loam over sandstone bedrock at a depth of less than 20 inches.

Natural fertility is low or very low. The available water capacity is very low, and permeability is moderate to moderately rapid. Stones on or in the surface layer and droughtiness very severely limit the use of this unit. Use of farm machinery is impractical. Only scattered, small nonstony included areas can be mowed or worked for hay or pasture.

The use of these soils is restricted mainly to grazing, wildlife, and woodland. All parts of this unit are suited to wildlife. Cleared areas are better suited to grazing. The narrow bottoms included in the upland are well suited to woodland. The steeper broken slopes are suited to woodland, but only to a limited degree.

Good plant cover helps maintain organic-matter content and available water capacity. Chemical sprays help control brush and weeds. Removing undesirable trees, protecting from fire, and fencing to control or prevent grazing increase timber production. Aerial weed and brush control, seeding, and fertilization are good management practices, especially for the prairie areas.

CAPABILITY UNIT VIII_a-8

Balltown flaggy silty clay loam, 9 to 20 percent slopes, is the only soil in this capability unit. It is shallow and somewhat excessively drained. It has 5 to 20 inches of flaggy silty clay loam over limestone bedrock.

Natural fertility is medium. The available water capacity is very low, and permeability is moderate. The organic-matter content is moderate. The main limitations are droughtiness, rock outcrops, and stoniness.

This soil is unsuited to cultivation. Maintaining a good stand of grass and legumes, controlling grazing, and using lime and fertilizer are good management practices.

Predicted yields

Table 2 lists the predicted average yields per acre of principal crops under two levels of management for the arable soils in Vernon County. All available sources of yield information were used to make these estimates. The estimates are based on the observations of the soil scientists that made the survey and on information obtained from local farmers, agronomists, public and private agencies, demonstration plots, and research data.

Management practices, weather conditions, plant diseases, and insect infestations vary from year to year and from place to place. Differences in any of these factors, especially droughts in summer, cause great fluctuation in crop yields. Crop damage can be heavy as a result of wind, hail, torrential downpours of rain, or flooding.

Columns A show the predicted yields that can be expected, over a period of years, based on the most common combination of management practices used by most of the farmers in the county. Crops are generally planted according to field boundaries. Only a small acreage is terraced, and not all the fields are contour cultivated. Wet areas are drained, but a better system of drainage is commonly needed. Lime and fertilizer are regularly used, but only about half the amount shown

TABLE 2.—Predicted average yields per acre of principal crops

[Yields in the A columns are those to be expected under ordinary management; those in the B columns are under improved management. Absence of a yield indicates that the crop is not ordinarily grown on the soil]

Soil	Average yield per acre of—											
	Corn		Soybeans		Grain sorghum		Wheat		Tall fescue		Alfalfa	
	A	B	A	B	A	B	A	B	A	B	A	B
	Bu	Bu	Bu	Bu	Bu	Bu	Bu	Bu	Tons	Tons	Tons	Tons
Balltown flaggy silty clay loam, 9 to 20 percent slopes										1.1		
Barco loam, 2 to 5 percent slopes	47	70	22	34	50	72	25	38	1.1	2.6	2.0	4.0
Barco loam, 2 to 5 percent slopes, eroded	39	62	18	30	40	63	21	32	1.0	2.4	1.8	3.4
Barco loam, 5 to 9 percent slopes	37	60	17	26	38	60	16	25	1.0	2.3	1.5	3.5
Barco loam, 5 to 9 percent slopes, eroded	32	52	13	19	36	58	15	22	.8	2.0	1.3	3.0
Barden silt loam, 1 to 5 percent slopes	57	80	26	38	62	83	28	43	1.2	2.8	3.0	4.0
Barden silt loam, 1 to 5 percent slopes, eroded	47	70	22	32	52	73	23	35	1.0	2.4	2.2	3.5
Bolivar fine sandy loam, 2 to 5 percent slopes	37	52	19	28	43	63	20	33	1.0	2.4	2.3	3.0
Bolivar fine sandy loam, 2 to 5 percent slopes, eroded	27	42	15	25	40	58	18	28	.7	2.0	2.0	2.8
Bolivar fine sandy loam, 5 to 9 percent slopes							16	22	.7	1.8		
Bolivar fine sandy loam, 5 to 9 percent slopes, eroded							12	20	.6	1.6		
Bronaugh silt loam, 2 to 5 percent slopes	57	80	25	37	59	83	28	41	1.2	2.8	3.5	5.0
Cleora loamy fine sand	40	56	15	20	50	60	19	28	1.0	2.2	2.5	4.0
Coweta fine sandy loam, 2 to 14 percent slopes									.8	1.6		
Coweta stony fine sandy loam, 5 to 14 percent slopes									.5	1.0		
Dubbs loam, 2 to 5 percent slopes	64	82	24	36	66	85	28	43	1.2	2.8	3.5	5.0
Eldon cherty loam, thin solum variant, 5 to 14 percent slopes									.9	1.6		
Hector fine sandy loam, 5 to 14 percent slopes									.6	1.3		
Hector stony fine sandy loam, 5 to 14 percent slopes									.5	1.0		
Hepler silt loam	52	70	23	32	60	80	25	35	1.5	2.6	2.3	4.0
Hepler silt loam, overwash	56	75	27	36	64	86	31	39	1.6	2.8	2.8	4.5
Hepler-Radley complex	54	72	25	34	62	84	26	37	1.5	2.7	2.5	4.2
Lanton silty clay loam	56	77	27	36	64	82	31	38	1.2	2.8	2.3	4.0
Liberal silt loam, 2 to 5 percent slopes	38	55	19	28	44	61	25	35	1.0	2.2	2.5	4.0
Liberal silty clay loam, 2 to 9 percent slopes, eroded							15	28	.6	1.7	2.0	3.0
Liberal-Coweta-Barco complex, 2 to 14 percent slopes									.8	1.5		
Lula silt loam, 2 to 5 percent slopes	60	75	29	39	68	84	33	44	1.5	2.7	3.4	5.4
Mayes silty clay loam	58	75	25	35	62	80	29	38	1.2	2.6	2.2	3.5
Osage silty clay	55	65	24	30	65	78	26	34	1.2	2.6		
Parsons silt loam	48	70	24	33	54	78	28	35	1.0	2.5	2.2	3.5
Radley silty clay loam	63	80	28	37	72	88	30	39	1.3	2.9	3.5	5.5
Verdigris silt loam	65	80	28	37	72	88	31	39	1.5	3.0	3.5	5.5
Zaar silty clay, 2 to 5 percent slopes	55	75	23	35	58	84	29	39	1.2	2.6	3.1	4.9
Zaar silty clay, 5 to 9 percent slopes	45	65	20	30	48	72	22	35	1.0	2.0	2.8	4.0

by soil tests to be needed is applied. Some fieldwork is not as timely as is desirable.

Columns B show predicted yields based on the improved combination of management practices that is used by some farmers in the county. These yields are not to be expected if a systematic cropping plan that is consistent with the capability of the soils is followed. Sloping upland is terraced, and most slopes of more than 2 percent are farmed on the contour. Adequate drainage is installed as needed. Adapted high yield crop

varieties are planted. Lime and fertilizer are applied regularly, according to soil tests, for maximum yields. Considerable attention is given to new methods of weed control and crop residue management. All fieldwork is timely.

The yield predictions in table 2 are approximate figures and are intended to serve only as guides. For many users comparing the yields of the soils is more valuable than knowing the actual yields. These relationships are likely to remain constant over a period of years.

Woodland ²

In 1967, about 98,200 acres, or 18 percent of the county, was still in woodland. Wooded tracts are small, and about half of the acreage is used for grazing.

The upland wooded areas in Vernon County are nearly all Bolivar and Hector soils. These soils have a shallow root zone. Most of the rest of the wooded areas are on bottom lands throughout the county on Dubbs, Hepler, Lanton, Osage, Radley, and Verdigris soils. Wetness limits woodland production in the Hepler, Lanton, and Osage soils.

Only the soils that are used mainly for woodland are rated in table 3. These soils have been placed in woodland suitability groups (3, 4) to help owners plan the use of their soils for wood crops. Each group is made up of soils that are suited to the same kinds of trees, that need approximately the same kind of management when the vegetation on them is similar, and that have about the same potential productivity.

Each woodland group is identified by a three-part symbol, such as 3o4, 4w6, or 5d9. The first part of the symbol, always a number, indicates relative potential productivity of the soils in the group: 1 is very high, 2 is high, 3 is moderately high, 4 is moderate, and 5 is low. These ratings are based on site index. Site index is the height, in feet, that the dominant trees of a given species will reach in a natural, unmanaged stand in a stated number of years. For the species included in this report, the index is based on 50 years. Site indexes for this survey were determined by actual field measurements for the indicated soil mapping unit.

The second part of the symbol identifying a woodland suitability group is a small letter. This letter indicates an important soil property that imposes slight to severe hazards or limitations in managing the soils of the group for wood crops. A letter *w* shows that water in or on the soil, either seasonally or all year, is the chief limitation; *d* indicates soils in which root penetration is restricted or limited by hard rock, hardpan, or other layers; and *o* indicates that the soils have few limitations that restrict their use for trees.

The third part of the symbol indicates the degree of hazard or limitation and the general suitability of the soils for certain kinds of trees. The numerals 1, 2, and 3 indicate soils that are suited to conifer species. The numeral 1 indicates soils that have no limitation or only slight limitations; 2 indicates one or more moderate limitations; and 3 indicates one or more severe limitations. The numerals 4, 5, and 6 indicate soils that are suited to deciduous species. The numeral 4 indicates no limitations or only slight limitations; 5 indicates one or more moderate limitations; and 6 indicates one or more severe limitations. The numerals 7, 8, and 9 indicate soils that are suited to either conifer or deciduous species. The numeral 7 indicates no limitations or only slight limitations; 8 indicates one or more moderate limitations; and 9 indicates one or more severe limitations.

The hazards or limitations that affect management of soils for woodland and seedling mortality, erosion, windthrow, plant competition, and equipment restrictions. These hazards are rated for each group in table 3

² FRANCIS T. HOLT, forester, Soil Conservation Service, helped prepare this section.

and are briefly described in the following paragraphs.

Seedling mortality refers to the expected degree of mortality of naturally occurring or planted seedlings. Seedlings are affected by soil texture, soil depth, drainage, flooding, height of the water table, and degree of erosion. Mortality is *slight* if the expected loss is less than 25 percent; *moderate* if losses are between 25 and 50 percent; and *severe* if losses are more than 50 percent.

Erosion is rated according to the risk of soil loss in woodland where normal practices are used in managing and harvesting trees. It is *slight* if erosion control is not an important concern; *moderate* if some attention must be given to reduce soil losses; and *severe* if intensive and generally expensive measures must be taken to control erosion.

Windthrow indicates the relative danger of trees being blown over by normally occurring high winds, excluding tornadoes. The hazard is *slight* if windthrow is no special concern. It is *moderate* if roots hold the trees firmly except when the soil is excessively wet or when the wind is strongest.

The expected hazard of competition from other plants is given a rating of slight, moderate, or severe. A rating of *slight* means that competition from other plants is no special concern. A rating of *moderate* means that plant competition develops but generally does not prevent an adequate stand from becoming established. A rating of *severe* means that plant competition prevents trees from restocking naturally.

Equipment limitations are based on the degree that soil characteristics and topographic features restrict or prohibit the use of equipment normally used in tending a crop of trees. The limitation is *slight* if there is little or no restriction to the type of equipment that can be used or the time of year that equipment can be used. It is *moderate* if the use of equipment is seasonally limited or if modified equipment or methods of harvesting are needed. It is *severe* if special equipment is needed or if the use of equipment is severely restricted by one or more unfavorable soil characteristics, such as drainage, slope, number or size of stones, and soil texture.

Wildlife

The soils and waters of Vernon County provide habitat for a wide variety and an abundance of game and nongame birds, mammals, and fish. Habitat suitable for openland wildlife is the most numerous and best distributed. Bobwhite quail, cottontail rabbits, mourning doves, fox squirrels, gray squirrels, and prairie chickens are the most important wildlife species. Bass, bluegill, and catfish are in the 2,500 acres or more of water in the major streams, large mine pits, farm ponds, and reservoirs. Mink, muskrats, raccoon, and beaver, the important furbearers, live close to these waters. White-tailed deer are increasing, especially in the interspersed woodland and cropland near the larger streams.

Specific areas must be set aside for management or preservation to achieve maximum number of wildlife species. The management should provide for the development or protection of the critical elements of habitat that are lacking or are in short supply. The designated areas must be manipulated for individual species, because no two species require the exact same elements of

TABLE 3.—Woodland

Woodland suitability groups and map symbols	Potential productivity			Hazards and limitations
	Trees	Site index	Average growth per acre	Seedling mortality
Group 2o4: DuB Silty soils on terraces; high potential productivity; slight management concerns; suitable for hard- woods.	Upland oak -----	75	Board feet 280	Slight -----
Group 3o4: Ve, Ra Silty soils on bottom lands; subject to overflow; high potential productivity; no serious manage- ment concerns; suitable for hardwoods.	Upland oak -----	70	280	Slight -----
Group 3o5: Hm Seasonally wet soils on low terraces; subject to occasional ponding or overflow; high potential productivity; suitable for hardwoods.	Pin oak -----	70	280	Slight -----
Group 4o7: BoB, BoB2, BoC, BoC2 Loamy soils on uplands; moderate potential pro- ductivity; slight to moderate management con- cerns; suitable for conifers and hardwoods.	Upland oak -----	52	130	Slight -----
Group 4w6: Os, La Seasonally wet soils on bottom lands; subject to occasional ponding or overflow; moderate potential productivity; suitable for hardwoods.	Pin oak -----	75	820	Severe -----
	Pecan -----	50	130	
Group 5d9: HcD, HeD, HeE Loamy soils on uplands that are shallow to bedrock; generally contain rock fragments in the surface layer; low potential productivity; better suited to Southern pines than to other trees.	Upland oak -----	48	130	Moderate -----

¹ Plant on coves, benches, and bases of cool slopes.

habitat. For example, the number of prairie chickens, blacktail jackrabbits, and other prairie species is directly related to the amount of permanent grassland and how it is managed. Continuing to convert native prairies and other grasslands to crops of heavily grazed pasture will drastically reduce the population of wildlife dependent on this type of habitat.

Wildlife is managed intensively only on small, privately owned areas and on two public tracts operated by the Missouri Department of Conservation. These are the 85-acre Milo Prairie Wildlife Area near Nevada and the 8,633-acre Schell-Osage Wildlife Area near Schell City. Nearly half of this area is in adjoining St. Clair County.

The soils of the county have been rated according to their suitability for wildlife habitat. The soil characteristics that most affect habitat are effective root zone, surface texture, natural drainage, surface stoniness, flooding, slope, permeability, and available water capacity. Important factors that were not considered are existing vegetation; present land use; size, shape, and location of soil areas; and the movement of wildlife from place to place.

The estimated degree and kind of limitations affect-

ing the use of the soils for wildlife habitat are shown in table 4. The ratings provided are helpful in selecting the sites and planning and developing wildlife habitat. They also indicate certain limitations affecting the use of the soils for openland, woodland, and wetland wildlife habitat.

A rating of *good* indicates that wildlife habitat generally is easily created, improved, or maintained. There are few or no soil limitations that affect wildlife habitat management, and satisfactory results can be expected. *Fair* indicates that wildlife habitat generally can be created, improved, or maintained, but there are moderate soil limitations. Moderately intense management and fairly frequent attention are required to assure satisfactory results. *Poor* indicates that wildlife habitat generally can be created, improved, or maintained on these soils, but that limitations are severe. Habitat management is difficult and expensive, or it requires intensive effort. *Very poor* indicates that establishing wildlife habitat is impractical.

Most managed wildlife habitats are created, improved, or maintained by planting suitable vegetation, manipulating existing vegetation, inducing natural establishment of desired plants, or a combination of these

suitability of the soils

Hazards and limitations—continued				Preferred trees—	
Erosion	Windthrow	Plant competition	Equipment restrictions	In existing stands	For planting
Slight -----	Slight -----	Slight -----	Slight -----	Upland oak -----	Upland oak.
Slight -----	Slight -----	Slight -----	Slight -----	Upland oak, black walnut, and green ash.	Black walnut, pecan, and yellow-poplar.
Slight -----	Slight -----	Slight -----	Slight -----	Pin oak -----	Pin oak.
Slight -----	Slight -----	Slight -----	Slight -----	Upland oak -----	Shortleaf pine, green ash, and black walnut. ¹
Slight -----	Moderate -----	Severe -----	Severe -----	Pin oak and pecan.	Pin oak and pecan.
Moderate -----	Moderate -----	Slight -----	Slight to moderate.	Upland oak and eastern redcedar.	Shortleaf pine.

measures. The seven elements of wildlife habitat rated are discussed in the following paragraphs.

Grain and seed crops are grain or seed-producing annuals planted to produce food for wildlife. These crops include corn, soybeans, wheat, oats, millet, and sorghum.

Grasses and legumes are domestic perennial grasses and herbaceous legumes planted to provide wildlife cover and food. These plants include fescue, brome, timothy, reedtop, orchardgrass, reed canarygrass, clover, trefoil, alfalfa, and lespedeza.

Wild herbaceous upland plants are native or introduced perennial grasses and weeds that provide food and cover, mainly for upland forms of wildlife, and that are established mostly through natural processes. These plants include big bluestem, little bluestem, some of the panicums, and other native grasses, and partridgepea, beggarticks, various native lespedezas, and other native herbs.

Hardwood woody plants are nonconiferous trees, shrubs, and woody vines that produce fruits, nuts, buds, catkins, twigs, or foliage used extensively as food by wildlife. They are commonly established through natural processes but may also be planted. These plants in-

clude dogwood, sumac, sassafras, persimmon, hazelnut, shrub lespedezas, wild cherry, autumn-olive, various oaks and hickory, grape, plum, blackberry, blackhaw, honeysuckle, and roses.

Coniferous woody plants are cone-bearing trees and shrubs that are important to wildlife mainly as cover, but that also furnish food in the form of browse, seeds, or fruitlike cones. Examples are Virginia pine, white pine, shortleaf pine, Scotch pine, red pine, and redcedar. The rating is based on limitations to growth that produce dense, low foliage and delayed canopy closure, rather than on timber production.

Wetland food and cover plants are annual and perennial wild herbaceous plants in moist to wet sites, but not including floating or submerged aquatics. These plants provide food or cover mainly for wetland forms of wildlife. Examples are smartweed, bulrush, barnyardgrass, duckweed, pondweed, pickerelweed, cattail, and various sedges.

Shallow water developments are impoundments or excavations for control of water. They are generally not more than 5 feet deep. Examples are low dikes and levees, such as ditches, and devices for water-level control in marshy streams or channels.

TABLE 4.—

Soil series and map symbols	Suitability of the soils for elements of wildlife habitat			
	Grain and seed crops	Grasses and legumes	Wild herbaceous upland plants	Hardwood woody plants
Balltown: BaD -----	Very poor: very low available water capacity.	Poor: shallow depth, very low available water capacity.	Poor: very low available water capacity.	Very poor: very low available water capacity.
Barco: BcB, BcB2, BcC, BcC2, and Barco part of LoD.	Fair: moderate depth.	Good -----	Good -----	Good -----
Barden: BdB, BdB2, and Barden part of RpE3.	Good -----	Good -----	Good -----	Good -----
Bolivar: BoB, BoB2, BoC, BoC2.	Fair: moderate depth.	Good -----	Good -----	Good -----
Bronaugh: BsB -----	Good -----	Good -----	Good -----	Good -----
Cleora: Ce -----	Poor: coarse-textured surface layer.	Fair: coarse-textured surface layer.	Good -----	Good -----
Coweta: CoC, CrD, and Coweta part of LoD.	Very poor: very low available water capacity.	Poor: shallow depth, very low available water capacity.	Poor: very low available water capacity.	Very poor: very low available water capacity.
Dubbs: DuB -----	Good -----	Good -----	Good -----	Good -----
Eldon variant: EdD -----	Fair: slope -----	Good -----	Good -----	Good -----
Hector: HcD, HeD, HeE -----	Very poor: very low available water capacity.	Poor: shallow depth, very low available water capacity.	Poor: very low available water capacity.	Very poor: very low available water capacity.
Hepler: Hm, Hp, and Hepler part of Hr.	Fair: wetness -----	Good -----	Good -----	Good -----
Lanton: La -----	Poor: wetness -----	Fair: wetness -----	Good -----	Fair: wetness -----
Liberal: LeB, LmC2, and Liberal part of LoD.	Good if slope is 2 to 5 percent. Fair if 5 to 9 percent.	Good -----	Good -----	Good -----
Lula: LuB -----	Good -----	Good -----	Good -----	Good -----
Mayes: Ma -----	Fair: wetness -----	Good -----	Good -----	Good -----
Mine pits and dumps: Mp -----	Very poor: slope -----	Poor: stones, well drained.	Poor: clayey surface layer.	Poor: well drained, low available water capacity.
Osage: Os -----	Poor: wetness -----	Fair: wetness, silty clay surface layer.	Good -----	Fair: wetness -----
Parsons: Pa, and Parsons part of RpE3.	Fair: wetness -----	Good -----	Good -----	Good -----
Radley: Ra, and Radley parts of Hr and RpE3.	Good -----	Good -----	Good -----	Good -----
Verdigris: Ve -----	Good -----	Good -----	Good -----	Good -----
Zaar: ZaB, ZaC -----	Fair: silty clay surface layer.	Fair: silty clay surface layer.	Fair: silty clay surface layer.	Good -----

Wildlife

Suitability of the soils for elements of wildlife habitat			Suitability of the soils for—		
Coniferous woody plants	Wetland food and cover plants	Shallow water developments	Openland wildlife	Woodland wildlife	Wetland wildlife
Very poor: very low available water capacity.	Poor: slope, somewhat excessively drained.	Very poor: slope, somewhat excessively drained.	Poor -----	Very poor -----	Very poor.
Good -----	Poor: well drained	Very poor: slope, well drained.	Good -----	Good -----	Very poor.
Good -----	Poor: moderately well drained.	Poor: moderately well drained.	Good -----	Good -----	Poor.
Good -----	Poor: well drained	Very poor: slope, well drained.	Good -----	Good -----	Very poor.
Good -----	Poor: well drained	Very poor: slope, well drained.	Good -----	Good -----	Very poor.
Good -----	Poor: well drained	Very poor: well drained.	Fair -----	Good -----	Very poor.
Very poor: very low available water capacity.	Very poor: slope, well drained.	Very poor: slope, well drained.	Poor -----	Very poor -----	Very poor.
Good -----	Poor: well drained	Very poor: slope, well drained.	Good -----	Good -----	Very poor.
Good -----	Very poor: slope	Very poor: slope.	Good -----	Good -----	Very poor.
Very poor: very low available water capacity.	Very poor: slope, well drained.	Very poor: slope, well drained.	Poor -----	Very poor -----	Very poor.
Good -----	Good -----	Fair: somewhat poorly drained.	Good -----	Good -----	Fair.
Fair: wetness -----	Good -----	Good -----	Fair -----	Fair -----	Good.
Good -----	Poor: moderately well drained, slope.	Very poor: slope	Good -----	Good -----	Very poor.
Good -----	Poor: well drained	Very poor: slope, well drained.	Good -----	Good -----	Very poor.
Good -----	Fair: somewhat poorly drained.	Fair: somewhat poorly drained.	Good -----	Good -----	Fair.
Poor: well drained, low available water capacity.	Very poor: slope, well drained.	Very poor: slope, well drained.	Poor -----	Poor -----	Very poor.
Fair: wetness -----	Good -----	Good -----	Fair -----	Fair -----	Good.
Good -----	Fair: somewhat poorly drained.	Fair: somewhat poorly drained.	Good -----	Good -----	Fair.
Good -----	Poor: somewhat poorly drained.	Poor: somewhat poorly drained.	Good -----	Good -----	Poor.
Good -----	Poor: moderately well drained.	Poor: moderately well drained.	Good -----	Good -----	Poor.
Good -----	Poor: silty clay surface layer.	Very poor: slope	Fair -----	Good -----	Very poor.

TABLE 5.—*Limitations of soils for recreation development*

Soil series and map symbols	Picnic areas	Playgrounds	Camp areas	Paths and trails	Golf fairways
Balltown: BaB -----	Moderate where slope is 9 to 15 percent; flaggy silty clay loam surface layer. Severe where slope is 15 to 20 percent.	Severe: 9 to 20 percent slopes, shallow over bedrock.	Moderate where slope is 9 to 15 percent. Severe where slope is 15 to 20 percent.	Moderate: flaggy silty clay loam surface layer.	Severe: flagstones.
Barco: BcB, BcB2, BcC, BcC2, and Barco part of LoD.	Slight -----	Moderate where slope is 2 to 5 percent; moderate depth to bedrock. Severe if slope is 5 to 9 percent.	Slight -----	Slight -----	Slight.
Barden: BdB, BdB2, and Barden part of RpE3.	Slight -----	Moderate: 1 to 5 percent slopes, slow permeability.	Moderate: slow permeability.	Slight -----	Slight.
Bolivar: BoB, BoB2, BoC, BoC2.	Slight -----	Moderate where slope is 2 to 5 percent; moderate depth to bedrock. Severe where slope is 5 to 9 percent.	Slight -----	Slight -----	Slight.
Bronaugh: BsB -----	Slight -----	Moderate: 2 to 5 percent slopes.	Slight -----	Slight -----	Slight.
Cleora: Ce -----	Moderate: flooding.	Severe: flooding -----	Severe: flooding.	Moderate: loamy fine sand surface layer.	Moderate: flooding, loamy fine sand surface layer.
Coweta: CoC -----	Slight where slope is 2 to 8 percent. Moderate where slope is 8 to 14 percent.	Severe: 2 to 14 percent slopes.	Slight where slope is 2 to 8 percent. Moderate where slope is 8 to 14 percent.	Slight -----	Slight where slope is 2 to 8 percent. Moderate where slope is 8 to 14 percent.
CrD, and Coweta part of LoD.	Moderate: stones.	Severe: 5 to 14 percent slopes, stones.	Severe: stones --	Severe: stones --	Severe: stones.
Dubbs: DuB -----	Slight -----	Moderate: 2 to 5 percent slopes.	Slight -----	Slight -----	Slight.
Eldon: EdD -----	Moderate: coarse fragments.	Severe: 5 to 14 percent slopes.	Moderate: coarse fragments.	Moderate: coarse fragments.	Severe: coarse fragments.
Hector: HcD -----	Slight where slope is 5 to 8 percent. Moderate where slope is 8 to 14 percent.	Severe: 5 to 14 percent slopes.	Slight where slope is 5 to 8 percent. Moderate where slope is 8 to 14 percent.	Slight -----	Slight where slope is 5 to 8 percent. Moderate where slope is 8 to 14 percent.
HeD, HeE -----	Moderate where slope is 5 to 15 percent; stones. Severe where slope is 15 to 30 percent.	Severe: 5 to 30 percent slopes, stones.	Severe: stones --	Severe: stones --	Severe: stones.
Hepler: Hm, Hp, and Hepler part of Hr.	Moderate: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding.	Moderate: flooding, wetness.	Moderate: flooding.

TABLE 5.—Limitations of soils for recreation developments—continued

Soil series and map symbols	Picnic areas	Playgrounds	Camp areas	Paths and trails	Golf fairways
Lanton: La -----	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness	Severe: wetness.
Liberal: LeB, LmC2, and Liberal part of LoD.	Slight where surface layer is silt loam. Moderate where surface layer is silty clay loam.	Moderate where slope is 2 to 6 percent. Severe where slope is 6 to 9 percent.	Slight where surface layer is silt loam. Moderate where surface layer is silty clay loam.	Slight where surface layer is silt loam. Moderate where surface layer is silty clay loam.	Slight.
Lula: LuB -----	Slight -----	Moderate: 2 to 5 percent slopes.	Slight -----	Slight -----	Slight.
Mayes: Ma -----	Moderate: silty clay loam surface layer, wetness.	Severe: very slow permeability.	Severe: very slow permeability.	Moderate: wetness, silty clay loam surface layer.	Slight.
Mine pits and dumps: Mp.	Severe: 20 to 65 percent slopes.	Severe: 20 to 65 percent slopes.	Severe: 20 to 65 percent slopes.	Moderate where slope is 20 to 25 percent. Severe where slope is more than 25 percent.	Severe: 20 to 65 percent slopes.
Osage: Os -----	Severe: wetness, silty clay surface layer.	Severe: wetness, silty clay surface layer, very slow permeability.	Severe: wetness, silty clay surface layer, very slow permeability.	Severe: wetness, silty clay surface layer.	Severe: wetness.
Parsons: Pa, and Parson part of RpE3.	Moderate: wetness.	Severe: very slow permeability.	Severe: very slow permeability.	Moderate: wetness.	Moderate: wetness.
Radley: Ra, and Radley parts of Hr and RpE3.	Moderate: flooding, silty clay loam surface layer.	Severe: flooding ----	Severe: flooding -	Moderate: silty clay loam surface layer.	Moderate: flooding.
Verdigris: Ve -----	Moderate: flooding.	Severe: flooding ----	Severe: flooding -	Slight -----	Moderate: flooding.
Zaar: ZaB, ZaC -----	Severe: silty clay surface layer.	Severe: silty clay surface layer.	Severe: silty clay surface layer.	Severe: silty clay surface layer.	Moderate: silty clay surface layer.

As shown in table 4, there are three main classes of wildlife. These classes are defined as follows:

Openland wildlife consists of birds and mammals that normally make their home on cropland and in pasture, lawns, and areas overgrown by grasses, herbs, and shrubby plants. Examples of this kind of wildlife are bobwhite quail, prairie chicken, meadowlark, field sparrow, redwinged blackbird, dove, cottontail rabbit, jack-rabbit, red fox, and woodchuck.

Woodland wildlife consists of birds and mammals that normally make their homes in areas of hardwood trees and shrubs, coniferous trees and shrubs, or mixtures of them. Examples are thrush, vireo, scarlet tanager, woodpecker, turkey, squirrel, gray fox, deer, and raccoon.

Wetland wildlife consists of birds and mammals that normally make their homes in wet areas, such as ponds, marshes, and swamps. Examples are duck, geese, heron, mink, muskrat, and otter.

Recreation Development

Knowledge of soils is necessary in planning, developing, and maintaining areas used for recreation. In table 5, the soils of Vernon County are rated according to limitations that affect their suitability for picnic areas, playgrounds, camp areas, paths and trails, and golf fairways.

In table 5 the degrees of limitations are expressed as slight, moderate, or severe for the specified uses. For all of these, it is assumed that a good cover of vegetation can be established and maintained. A limitation of *slight* means the 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.



Figure 19.—A picnic area and water impoundment in an area of Zaar silty clay, 2 to 5 percent slopes.

Picnic areas are attractive natural or landscaped tracts that are subject to heavy foot traffic (fig. 19). 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, and do not have slopes or stones that can greatly increase the cost of leveling a site or building access roads.

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

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 drainage, and a surface free of rocks and coarse fragments and are not subject to flooding during periods of heavy use; their surface is firm after rain but not dusty when dry.

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.

Golf fairways are the areas of a golf course between the greens. These areas have a cover of vegetation. Soil characteristics considered in rating soils for fairways are rocky surface, steep slopes, flooding, sandy areas, wetness, available water capacity, and difficulty in establishing and maintaining vegetative cover.

Engineering Uses of the Soils ³

This section is useful to planning commissions, town and city managers, land developers, engineers, contrac-

³ PHILLIP D. COOMBS, assistant State conservation engineer, Soil Conservation Service, helped prepare this section.

tors, farmer, and others who need information about soils used as structural material or as foundation on which structures are built.

Properties of soils highly important in engineering are permeability, strength, compaction characteristics, drainage, shrink-swell potential, grain size, plasticity, and reaction. Also important are depth to the water table, depth to bedrock, and 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 soils on which they are built to help predict 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. Table 6 shows several estimated soil properties significant in engineering, and table 7 gives interpretations for various engineering uses.

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 of more than 6 feet. Also, inspection of sites, especially the small ones, is needed because many delineated areas of a given soil can include small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have special meaning in soil science. The Glossary defines many of these terms.

Classification systems

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

In the Unified system (2), soils are classified according to particle-size distribution, plasticity, liquid limit, and organic matter. Soils are grouped in 15 classes. There are 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 (1) is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A-1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A-7, are clay soils that have low strength when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A-1, A-2, and A-7 groups are divided as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6.

Soil properties

Several estimated soil properties significant in engineering are given in table 6. 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 column headings in table 6.

Depth to bedrock is distance from the surface of the soil to 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.

Soil texture is described in the standard terms used by the Department of Agriculture (6). 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 loamy sand." "Sand," "silt," "clay," and some of the other terms used are defined in the Glossary.

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 includes the range of moisture content within which a soil material is plastic. Liquid limit and plasticity index are estimated in table 6.

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 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

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 explained in the Glossary.

Shrink-swell potential is the relative change in volume of soil material to be expected 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 cause much damage to building foundations, roads, and other structures. A *high* shrink-swell potential indicates a hazard to the maintenance of structures built in, on, or with material having this rating. Shrink-swell is not indicated for organic soils or certain soils that shrink markedly on drying but do not swell quickly when rewetted.

Corrosivity 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.

Interpretations of soils

The estimated interpretations in table 7 are based on the engineering properties shown in table 6, 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 Vernon County. In table 7, summarized limitations or ratings of suitability of the soils are given for all listed purposes other than for drainage of cropland and pasture, irrigation, ponds and

TABLE 6.—Estimated soil properties

[Absence of data indicates that no estimate was made. The

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	
	<i>Feet</i>	<i>Feet</i>	<i>Inches</i>				<i>Pct</i>
Balltown: BaD -----	½-1½	>6	0-16 16	Flaggy silty clay loam. Limestone bedrock.	CL	A-6	40-80
Barco: BcB, BcB2, BcC, BcC2.	1½-3½	>6	0-16 16-31 31-35 35	Loam ----- Clay loam ----- Gravelly loam ----- Sandstone bedrock.	ML, CL CL SM, SC	A-4 A-6 A-4, A-2	0 0 0
Barden: BdB, BdB2 -----	4½	2-3	0-12 12-35 35-55 55	Silt loam ----- Silty clay loam ----- Clay loam ----- Soft shale bedrock.	CL CL, CH CL	A-4, A-6 A-7 A-6, A-7	0 0 0
Bolivar: BoB, BoB2, BoC, BoC2.	1½-3½	>6	0-12 12-27 27-35 35	Fine sandy loam ----- Sandy clay loam ----- Sandy clay loam ----- Sandstone bedrock.	ML, SM, ML-CL, SM-SC CL, SC CL, SC, ML-CL, SM-SC	A-4 A-6 A-4 to A-6	0 0-5 5-10
Bronaugh: BsB -----	>4	>6	0-7 7-52 52	Silt loam ----- Silty clay loam ----- Sandstone bedrock.	CL CL	A-4 to A-6 A-7	0 0
Cleora: Ce -----	>6	>4	0-37 37-60	Loamy fine sand, loamy very fine sand. Fine sandy loam, loam.	SM SM, ML, CL, SC	A-4 to A-2 A-4 to A-2	0 0
Coweta: CoC -----	½-1½	>6	0-14 14-35	Fine sandy loam ----- Weathered sandstone bedrock.	ML, SM	A-4	0-5
CrD -----	½-1½	>6	0-12 12-24 >24	Stony fine sandy loam. Weathered sandstone bedrock. Sandstone bedrock.	SM, GM	A-2 to A-4	20-40
Dubbs: DuB -----	>6	>6	0-11 11-49 49-66	Loam ----- Clay loam ----- Loam -----	ML-CL, CL CL ML-CL, CL	A-4 A-6 A-4	0 0 0
Eldon variant: EdD -----	>4	>6	0-14 14-28 28-51 >51	Cherty loam, very cherty loam. Cherty silty clay ----- Silty clay, silty clay loam. Limestone bedrock.	ML, ML-CL GC CL, CH	A-4 A-2, A-7 A-7	5-15 5-15 2-10
Hector: HcD -----	½-1½	>6	0-14 >14	Fine sandy loam ----- Sandstone bedrock.	SM, ML	A-2, A-4	0-10
HeD, HeE -----	½-1½	>6	0-15 15	Stony fine sandy loam. Sandstone bedrock.	SM, GM	A-2, A-4	20-40
Hepler: Hm, Hp, Hr ----- For Radley part of Hr, see that series.	>6	1-2	0-25 25-70	Silt loam ----- Silty clay loam -----	ML, CL CL	A-4, A-6 A-6, A-7	0 0

significant in engineering

symbol > means more than, and the symbol < means less than]

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity of—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
80-90	75-85	70-80	65-75	Pet 30-40	18-25	In per hr 0.6-2.0	In per in of soil 0.05-0.10	pH 7.4-7.8	Moderate ---	Moderate ---	Low.
95-100	95-100	70-95	55-75	22-30	2-8	2.0-6.0	0.16-0.20	5.1-7.3	Low -----	Low -----	Moderate.
95-100	95-100	80-98	55-65	25-40	11-22	0.6-2.0	0.12-0.16	5.1-5.5	Moderate ---	Low -----	Moderate.
65-85	60-80	40-60	30-50	20-30	2-8	0.6-2.0	0.10-0.14	5.1-5.5	Low -----	Low -----	Moderate.
100	100	90-100	75-85	28-35	9-16	0.6-2.0	0.21-0.24	5.1-5.5	Low -----	Low -----	Moderate.
100	100	95-100	80-90	41-57	28-39	0.06-0.2	0.11-0.19	5.1-5.5	High -----	High -----	Moderate.
100	100	90-100	80-90	32-44	18-25	0.06-0.2	0.10-0.14	6.1-7.3	Moderate ---	High -----	Low.
100	90-100	70-95	40-60	22-30	2-8	2.0-6.0	0.15-0.17	5.6-6.5	Low -----	Low -----	Moderate.
85-100	70-95	70-95	45-65	25-40	11-22	0.6-2.0	0.15-0.17	4.5-6.0	Moderate ---	Low -----	Moderate.
70-95	70-95	60-90	36-60	24-35	5-15	0.6-2.0	0.14-0.16	4.5-5.0	Low -----	Low -----	Moderate.
100	100	90-100	75-85	28-35	9-16	0.6-2.0	0.22-0.24	5.6-6.0	Low -----	Low -----	Moderate.
90-100	90-100	85-100	80-95	41-50	21-30	0.6-2.0	0.13-0.17	5.6-6.0	Moderate ---	Moderate ---	Moderate.
100	100	60-75	30-50	20	NP	>6.0	0.10-0.12	5.6-6.0	Low -----	Low -----	Low.
100	100	60-75	30-60	15-30	2-15	2.0-6.0	0.16-0.22	5.6-6.0	Low -----	Low -----	Low.
90-100	80-95	50-70	45-65	<30	NP-10	0.6-2.0	0.16-0.18	5.6-6.0	Low -----	Low -----	Moderate.
55-70	50-65	40-55	30-50	<20	NP-4	>6.0	0.07-0.09	5.6-6.0	Low -----	Low -----	Moderate.
100	100	100	90-100	20-30	5-10	0.6-2.0	0.22-0.24	6.6-7.3	Low -----	Moderate ---	Moderate.
100	100	100	90-100	30-40	11-20	0.6-2.0	0.18-0.20	5.1-7.3	Moderate ---	Moderate ---	Moderate.
100	100	100	85-100	20-35	5-10	2.0-6.0	0.17-0.19	5.1-5.5	Moderate ---	Moderate ---	Moderate.
70-95	65-90	60-85	55-80	20-30	2-8	2.0-6.0	0.13-0.18	5.6-6.5	Low -----	Low -----	Moderate.
30-50	20-45	15-40	15-40	40-50	24-30	0.6-2.0	0.03-0.06	5.6-6.5	Low -----	Moderate ---	Moderate.
80-100	75-100	70-95	70-90	45-65	26-35	0.6-2.0	0.11-0.14	6.6-7.3	Moderate ---	Moderate ---	Moderate.
55-100	55-100	45-100	30-65	<20	NP-4	2.0-6.0	0.09-0.12	4.5-6.0	Low -----	Low -----	Moderate.
55-70	50-65	40-55	30-50	<20	NP-4	2.0-6.0	0.07-0.09	4.5-6.0	Low -----	Low -----	Moderate.
100	100	100	85-95	20-35	1-15	0.6-2.0	0.22-0.24	5.1-7.3	Low -----	High -----	Moderate.
100	100	100	90-95	35-44	13-22	0.2-0.6	0.18-0.20	5.1-6.5	Moderate ---	High -----	Moderate.

TABLE 6.—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	
	Feet	Feet	Inches				Pct
Lanton: La -----	>6	0-1½	0-60	Silty clay loam -----	CL	A-6, A-7	0
Liberal: LeB, LmC2, LoD. For Barco part of LoD, see Barco series; for Coweta part, see CoC in Coweta series.	3½-5	2-3	0-9 9-20 20-43 >43	Silt loam, silty clay loam. Silty clay loam ----- Silty clay ----- Shale bedrock.	CL CL, CH CH	A-6, A-7 A-7 A-7	0 0 0
Lula: LuB -----	3½-5	>6	0-12 12-43 >43	Silt loam ----- Silty clay loam ----- Limestone bedrock.	ML, CL CL	A-4, A-6 A-6, A-7	0 0
Mayes: Ma -----	>6	1-2	0-19 19-74	Silty clay loam ----- Silty clay -----	CL CL, CH	A-6, A-7 A-6, A-7	0 0
Mine pits and dumps: Mp. Too variable to be estimated.							
Osage: Os -----	>6	0-1½	0-67	Silty clay -----	CH	A-7	0
Parsons: Pa -----	>5	1-1½	0-13 13-38 38-71	Silty loam ----- Clay ----- Silty clay -----	ML, CL, CH CL, CH	A-4, A-6 A-7 A-7	0 0 0
Radley: Ra, RpE3 ----- For Barden and Parsons parts of RpE3, see those series.	>6	2-3	0-13 13-62	Silty clay loam ----- Silt loam -----	CL CL	A-6, A-7 A-4, A-6, A-7	0 0
Verdigris: Ve -----	>6	2-3	0-60	Silt loam -----	CL	A-4, A-6, A-7	0
Zaar: ZaB, ZaC -----	>4	2-3	0-70	Silty clay -----	CH	A-7	0

¹ NP means nonplastic.

reservoirs, embankments, and terraces and diversions. For these particular uses, table 7 lists those soil features not to be overlooked in planning, installation, and maintenance.

Soil limitations are expressed as slight, moderate, and severe. *Slight* means soil properties generally favorable for the given use or, in other words, the 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 soil properties are so unfavorable and so difficult to correct or overcome that major soil reclamation and special designs are needed.

Soil suitability is rated by the terms *good*, *fair*, and *poor*, which have meanings approximately parallel to the terms slight, moderate, and severe.

Following are explanations of some of the column headings in table 7.

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 from a depth of 18 inches to 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 effect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope affects layout and construction and also the risk of soil erosion, lateral seepage, and down-slope 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; its sides, or embankments, are of compacted soil material. The assumption is made that the embankment is compacted to medium density and that the pond is protected from flooding. Properties that affect the pond floor are permeability, organic matter, and slope, and if the flood needs to be leveled, depth to bedrock becomes important. The soil properties that affect the

significant in engineering—continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity of—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
				<i>Pct</i>		<i>In per hr</i>	<i>In per in of soil</i>	<i>pH</i>			
100	100	95-100	90-95	30-45	14-22	0.06-0.2	0.18-0.23	6.1-7.3	Moderate	High	Low.
100	100	90-100	80-95	28-35	9-16	0.6-2.0	0.22-0.24	5.1-5.5	Low	Moderate	Moderate.
100	100	95-100	90-95	41-57	28-39	0.06-0.2	0.18-0.20	5.1-5.5	High	High	Moderate.
100	100	95-100	80-90	52-65	30-40	0.06-0.2	0.11-0.13	5.6-8.4	High	High	Moderate.
100	100	90-100	75-85	21-37	1-15	0.6-2.0	0.22-0.24	5.6-7.8	Low	Low	Moderate.
95-100	95-100	85-95	80-90	34-45	12-22	0.6-2.0	0.18-0.20	5.6-7.8	Moderate	Moderate	Moderate.
100	100	95-100	85-95	30-43	10-20	0.2-0.6	0.21-0.23	5.6-6.5	Moderate	High	Moderate.
100	100	95-100	90-98	37-65	15-38	<0.06	0.11-0.13	6.6-7.3	High	Very high	Low.
100	100	100	95-100	50-75	30-55	<0.06	0.11-0.14	5.1-8.4	Very high	High	Moderate.
100	100	96-100	85-95	20-37	1-12	0.6-2.0	0.22-0.24	6.1-7.8	Low	High	Moderate.
100	100	96-100	85-99	50-70	30-40	<0.06	0.09-0.11	5.6-6.0	High	Very high	Moderate.
100	100	96-100	85-99	45-65	25-35	<0.06	0.06-0.07	5.6-6.0	High	Very high	Moderate.
100	100	96-100	85-95	30-45	10-25	0.6-2.0	0.22-0.24	6.6-7.8	Moderate	Low	Low.
100	100	94-100	75-90	30-45	8-20	0.6-2.0	0.20-0.22	6.1-7.3	Moderate	Low	Low.
100	100	96-100	75-90	30-45	8-20	0.6-2.0	0.20-0.24	5.6-7.3	Moderate	Low	Low.
100	100	95-100	90-95	50-70	25-40	<0.06	0.10-0.14	5.6-7.3	High	High	Low.

embankment are the engineering properties of the embankment material as interpreted from the Unified Soil Classification and the amount of stones, if any, that influence the ease of excavation and compaction of the embankment material.

Shallow excavations are those that require digging or trenching to a depth of less than 6 feet, 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 absence of a high water table.

Dwellings 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 settling under load, and those that relate to ease of excavation. Soil properties that affect capacity to support load are wetness, susceptibility to

flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

Sanitary landfill is a method of disposing of refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil. 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 limitations apply only to the soil material to a depth of about 6 feet, so a limitation 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; nevertheless, every site should be investigated before it is selected.

Roads and streets have an all-weather surface expected to carry automobile traffic all year. They have a

TABLE 7.—*Interpretations of*

["Seepage" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basement	Sanitary landfill	Roads and streets
Balltown: BaD -----	Severe: shallow to bedrock.	Severe: shallow to bedrock; seepage.	Severe: shallow to bedrock.	Severe: shallow to bedrock.	Severe: shallow to bedrock; seepage.	Severe: shallow to bedrock.
Barco: BcB, BcB2, BcC, BcC2.	Severe: bedrock at a depth of 20 to 40 inches	Severe: bedrock at a depth of 20 to 40 inches.	Moderate: rippable bedrock at a depth of 20 to 40 inches.	Moderate: rippable bedrock at a depth of 20 to 40 inches; moderate shrink-swell potential.	Moderate: rippable bedrock at a depth of 20 to 40 inches.	Moderate: rippable bedrock at a depth of 20 to 40 inches; moderate shrink-swell potential.
Barden: BdB, BdB2 -----	Severe: slow permeability; seasonal perched water table.	Moderate: slopes are 1 to 5 percent.	Severe: too clayey; seasonal perched water table.	Severe: high shrink-swell potential.	Moderate: seasonal perched water table.	Severe: high shrink-swell potential; low strength.
Bolivar: BoB, BoB2, BoC, BoC2.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Moderate: rippable bedrock at a depth of 20 to 40 inches.	Moderate: rippable bedrock at a depth of 20 to 40 inches; moderate shrink-swell potential.	Moderate: rippable bedrock at a depth of 20 to 40 inches.	Moderate: rippable bedrock at a depth of 20 to 40 inches; moderate shrink-swell potential.
Bronaugh: BsB -----	Slight -----	Moderate: seepage; slopes are 2 to 5 percent.	Slight -----	Moderate: moderate shrink-swell potential.	Moderate: seepage.	Moderate: low strength; moderate shrink-swell potential.
Cleora: Ce -----	Severe: floods.	Severe: floods; moderately rapid permeability.	Severe: floods; cut-banks cave.	Severe: floods.	Severe: floods; moderately rapid permeability.	Severe: floods.
Coweta: CoC, CrD -----	Severe: shallow to weathered bedrock.	Severe: shallow to weathered bedrock.	Moderate: slopes are 5 to 14 percent; shallow to weathered bedrock.	Moderate: slopes are 2 to 14 percent; shallow to weathered bedrock.	Severe: shallow to weathered bedrock.	Moderate: slopes are 2 to 14 percent; shallow to weathered bedrock.
Dubbs: DuB -----	Moderate: moderate permeability.	Moderate: moderate permeability.	Slight -----	Moderate: moderate shrink-swell potential.	Slight -----	Moderate: moderate shrink-swell potential.
Eldon variant: EdD ---	Moderate: bedrock at a depth of 48 to 60 inches.	Severe: small stones; seepage.	-----	Moderate: moderate shrink-swell potential.	Severe: bedrock at a depth of 48 to 60 inches.	Moderate: moderate shrink-swell potential.

engineering properties of the soils

definitions of "slight," "moderate," "good," "fair," and other terms used to express the degree of limitation or suitability]

Suitability as a source of—		Soil features affecting—				
Road fill	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions
Poor: thin layer; high content of clay.	Poor: thin layer; large stones.	Shallow to bedrock; moderate permeability.	Limited borrow material; medium compressibility; large stones.	Not needed -----	Slopes are 0 to 20 percent; shallow rooting depth; very low available water capacity.	Shallow to bedrock; slopes are 9 to 20 percent.
Fair: moderate shrink-swell potential; thin layer.	Fair: less than 16 inches of good material.	Moderate permeability; bedrock at a depth of 20 to 40 inches; seepage along bedrock.	Limited borrow material; susceptible to piping; medium to low shear strength.	Not needed -----	Medium to low available water capacity; slopes are 2 to 9 percent; moderate rooting depth.	Moderate depth to bedrock; moderate rooting depth; susceptible to piping.
Poor: high shrink-swell potential; low strength.	Fair: less than 16 inches of good material.	All features favorable.	High shrink-swell potential; medium to low shear strength; high compressibility.	Slow permeability; needed only in seepy areas.	Slopes are 1 to 5 percent; high available water capacity; slow intake rate.	All features favorable.
Fair: moderate shrink-swell potential; thin layer.	Fair: less than 16 inches of good material.	Moderate permeability; bedrock at a depth of 20 to 40 inches; seepage along bedrock.	Limited borrow material; fair to good compaction; low compacted permeability.	Not needed -----	Low available water capacity; moderate rooting depth; fast intake rate; slopes are 2 to 9 percent.	Moderate depth to bedrock; moderate rooting depth; susceptible to piping.
Fair: low strength; moderate shrink-swell potential.	Poor: less than 8 inches of good material.	Moderate permeability; seepage along bedrock.	Medium compressibility; medium to low shear strength; low compacted permeability.	Not needed -----	High available water capacity; erodes easily; slopes are 2 to 5 percent.	All features favorable.
Good -----	Poor: too sandy.	Moderately rapid permeability; floods.	Susceptible to piping; fair to good compaction; medium shear strength.	Not needed -----	Medium available water capacity; fast intake rate; floods.	Not needed.
Poor: shallow to weathered bedrock.	Fair: thin layer; stony in places.	Shallow to bedrock; moderate permeability.	Limited borrow material; susceptible to piping; fair to good compaction.	Not needed -----	Shallow rooting depth; very low available water capacity; slopes are 2 to 14 percent.	Shallow to bedrock; slopes are 2 to 14 percent.
Fair: moderate shrink-swell potential; low strength.	Fair: less than 16 inches of good material.	Moderate permeability; sand layers may occur in substratum.	Fair to good compaction; susceptible to piping; unstable fill.	Not needed -----	Slopes are 2 to 5 percent; high available water capacity.	All features favorable.
Fair: moderate shrink-swell potential; small stones.	Poor: 30 to 65 percent coarse fragments.	Bedrock at a depth of 50 to 60 inches; seepage along bedrock.	Medium to low shear strength; fair compaction; low compacted permeability.	Not needed -----	Slopes are 5 to 14 percent; low available water capacity.	30 to 65 percent coarse fragments; slopes are 5 to 14 percent.

TABLE 7.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basement	Sanitary landfill	Roads and streets
Hector: HcD, HeD, HeE.	Severe: shallow to bedrock; large stones.	Severe: shallow to bedrock; seepage.	Severe: shallow to bedrock; large stones.	Severe: shallow to bedrock; large stones.	Severe: shallow to bedrock; lateral seepage.	Severe: shallow to bedrock; large stones.
Hepler: Hm, Hp, Hr For Radley part of Hr, see Radley series.	Severe: floods; seasonal high water table.	Severe: floods; slight if protected by levee.	Severe: floods; seasonal high water table.	Severe: floods.	Severe: floods.	Severe: floods; seasonal high water table.
Lanton: La	Severe: floods; slow permeability.	Severe: floods; slight if protected by levees.	Severe: floods; seasonal high water table.	Severe: floods; seasonal high water table.	Severe: floods.	Severe: floods; seasonal high water table.
Liberal: LeB, LmC2, LoD. For Barco and Coweta parts of LoD, see those series.	Severe: slow permeability.	Moderate: bedrock at a depth of 40 to 60 inches.	Severe: too clayey; seasonal high water table.	Severe: high shrink-swell potential.	Severe: too clayey; rippable bedrock at a depth of 40 to 60 inches.	Severe: high shrink-swell potential.
Lula: LuB	Moderate: bedrock at a depth of 40 to 60 inches.	Moderate: bedrock at a depth of 40 to 60 inches; moderate permeability.	Moderate: bedrock at a depth of 40 to 60 inches.	Moderate: low strength; moderate shrink-swell potential.	Severe: hard bedrock at a depth of 40 to 60 inches.	Moderate: low strength; moderate shrink-swell potential.
Mayes: Ma	Severe: very slow permeability.	Slight	Severe: too clayey; seasonal perched water table.	Severe: high shrink-swell potential; seasonal perched water table.	Severe: seasonal perched water table; too clayey.	Severe: low strength; high shrink-swell potential.
Mine pits and dumps: Mp. No interpretations made; properties too variable.						
Osage: Os	Severe: floods; very slow permeability.	Severe: floods; slight if protected by levees.	Severe: floods; too clayey; seasonal high water table.	Severe: floods; high shrink-swell potential; seasonal high water table.	Severe: floods; too clayey; seasonal high water table.	Severe: floods; high shrink-swell potential; seasonal high water table.
Parsons: Pa	Severe: very slow permeability.	Slight	Severe: too clayey; seasonal perched water table.	Severe: high shrink-swell potential; seasonal perched water table.	Severe: seasonal perched water table; too clayey.	Severe: high shrink-swell potential; seasonal perched water table.

properties of the soils—continued

Suitability as a source of—		Soil features affecting—				
Road fill	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions
Poor: thin layer; large stones.	Poor: thin layer; large stones.	Shallow to bedrock; seepage along bedrock; moderately rapid permeability.	Limited borrow material; large stones; susceptible to piping.	Not needed -----	Slopes are 5 to 30 percent; very low available water capacity; shallow rooting depth.	Shallow to bedrock; rock outcrops; slopes are 5 to 30 percent; stony areas.
Poor: floods; seasonal high water table.	Good -----	Subject to flooding; nearly level slopes; moderately slow permeability.	Medium to low shear strength; fair to good compaction; susceptible to piping.	Subject to flooding; moderately slow permeability; seasonal high water table.	Floods; seasonal high water table; very high available water capacity.	Not needed.
Poor: high shrink-swell potential; seasonal high water table.	Poor: poorly drained.	Subject to flooding; nearly level slopes; slow permeability.	Fair to good compaction; medium to low shear strength; low compacted permeability.	Subject to flooding; slow permeability; surface ponding.	Floods; slow intake rate; high available water capacity.	Not needed.
Poor: high shrink-swell potential.	Fair: too clayey.	Slopes are 2 to 9 percent; slow permeability; shale bedrock at a depth of 40 to 60 inches.	Fair compaction; medium to low shear strength; low compacted permeability.	Slow permeability; slopes are 2 to 9 percent; drainage needed in seepy areas.	Slow intake rate; erodes easily; slopes are 2 to 9 percent.	Erodes easily; many knobs and saddles in landscape; slopes are 2 to 9 percent.
Fair: low strength; moderate shrink-swell potential.	Fair: less than 16 inches of good material.	Limestone bedrock at a depth of 40 to 60 inches; moderate permeability; seepage along bedrock.	Fair to good compaction; medium to low shear strength; low compacted permeability.	Not needed -----	Slopes are 2 to 5 percent; moderate intake rate; moderate available water capacity.	All features favorable.
Poor: high shrink-swell potential; low strength.	Fair: too clayey.	Nearly level slopes; very slow permeability.	Medium to low shear strength; medium to high compressibility; unstable fill.	Very slow permeability; surface ponding; receives runoff in places.	Slow intake rate; moderate available water capacity; surface ponding.	Not needed.
Poor: high shrink-swell potential; seasonal high water table.	Poor: too clayey; poorly drained.	Nearly level slopes; very slow permeability; floods.	Very high shrink-swell potential; high compressibility; fair to low compaction.	Subject to flooding; very slow permeability; surface ponding.	Slow intake rate; floods; moderate available water capacity.	Not needed.
Poor: high shrink-swell potential; low strength.	Fair: less than 16 inches of good material.	Nearly level slopes; very slow permeability.	High compressibility; medium to low shear strength; unstable fill.	Very slow permeability; seasonal perched water table; shallow to claypan.	Slow intake rate; shallow to claypan; moderate available water capacity.	Not needed.

TABLE 7.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basement	Sanitary landfill	Roads and streets
Radley: Ra, RpE3 ----- For Barden and Parsons parts of RpE3, see those series.	Severe: floods. Slight if protected by levees.	Severe: floods. Moderate if protected by levees; moderate permeability.	Severe: floods. Slight if protected by levees.	Severe: floods.	Severe: floods.	Severe: floods.
Verdigris: Ve -----	Severe: floods. Slight if protected by levees.	Severe: floods. Moderate if protected by levees; moderate permeability.	Severe: floods. Slight if protected by levees.	Severe: floods.	Severe: floods.	Severe: floods.
Zaar: ZaB, ZaC -----	Severe: very slow permeability.	Moderate where slopes are 2 to 7 percent. Severe where slopes are 7 to 9 percent.	Severe: too clayey; wet.	Severe: high shrink-swell potential; low strength.	Severe: too clayey; bed-rock is at a depth of less than 72 inches in places.	Severe: low strength; high shrink-swell potential.

subgrade of underlying soil material; a base 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, stability of 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.

Road fill is soil material used in embankments for roads. The suitability ratings reflect (1) the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage and (2) the relative ease of excavating the material at borrow areas.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as in preparing a seedbed; natural fertility of the material or plant response when fertilizer is added to the soil; and absence of substances toxic to plants. Texture of the soil material and its content of stone fragments affect suitability, and also considered in the ratings is damage that can result at the area from which topsoil is taken.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to their permeability and depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage and piping and that is of favorable stability, shrink-swell potential, shear strength, and compactibility. Stones or organic material in a soil are among factors that are unfavorable.

Drainage of cropland and pasture is affected by such soil properties as permeability, texture, and structure; depth to claypan, rock, or other layers that influence rate of water movement; depth to the water table; slope; stability in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage.

Irrigation of a soil is affected by such features as slope; susceptibility to stream overflow, water erosion, or soil blowing; soil texture; content of stones; accumulation of salts and alkali; depth of root zone; rate of water intake at the surface; permeability 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,

properties of the soils—continued

Suitability as a source of—		Soil features affecting—				
Road fill	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions
Fair: low strength.	Fair: too clayey.	Nearly level slopes; moderate permeability; floods.	Susceptible to piping; medium compressibility; medium to low shear strength.	Not needed -----	Floods; very high available water capacity.	Not needed.
Fair: low strength.	Good -----	Nearly level slopes; moderate permeability; floods.	Low shear strength; susceptible to piping; medium compressibility.	Not needed -----	Floods; very high available water capacity.	Not needed.
Poor: high shrink-swell potential; low strength.	Poor: too clayey.	Slopes are 2 to 9 percent; bedrock at a depth of 45 inches or more.	Low shear strength; high shrink-swell potential; fair to poor compaction.	Very slow permeability; slopes are 2 to 9 percent; needed only in seepy areas.	Slow intake rate; slopes are 2 to 9 percent; moderate available water capacity.	Slopes are 2 to 9 percent; high clay content; very slow permeability.

and soil blowing. A soil suitable for these structures provides outlets for runoff, and establishing a plant cover is not difficult on such a soil.

Formation and Classification of Soils

This section discusses how the factors of soil formation have affected the development of soils in Vernon County. It also explains the current system of soil classification, and it places the soil series represented in the county in higher categories of this classification.

Factors of Soil Formation

Soil is produced by soil-forming processes acting on material deposited or accumulated by geologic forces. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time the forces of soil formation have acted on the soil material.

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

the parent material into a soil profile. It may be little or much, but some time is always required for horizon differentiation. Usually a long time is required for the development of distinct horizons.

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

Parent material

Parent material is the unconsolidated and more or less chemically weathered mineral material from which a soil is formed. Most parent materials in Vernon County are at the original site. They formed in residual material weathered from bedrock. In many places, especially on high wide divides, loess, a windblown material, thinly mantles these residues. Sediments washed from the nearby uplands were deposited on the flood plains of streams. These deposits make up the part of the parent material that has been transported by water.

Pennsylvania age rocks underlie almost all of the surficial deposits of Vernon County. Older Mississippian age rocks underlie less than 1 percent of the county, mostly along Clear Creek on the east side of the county close to the county line. These rocks are part of the Burlington-Keokuk Formation. They are mainly cherty limestone. Eldom cherty loam is the only soil mapped in Vernon County that formed in material weathered from these rocks.

All of the Pennsylvanian strata in Vernon County

are assigned to the Cherokee and Marmaton Groups of the Desmoinesian Series. The Cherokee Group is at the base of the Pennsylvania System and consists of cyclic deposits of sandstone, siltstone, shale, clay, limestone, and coal beds. The limestone deposits are few and thin, where they occur. Because of the prevailing dip to the northwest, the lowest part of the Pennsylvanian System is exposed on the east side of the county. Because the lower part of the Cherokee Group is chiefly sandstone, the soils in the eastern part of the county were derived mostly from sandstone. The Barco, Coweta, Bolivar, and Hector series are common in that part of the county. Because the upper part of the Cherokee Group is chiefly shale and some clay, the silt loam soils of the Parsons and Barden series formed in residues weathered from this material.

The Marmaton Group lies above the Cherokee and is exposed mostly in the northwest corner of the county. This group consists mostly of limestone, clayey shale, and thin beds of sandstone. Soils of the Lula series formed in material weathered from limestone, and soils of the Zaar series formed in material weathered from both limestone and shale.

The characteristics of the soils of Vernon County have been influenced by the parent material. In some instances, soil and parent material are very similar in texture, structure, and chemical and mineralogical composition. The young and shallow Coweta and Hector soils that were derived from sandstone are good examples. Radley and Verdigris soils formed in recent stream deposits. Another example is the Zaar series. It is high in calcium and is derived from limestone and shale that is rich in calcium. In all of these examples, the kind and nature of the parent material greatly influenced the character of the soils that were formed.

Climate

Climate is one of the active factors in soil formation. It influences both the chemical and physical weathering processes and the biological forces at work in the parent material. Vernon County is subject to rapid changes of temperature, precipitation, cloudiness, and wind. The downward movement of water transforms the parent material into a soil that has distinct horizons. The amount of water that percolates through the soils depends mainly on temperature, type and intensity of precipitation, relief, and nature of the soil material.

Soil-forming processes are most active when the soil is warm and moist. In Vernon County they are most active during the warmer months. Freezing, thawing, and drying speeds up soil formation. Soil structure is modified by freezing and thawing. When wet clays freeze and thaw, they tend to form soil into aggregates. Wetting and drying also creates soil structure.

Climate is an important factor in causing differences in soils over a wide region, but differences in soils as a consequence of climate in as small an area as Vernon County are slight.

Plant and animal life

Plants and animals living on or in the soil are active in the soil-forming process. They furnish organic matter to the soil and bring up plant nutrients from underlying layers to the surface layer. As plants die and decay they contribute organic matter to the soil. Bac-

teria and fungi promote the decomposition of plant remains and the incorporation of organic matter into the soil. This organic matter modifies the color, structure, and other properties of the soil both chemically and physically. Burrowing animals loosen the soil, mix various soil horizons, and bring some fresh material into the surface layer.

Most soils in Vernon County formed under tall prairie grasses. Deciduous trees bordered the streams and covered about 20 percent of the land. The root growth and mineral composition of tall prairie grasses and deciduous trees are quite different. There is also a marked difference in the micro-organisms and animals that are associated with each.

Under trees, the accumulating organic matter is mixed with the upper part of the surface layer. The surface layer is less than 6 inches thick, and commonly it is less than 4 inches thick. A thicker, leached, lighter colored subsurface layer of brown, yellowish brown, or grayish brown that has platy structure is formed. It is underlain by a subsoil that is brighter colored, finer textured, and has blocky structure. The nitrogen supply, fertility level, and organic-matter content are low.

Soils that formed under trees are commonly called "light-colored timbered soils." Bolivar, Hector, and Dubbs soils are examples of this group.

The rest of the soils in the county formed under grass or a mixture of grass and trees. In soils that formed under grass, organic matter accumulates faster and the total content is greater than it is under trees. The organic matter is thoroughly mixed with the mineral material of the surface layer. The resulting thick, dark-colored surface layer has granular structure. In the subsoil, organic stains and films partly or completely coat the blocky peds. In most places, the subsoil has a finer texture than the surface layer. The dark color extends from the surface to a depth of about 6 inches in eroded Barden and Barco soils. In Osage, Lanton, and Verdigris soils it extends to a depth of more than 24 inches. The nitrogen supply and organic-matter content are moderate to high. Natural fertility is medium to high.

Soils that formed under grass are commonly called "dark-colored prairie soils." They were free of trees and ready for the first men to plow and plant.

Man has greatly changed the soils in many ways. The kind of vegetation has been changed and crops have been planted. Erosion in sloping areas and deposition on the flood plains have been increased by cultivating the soils. In some places much of the original surface layer has been washed away and material from the subsoil mixed with the remaining surface layer by plowing. This has changed the texture and color of the surface layer. The natural condition of the soils has been changed. Wet soils have been drained, sloping soils terraced, lime has been applied to acid soils, and large amounts of fertilizer have been applied. A new cycle of soil formation has begun where soils are strip mined or where soil profiles have been destroyed by much grading or covered by much filling.

Relief

Although climate and vegetation are the most active factors in changing parent material into soil, the relief, or lay of the land, modifies the change. Relief

influences drainage, runoff, temperature, and other related factors, including accelerated erosion.

The topographic features of the county are controlled by the geologic structure and the relative resistance of the bedrock to weathering and erosion. Consequently most of the soils over thick beds of shale, such as the Parsons soil, are nearly level and have long and uniform slopes. Normal relief of shorter, somewhat broken, and steeper slopes is typical of the soils derived from sandstone—the Barco and Bolivar soils. The sloping to steep Hector and Coweta soils are also derived from sandstone. They have normal to excessive relief and include most of the rough and broken land along the streams.

Large areas in Vernon County have subnormal relief. During soil formation, runoff was slow or very slow. Excess water kept the soil and parent material wet during much of the year. Under native vegetation there was almost no erosion. During this time clay moved downward and accumulated below a very strongly acid surface layer. Subnormal relief hastened the process, and a very large amount of clay was translocated. As a result, prominent dark clay accumulations abruptly underlie bleached, severely leached, silty subsurface layers. Soils of the Parsons series are good examples.

Most of the soils formed in areas of normal relief, where climate and the other factors influencing soil formation were neither hastened nor delayed. The Barden, Liberal, Lula, Bronaugh, and Dubbs series are good examples of mature soils that formed in areas of normal relief.

Time

Time is necessary for the formation of soil from parent material, but the length of time required is largely dependent on the combined action of the other soil-forming factors. Soils that have little or no horizon development are immature, while those that have distinct, well-expressed horizons are mature. On slopes where geologic erosion is rapid, soils may be in the early stages of development even though the slopes have been exposed to weathering for thousands of years. Horizon development generally is faster in a humid climate that supports good vegetation than in a dry climate that supports little vegetation. Also, it is generally faster under forest vegetation than under prairie vegetation. More time is required if the parent material is fine textured than if it is coarse textured, because water percolates slowly through the fine-textured material and the consequent leaching of soluble minerals and fine particles from the surface layer is slower.

Soils in Vernon County range in age from very young to very old. Radley and Verdigris soils, which were derived from local alluvium, are examples of young soils that have little horizon development. Except for the darkening of the surface layer by accumulated organic matter, these soils have most of the characteristics of the parent material. Hector, Coweta, and Balltown soils are also young in horizon development. They formed on steep slopes where soil materials have been weathering for thousands of years, but erosion has removed soil material as it formed.

Parsons soils formed in clay and clayey shale on nearly level topography. They show the most development of any soil in the county. The very strongly acid surface

layer and the thick, distinct clay layers of the subsoil show that these soils have been developing for many thousands of years. The rest of the soils in the county have had time to mature. Their profiles reflect the conditions under which they formed.

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 comparison in large areas such as countries and continents.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Because this system is under continual study, readers interested in developments of the current system should search the latest literature available (5, 7).

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped. In table 8 the soil series of Vernon County are placed in three 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* (Moll-i-sol).

SUBORDER. Each order is divided 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 to 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 *Udoll* (*Ud* meaning humid climate, and *oll*, from Mollisol).

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 the growth of roots, movement of water, or both; and thick, dark-colored surface hori-

TABLE 8.—*Classification of the soils*

Soil series	Family	Subgroup	Order
Balltown	Loamy-skeletal, mixed, thermic	Lithic Hapludolls	Mollisols.
Barco	Fine-loamy, mixed, thermic	Mollic Hapludalfs	Alfisols.
Barden	Fine, mixed, thermic	Aquollic Hapludalfs	Alfisols.
Bolivar	Fine-loamy, mixed, thermic	Ultic Hapludalfs	Alfisols.
Bronaugh	Fine, mixed, thermic	Mollic Hapludalfs	Alfisols.
Cleora	Coarse-loamy, mixed, thermic	Fluventic Hapludolls	Mollisols.
Coweta	Loamy, siliceous, thermic, shallow	Typic Hapludolls	Mollisols.
Dubbs ¹	Fine-silty, mixed, thermic	Typic Hapludalfs	Alfisols.
Eldon variant	Clayey-skeletal, mixed, thermic	Typic Argiudolls	Mollisols.
Hector	Loamy, siliceous, thermic	Lithic Dystrachrepts	Inceptisols.
Hepler	Fine-silty, mixed, thermic	Udolic Ochraqualfs	Alfisols.
Lanton	Fine-silty, mixed, thermic	Cumulic Haplaquolls	Mollisols.
Liberal	Fine, mixed, thermic	Aquollic Hapludalfs	Alfisols.
Lula	Fine-silty, mixed, thermic	Typic Argiudolls	Mollisols.
Mayes	Fine, montmorillonitic, thermic	Vertic Argiaquolls	Mollisols.
Osage	Fine, montmorillonitic, thermic	Vertic Haplaquolls	Mollisols.
Parsons	Fine, mixed, thermic	Mollic Alfaqualfs	Alfisols.
Radley	Fine-silty, mixed, thermic	Fluventic Hapludolls	Mollisols.
Verdigris	Fine-silty, mixed, thermic	Cumulic Hapludolls	Mollisols.
Zaar	Fine, montmorillonitic, thermic	Vertic Hapludolls	Mollisols.

¹ These soils are taxadjuncts to the Dubbs series because they are fine-loamy and have approximately 5 percent more sand coarser than very fine sand in the control section.

zons. The features used are the self-mulching properties of clay, soil temperature, major differences 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 *Argiudol* (*Arg*, meaning clay accumulation, *ud* for humid climate, and *oll*, from Mollisol).

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 Argiudolls (a typical Argiudoll).

FAMILY. Soil families are separated within a subgroup primarily on the basis of properties important to the growth of plants or 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 differentiae. An example is the fine-silty, mixed, thermic family of Typic Argiudolls.

Environmental Factors Affecting Soil Use

Vernon County was formerly the southern part of Bates County. It was organized in 1855, and Nevada

was selected as the county seat. The early settlers located in the tree-covered upland areas near the larger streams. There, game and water were plentiful. Timber was available for buildings, fences, and fuel. The cattle and work animals grazed the nearby prairie.

Settlement progressed slowly at first because of border troubles and the Civil War. After the Civil War, population and farming increased rapidly and coal mining became an important industry. Coal mining has since declined, and very little coal is now mined. Farming has increased steadily in importance.

The population trend of the county is downward. Since 1920, it has declined by more than 5,000. In 1970, there were 19,065 people in Vernon County and 9,736 in Nevada, the largest city. This represents about a 7 percent decrease in total county population and about a 15 percent increase in the city of Nevada since 1960.

Farming has always been the most important enterprise in Vernon County. Much progress has been made in recent years, and the potential for further development is great.

The total land area of the county is 536,320 acres. An estimated 21,522 acres is in urban, or built up areas. In 1969, there were 1,711 farms in Vernon County, and the average size was 272 acres. In 1964, there were 1,789 farms averaging 256 acres.

Most farmers prefer the nearly level and gently sloping areas near the crests of divides that separate the watersheds of the major streams. Here cash-grain commercial farms are most common and large machines are economical and efficient to use. The main crops are corn, soybeans, wheat, and grain sorghum. Many farmers use their crops for cattle and hog feed. In the more rolling parts of the county closer to the streams, farming is more diversified. Similar crops are grown but small grain, grass, and legumes make up a greater part of the total production. Cattle produced mostly on forage are sold as feeders. Many farmers use their

corn and grain as feed for cattle and hogs. Wheat and soybeans are sold for cash. The sale of dairy products is also important.

Farming is becoming more intensive as farms become larger and fewer in number. Adapted varieties of grain and forage crops are planted, and they are limed and fertilized for high production on many farms. Each year more farmers use chemicals for plant disease prevention and weed and insect control. Many farmers are providing the necessary drainage and erosion control. Well managed, intensive, highly specialized crop production is increasing.

Water is available to farmers and others in rural areas from deep wells that have been developed by the Vernon County Public Water District. More water can be obtained by developing other wells and impoundments that trap the surface water. There are also potentials for the development of water supplies for supplemental irrigation.

Relief and Drainage

Most of Vernon County is a low plain that slopes from an elevation of about 850 feet in the southwest to an elevation of 750 feet in the northeast corner. The northwest and southeast corners are slightly higher areas that slope toward the center. The high area in the northwest ranges in elevation from 850 to 900 feet, and the one in the southeast ranges from 950 to 1,000 feet. Scattered over the central plain are several high mounds, conspicuous on the landscape for many miles. Walker Mound, Timber Hill, Howard Mound, Blue Mound, and the mounds between Moundville and Bronaugh are the most prominent.

The drainage pattern follows the general relief of the county. Streams generally flow from the higher southwest part to the lower northeast part. The main stream is the Marmaton River, which enters the west central part of the county, flows generally northeasterly, and enters the Osage River. The Osage River is the north boundary in the northeast part of the county. The main tributaries of the Marmaton River are the Little Osage River, which drains the northwest corner of the county, and Drywood and Little Drywood Creeks, which drain the southwest part of the county. The southeast is drained mostly through Clear Creek, which eventually flows into the Osage River.

Climate ⁴

The data used in preparing this section were recorded at Nevada, Missouri for the years 1941 to 1970. The elevation at Nevada is about 780 feet above mean sea level.

Nevada has a typical warm continental-type climate characterized by frequent and often extreme changes in temperature, humidity, cloudiness, and winds. Seasonal characteristics are well defined, but changes between seasons are usually gradual.

Temperature and precipitation data are given in table 9. Table 10 shows the probabilities for freezing temperatures in spring and fall.

⁴ By WARREN M. WISNER, former State climatologist for Missouri, National Weather Service, U.S. Department of Commerce.

Winters in Vernon County are generally mild and short. Colder spells last only a few days. Long periods of severe cold or heavy snow are infrequent. Precipitation is generally infrequent and light.

Spring has the most variable weather. Large daily temperature changes result from the competition between the lingering winter air masses from the north and the warm humid air mass from the Gulf of Mexico. The clash between these contrasting air masses makes this the season of the greatest number of severe local storms.

Summers are generally long and warm. The average length of the growing season is about 195 days. At times, hot humid weather persists for periods of two weeks or longer, but it is usually broken by thunderstorm activity after a short time. From late June until early September there are sometimes extended dry spells, because a sustained southwesterly wind brings in hot dry air from the Texas Panhandle.

Autumn has mild pleasant days and cool nights. In September rainshower activity increases as the invading cool northern air pushes out the warm air masses from the south. These soaking rains replenish the soil moisture needed for establishing and maintaining winter grains and pastures.

The records for Nevada indicate that the temperature exceeds 100° F about 6 years in 10, but only in half of those cases the high temperature lasts for 3 or 4 days in a row. The summer of 1954 was exceptionally hot; temperatures in July and August averaged 87.5° F. The coolest summer between 1941 and 1970 was in 1950 when July and August averaged only 72.5° F. The generally mild winters are characterized by occasional days of biting cold when temperatures are near or below zero. Only three times in the past 30 years has the temperature dropped below zero for five consecutive days.

Nevada's average of 40.5 inches of precipitation each year is uniformly distributed through the growing season. Thirty percent of the precipitation falls in spring; 33 percent falls in summer; 25 percent falls in autumn; and 12 percent occurs in winter. Only 1 year in 10 will receive less than 27 inches of precipitation or more than 51 inches. Monthly rainfall has ranged from 0 inches in November 1950 and 1955 and July 1970 to 18.28 inches in July 1958.

Snowfall averages 13 inches a year, but it usually snows only three or four times a season and the snow melts quickly. In 1958, 37 inches of snow fell, and it snowed 10 times during the season. In 1950, only 1 inch of snow fell. January is the snowiest month, averaging about 3½ inches; but the heaviest single snowstorm was in November 1951, when almost 19 inches fell in a 24-hour period.

Severe local storms occur mainly during the spring when the contrast between the conflicting air masses is the greatest. Since 1916, 13 tornadoes have occurred in Vernon County. Lightning displays associated with thunderstorms are sometimes quite destructive. Hail and strong damaging winds associated with severe thunderstorms occur almost every year in some part of the county. Fortunately, the greatest likelihood of hail is during spring when it is the least damaging to developing field crops.

The column "Average heating degree days" in table

TABLE 9.—*Temperature and*
[Recorded at Nevada during a 30-year

Month	Temperature					Average number of heating degree days ¹	Precipitation
	Average daily maximum	Average daily minimum	Average	Record high	Record low		Rainfall
						Average	Average
	°F	°F	°F	°F	°F		In
January -----	44.3	21.7	33.0	77	-19	993	1.43
February -----	49.7	26.0	37.8	82	-12	767	1.78
March -----	57.7	32.6	45.1	89	-9	620	2.77
April -----	71.1	45.4	58.2	92	19	240	4.03
May -----	78.8	54.7	66.7	97	27	73	5.12
June -----	86.5	63.6	75.0	106	44	7	5.68
July -----	91.7	67.0	79.3	116	45	0	3.75
August -----	91.6	65.4	78.5	109	43	1	3.90
September -----	84.0	57.7	70.9	108	29	31	4.86
October -----	74.3	47.0	60.6	96	18	190	3.44
November -----	58.9	34.2	46.6	82	3	557	1.99
December -----	47.3	25.5	36.4	77	-12		1.82
Year -----	69.7	45.2	57.4	116	-19	4365	40.58

¹ Based on a temperature of 65°F and computed from average monthly temperatures. These data show relative heating requirements for dwellings.

TABLE 10.—*Probability of freezing temperatures*
[At Nevada]

Probability	Dates for probable temperature of—				
	16° F or lower	20° F or lower	24° F or lower	28° F or lower	32° F or lower
Spring:					
1 year in 10 later than -----	March 26	April 2	April 9	April 25	May 3
2 years in 10 later than -----	March 19	March 28	April 4	April 20	April 27
5 years in 10 later than -----	March 8	March 18	March 26	April 11	April 17
Fall:					
1 year in 10 earlier than -----	November 8	November 1	October 20	October 15	October 2
2 years in 10 earlier than -----	November 14	November 7	October 26	October 20	October 8
5 years in 10 earlier than -----	November 25	November 18	November 6	October 29	October 19

9 provides a comparative number, or average, for calculating relative heating requirements for dwellings. Fuel consumption for heating is proportional to total degree days, that is, a month that has twice as many degree-days as another month requires twice as much fuel for heating.

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- (3) Lemmon, Paul E. 1958. Soil interpretations for woodland conservation. 1st North Am. Forest Soils Conf. Proc.: 153-158.
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precipitation data

period. The symbol < means less than]

Precipitation—Continued				Average number of days that have—				
Rainfall— Continued	Snow and sleet			Precipitation of 0.10 inch or more	Minimum temperature of—		Maximum temperature of—	
	Average	Maximum during month	Maximum during 24- hour period		90° F and above	2° F and below	Between 0° F and 32° F	0° F and below
In	In	In	In					
1.81	3.4	13.0	12.0	3	0	6	26	2
2.62	2.9	11.0	6.0	4	0	3	20	^a
2.80	2.7	15.0	10.0	6	0	1	16	^a
4.18	<.5	3.0	3.0	7	^a	0	^a	0
4.08	0	0	0	8	2	0	0	0
5.42	0	0	0	7	10	0	0	0
4.43	0	0	0	5	20	0	0	0
4.29	0	0	0	5	20	0	4	0
5.18	0	0	0	6	8	0	^a	0
3.40	0	0	0	5	1	^a	3	0
4.56	1.0	22.7	18.9	4	0	^a	14	0
1.85	3.0	16.0	11.0	4	0	3	24	1
5.42	13.0	22.7	18.9	64	61	13	107	3

^a Less than one-half day.

Glossary

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field 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.

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.

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.

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 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.

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.

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 residue.

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 those. 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.

Loess. Fine-grained material, dominantly of silt-sized particles, that has been deposited by wind.

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.

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, rapid, and very rapid*.

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.

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

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is 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 degree of acidity or alkalinity are expressed thus:

	pH		pH
Extremely acid	-----Below 4.5	Mildly alkaline	-----7.4 to 7.8
Very strongly acid	---4.5 to 5.0	Moderately	
Strongly acid	-----5.1 to 5.5	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	
Neutral	-----6.6 to 7.3	alkaline	-----9.1 and higher

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.

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.

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.

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.

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.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and the description of the soil series to which the mapping unit belongs. In referring to a capability unit, read the introduction to the section for general information about its management.

Map symbol	Mapping unit	Page	Capability unit	
			Symbol	Page
BaD	Balltown flaggy silty clay loam, 9 to 20 percent slopes-----	8	VIIIs-8	35
BcB	Barco loam, 2 to 5 percent slopes-----	9	IIe-4	32
BcB2	Barco loam, 2 to 5 percent slopes, eroded-----	9	IIIe-7	33
BcC	Barco loam, 5 to 9 percent slopes-----	10	IIIe-4	32
BcC2	Barco loam, 5 to 9 percent slopes, eroded-----	10	IVe-7	34
BdB	Barden silt loam, 1 to 5 percent slopes-----	11	IIe-5	32
BdB2	Barden silt loam, 1 to 5 percent slopes, eroded-----	11	IIIe-5	33
BoB	Bolivar fine sandy loam, 2 to 5 percent slopes-----	12	IIIe-7	33
BoB2	Bolivar fine sandy loam, 2 to 5 percent slopes, eroded-----	13	IVe-7	34
BoC	Bolivar fine sandy loam, 5 to 9 percent slopes-----	13	IIIe-7	33
BoC2	Bolivar fine sandy loam, 5 to 9 percent slopes, eroded-----	13	IVe-7	34
BsB	Bronaugh silt loam, 2 to 5 percent slopes-----	14	IIe-1	31
Ce	Cleora loamy fine sand-----	14	IIw-2	32
CoC	Coweta fine sandy loam, 2 to 14 percent slopes-----	15	VIIs-6	35
CrD	Coweta stony fine sandy loam, 5 to 14 percent slopes-----	15	VIIIs-6	35
DuB	Dubbs loam, 2 to 5 percent slopes-----	16	IIe-1	31
Edd	Eldon cherty loam, thin solum variant, 5 to 14 percent slopes-----	17	IVs-6	34
HcD	Hector fine sandy loam, 5 to 14 percent slopes-----	18	VIIs-4	34
HeD	Hector stony fine sandy loam, 5 to 14 percent slopes-----	18	VIIIs-6	35
HeE	Hector stony fine sandy loam, 14 to 30 percent slopes-----	18	VIIIs-6	35
Hm	Hepler silt loam-----	19	IIw-1	32
Hp	Hepler silt loam, overwash-----	19	IIw-1	32
Hr	Hepler-Radley complex-----	19	IIw-1	32
La	Lanton silty clay loam-----	20	IIw-1	32
LeB	Liberal silt loam, 2 to 5 percent slopes-----	22	IIe-2	31
LmC2	Liberal silty clay loam, 2 to 9 percent slopes, eroded-----	22	IVe-2	33
LoD	Liberal-Coweta-Barco complex, 2 to 14 percent slopes-----	22	VIe-2	34
LuB	Lula silt loam, 2 to 5 percent slopes-----	23	IIe-1	31
Ma	Mayes silty clay loam-----	24	IIw-1	32
Mp	Mine pits and dumps-----	24	VIIe-7	35
Os	Osage silty clay-----	26	IIIw-14	33
Pa	Parsons silt loam-----	26	IIIs-2	32
Ra	Radley silty clay loam-----	28	IIw-1	32
RpE3	Radley, Parsons, and Barden soils, 0 to 25 percent slopes, severely eroded----	28	VIe-5	34
Ve	Verdigris silt loam-----	29	IIw-1	32
ZaB	Zaar silty clay, 2 to 5 percent slopes-----	29	IIIe-6	33
ZaC	Zaar silty clay, 5 to 9 percent slopes-----	30	IVe-6	34

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