SOIL SURVEY

Cottle County, Texas

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

Issued November 1974

Major fieldwork for this soil survey was done in the period 1964–67. Soil names and descriptions were approved in 1969. Unless otherwise indicated, statements in this publication refer to conditions in the county in 1967. This survey was made cooperatively by the Soil Conservation Service and the Texas Agricultural Experiment Station. It is part of the technical assistance furnished to the Upper Pease Soil and Water Conservation District.

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, United States Department of Agriculture, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

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

Locating Soils

All of the soils of Cottle County are shown on the detailed map at the back of this publication. The 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 it belongs.

Finding and Using Information

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

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

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the range sites.

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

Ranchers and others can find, under "Range," groupings of the soils according to their suitability for range and descriptions of the vegetation of each range site.

Community planners and others can read about soil properties that affect the choice of sites for nonindustrial buildings and for recreation areas in the section "Engineering uses of the soils."

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

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and classification of the soils." They may also be interested in the section entitled "General Soil Map," where broad patterns of soils are described.

Cover: **Cattle grazing in a field that has been seeded to grass. The soil is a Woodward loam, and the range site is Mixedland.**

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Issued November 1974

SOIL SURVEY OF COTTLE COUNTY, TEXAS

BY WAYNE E. RICHARDSON, JOHNNY HAJEK, EARL BLAKLEY, AND CONRAD NEITSCH, SOIL CONSERVATION SERVICE

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

COTTLE COUNTY is in the north-central part of the Rolling Plains province of Texas (fig. 1). It has an area of 906 square miles, or 579,840 acres. Paducah is the county seat.

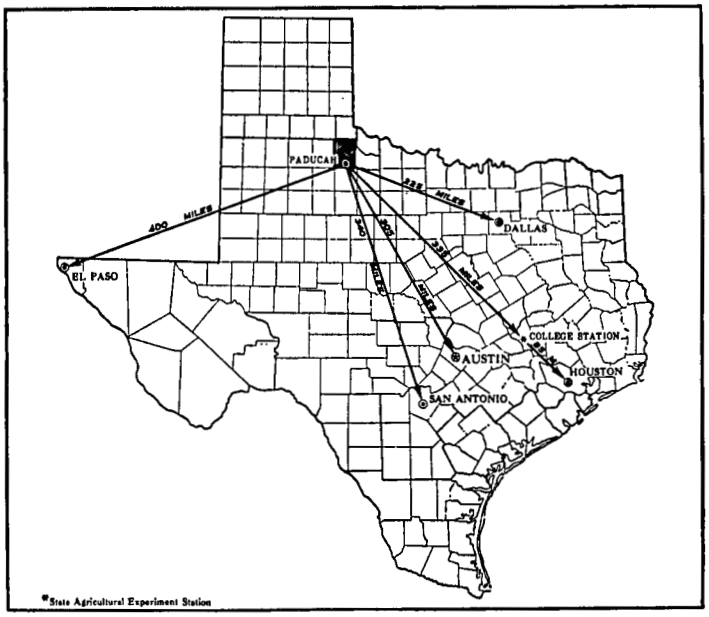

Figure 1.—Location of Cottle County in Texas.

Elevation of the county ranges from 1,600 feet in the southeast corner to 1,800 feet in the northwest corner, and from 1,600 feet in the northeast corner to 2,000 feet in the southwest corner.

Cottle County derives most of its income from farming and ranching. About 397,489 acres is rangeland, 159,051 acres is dryfarmed cropland, and 11,066 acres is irrigated cropland.

Cattle ranching is very extensive, and several large ranches are in the county. The larger ranches are confined mostly to the rough, steep, or sandy areas that are unsuitable for cultivation.

The principal crops grown in the county are cotton, wheat, and grain sorghum. Many cultivated areas of marginal land are better suited to grass. Some areas have been seeded back to grass.

Drainage in the county is mainly from west to east. Most of the county is drained by the North, Middle, and South Pease Rivers and their tributaries. These three rivers combine within the county to become the Pease River. The southeastern part of the county is drained by the North Wichita River and its tributaries. All of these rivers commonly flow only during the wetter months of the year. However, springs are common along some of the tributaries in the eastern part of the county, and these produce a permanent flow of water.

Irrigation in the county, confined mostly to the southern part, is from wells that produce about 90 to 900 gallons per minute. The first irrigation wells were dug in the early fifties. The poor quality and relatively small amount of water available limited progress. Most of the water analyses showed high concentrations of sodium, magnesium, and chlorine. Many wells have been abandoned because of salt buildup on the land. An irrigation survey shows that there are about 82 operating units that have some irrigated land, and most of these use the water to supplement rainfall.

In the west-central part of the county, northwest of Paducah, there is a 30,000-acre wildlife management area, formerly part of the Matador Ranch, that is now administered by the Texas Parks and Wildlife Department.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Cottle 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 familiar soils and perhaps some unfamiliar ones. They observed the steepness, length, and shape of slopes; the size and speed of streams; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down to the depth at which the parent material has not been changed much by leaching or by plant roots.

The soil scientists compared 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 uniform nationwide 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. Miles and Springer, for example, are the names of two soil series. All the soils in the United States having the same series names are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases, each indicating a feature that affects management. For example, Sagerton loam, 0 to 1 percent slopes, is one of several phases in the Sagerton series.

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

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some 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 shown on the soil map of Cottle County are soil complexes and undifferentiated groups.

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

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of the 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. Woodward and Quinlan loams is an undifferentiated group in the county.

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. Badland is a land type in Cottle County.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory measurements and for engineering tests. Laboratory data from the same 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 of the soils.

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

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

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Cottle County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and is named for the major soils. The soils in one association may occur in another, but in a different pattern.

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

The soil associations in Cottle County are discussed in the following pages. The terms for texture used in the descriptive heading of the associations apply to the surface layer. For example, in the title of association 1, the words, "coarse textured and moderately coarse textured" refer to the texture of the surface layer.

1. Miles-Springer association

Nearly level to strongly sloping, deep, coarse textured and moderately coarse textured soils on outwash plains

This association occupies about 27 percent of the county. Miles soils make up about 58 percent of the

association, and Springer soils about 9 percent. The remaining 33 percent consists mainly of Heatly, Delwin, Nobscot, Hilgrave, Woodward, and Veal soils (fig. 2).

Miles soils have a brown loamy fine sand surface layer 17 inches thick. Below this is reddish-brown sandy clay loam 34 inches thick. The next layer is yellowish-red sandy clay loam 18 inches thick. The underlying material is red loam.

Springer soils have a reddish-brown loamy fine sand surface layer 16 inches thick. Below this is reddish-brown fine sandy loam 15 inches thick. The next layer is fine sandy loam about 44 inches thick. It is yellowish red in the upper part and red in the lower part. The underlying material is reddish-brown loamy fine sand.

About 50 percent of the acreage in this association is used for crops, and about 50 percent is used for range. The hazard of soil blowing is slight, and the hazard of water erosion is slight to severe.

2. *Tillman-Vernon-Talpa association*

Nearly level to steep, deep to very shallow, moderately fine textured and medium-textured soils on upland plains

This association occupies about 22 percent of the county. Tillman soils make up about 34 percent of the association, Vernon soils about 15 percent, and Talpa soils about 8 percent. The remaining 43 percent consists mainly of Owens, Lofton, Sagerton, Quanah, Colorado, Cottonwood, and Weymouth soils (fig. 3).

Tillman soils have a brown silty clay loam surface layer about 6 inches thick. The next layer is dark reddish-brown and reddish-brown clay about 32 inches thick. Below this is red clay about 22 inches thick. The next layer, extending to a depth of 69 inches, is gravelly clay.

Vernon soils have a reddish-brown clay loam surface layer about 6 inches thick. The next layer is reddish-brown clay about 22 inches thick. The underlying material, extending to a depth of 60 inches, is reddish-brown clayey shale.

Talpa soils have a brown stony loam surface layer, about 6 inches thick, that is underlain by hard, fractured dolomitic limestone.

Most of the acreage in this association is used for range, but some is used for crops. The hazard of soil blowing is slight, and the hazard of water erosion is slight to severe.

3. *Bukreek-Sagerton association*

Nearly level to gently sloping, deep, medium-textured and moderately fine textured soils on outwash plains

This association occupies about 17 percent of the county. Bukreek soils make up about 31 percent of the

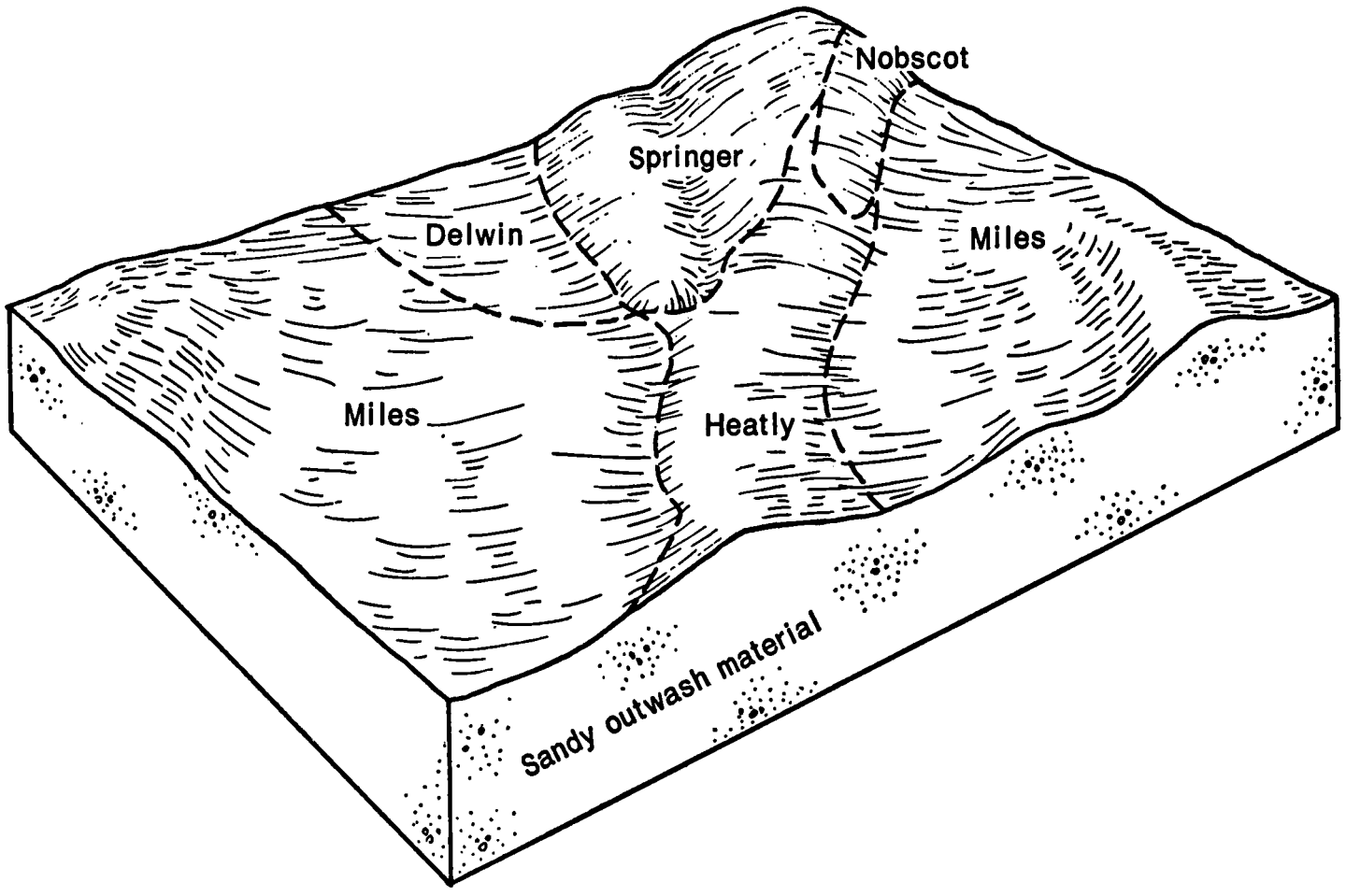

Figure 2.—Pattern of soils and parent material in the Miles-Springer association.

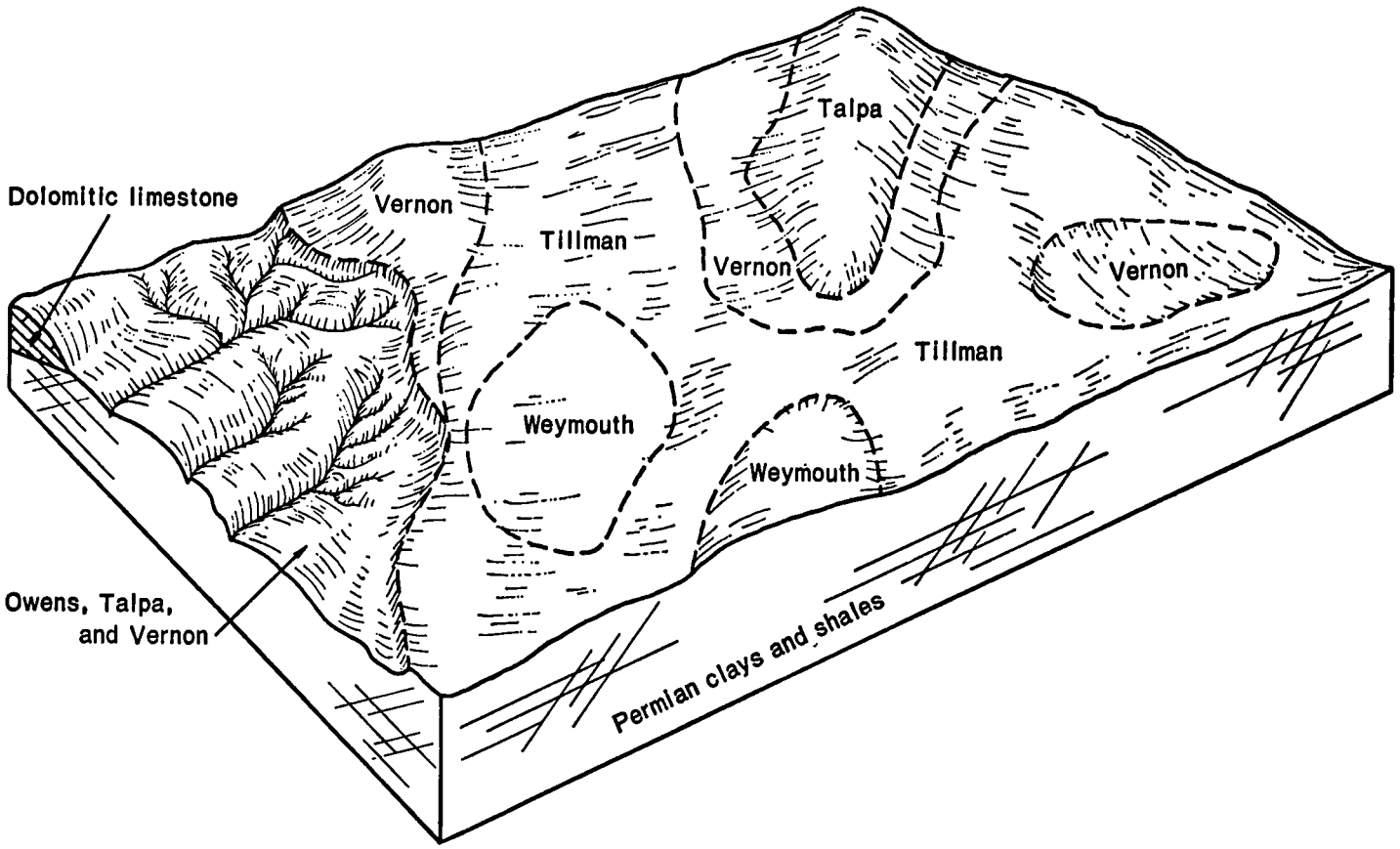

Figure 3.—**Pattern of soils and parent material in the Tillman-Vernon-Talpa association.**

association, and Sagerton soils about 23 percent. The remaining 46 percent consists mainly of Miles, Woodward, Abilene, and Weymouth soils (fig. 4).

Bukreek soils have a reddish-brown loam surface layer 9 inches thick. The next layer is sandy clay loam about 39 inches thick. It is reddish brown in the upper part and yellowish red in the lower part. Below this is red sandy clay loam about 18 inches thick. The underlying material, extending to a depth of 102 inches, is red loam.

Sagerton soils have a brown clay loam surface layer about 7 inches thick. The next layer is clay about 18 inches thick. It is brown in the upper part and reddish brown in the lower part. Below this is yellowish-red clay loam about 11 inches thick. The underlying material, extending to a depth of 84 inches, is clay loam that is red in the upper part and light red in the lower part.

Most of the acreage in this association is used for crops, but some is used for range. The hazard of soil blowing is slight, and the hazard of water erosion is moderate.

4. *Woodward-Quinlan-Rough broken land association*

Gently sloping to steep, shallow to moderately deep, medium-textured soils and dissected areas; on uplands

This association occupies about 12 percent of the county. Woodward soils make up about 40 percent of the association, Quinlan soils 22 percent, and Rough broken land 27 percent. The remaining 11 percent consists mainly of Colorado, Yahola, Lincoln, Enterprise, Hardeman, and Tivoli soils (fig. 5).

Woodward soils have a reddish-brown loam surface layer 22 inches thick. The next layer is red loam about 8 inches thick. The underlying material, extending to a depth of 60 inches, is red, weakly consolidated very fine sandy loam.

Quinlan soils have a yellowish-red loam surface layer 5 inches thick. Below this is light-red loam about 8 inches thick. The underlying material, extending to a depth of 60 inches, is red, weakly cemented sandstone.

Rough broken land is a miscellaneous land type that consists of rough, steep, gullied, exposed, sandy and silty red-bed materials. It is dissected by many drainage channels that were formed by geological erosion cutting into the soft sandstone.

Most of the acreage of this association is used for range, and most of it is not suited to crops. The hazard of soil blowing is slight, and the hazard of water erosion is moderate to severe.

5. *Woodward-Carey association*

Nearly level to gently sloping, deep to moderately deep, medium-textured soils on upland plains

This association occupies about 8 percent of the county. Woodward soils make up about 63 percent of the association, and Carey soils about 26 percent. The remaining 11 percent consists mainly of Quinlan, Yahola, Paducah, and St. Paul soils and Rough broken land (fig. 6).

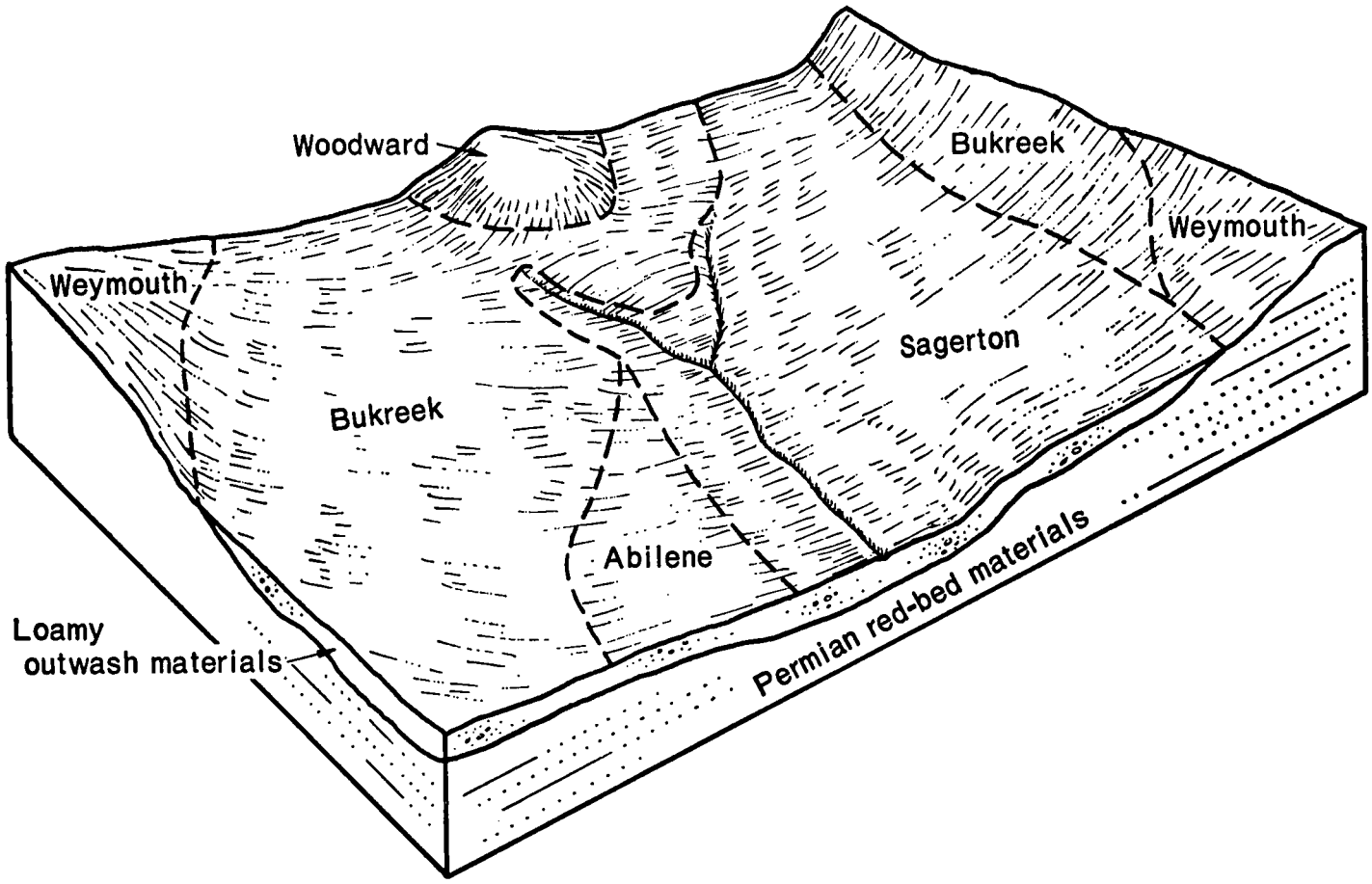

Figure 4.—**Pattern of soils and parent material in the Bukreek-Sagerton association.**

Woodward soils have a reddish-brown loam surface layer 22 inches thick. The next layer is red loam about 8 inches thick. The underlying material, to a depth of 60 inches, is red, weakly consolidated very fine sandy loam.

Carey soils have a reddish-brown loam surface layer about 13 inches thick. The next layer is red sandy clay loam about 15 inches thick. Below this is red loam about 26 inches thick. The next layer is light-red very fine sandy loam about 30 inches thick. The underlying material is soft, light-red, calcareous sandstone.

Most of the acreage of this association is used for crops, but some is used for range. The hazard of soil blowing is slight, and the hazard of water erosion is slight to moderate.

6. *Owens-Badland association*

Gently sloping to very steep, shallow, clayey soils and dissected areas; on uplands

This association occupies about 7 percent of the county. Owens soils make up about 45 percent of the association, and Badland about 45 percent. The remaining 10 percent consists mainly of Colorado, Lincoln, Cottonwood, and Talpa soils (fig. 7).

Owens soils have a reddish-brown clay surface layer 13 inches thick. The underlying material is olive clayey shale.

Badland is a miscellaneous land type that consists of nearly barren areas of clay and outcrops of red-bed shale.

Most of the acreage in this association is used for range and is not well suited to crops. The hazard of soil blowing is slight, and the hazard of water erosion is severe.

7. *Nobscot-Heatly association*

Nearly level to gently sloping, deep, coarse-textured soils on upland plains

This association occupies about 5 percent of the county. Nobscot soils make up about 57 percent of the association, and Heatly soils about 32 percent. The remaining 11 percent consists mainly of Delwin, Springer, and Miles soils (fig. 8).

Nobscot soils have a fine sand surface layer 22 inches thick. It is brown in the upper part and light brown in the lower part. The next layer is yellowish-red sandy loam about 30 inches thick. The underlying material, extending to a depth of 76 inches, is yellowish-red loamy fine sand.

Heatly soils have a light-brown fine sand surface layer 28 inches thick. The next layer is reddish-brown sandy loam about 6 inches thick. Below this is about 40 inches of sandy clay loam that is red in the upper part and reddish brown in the lower part. The underlying material, extending to a depth of 80 inches, is yellowish-red sandy clay loam.

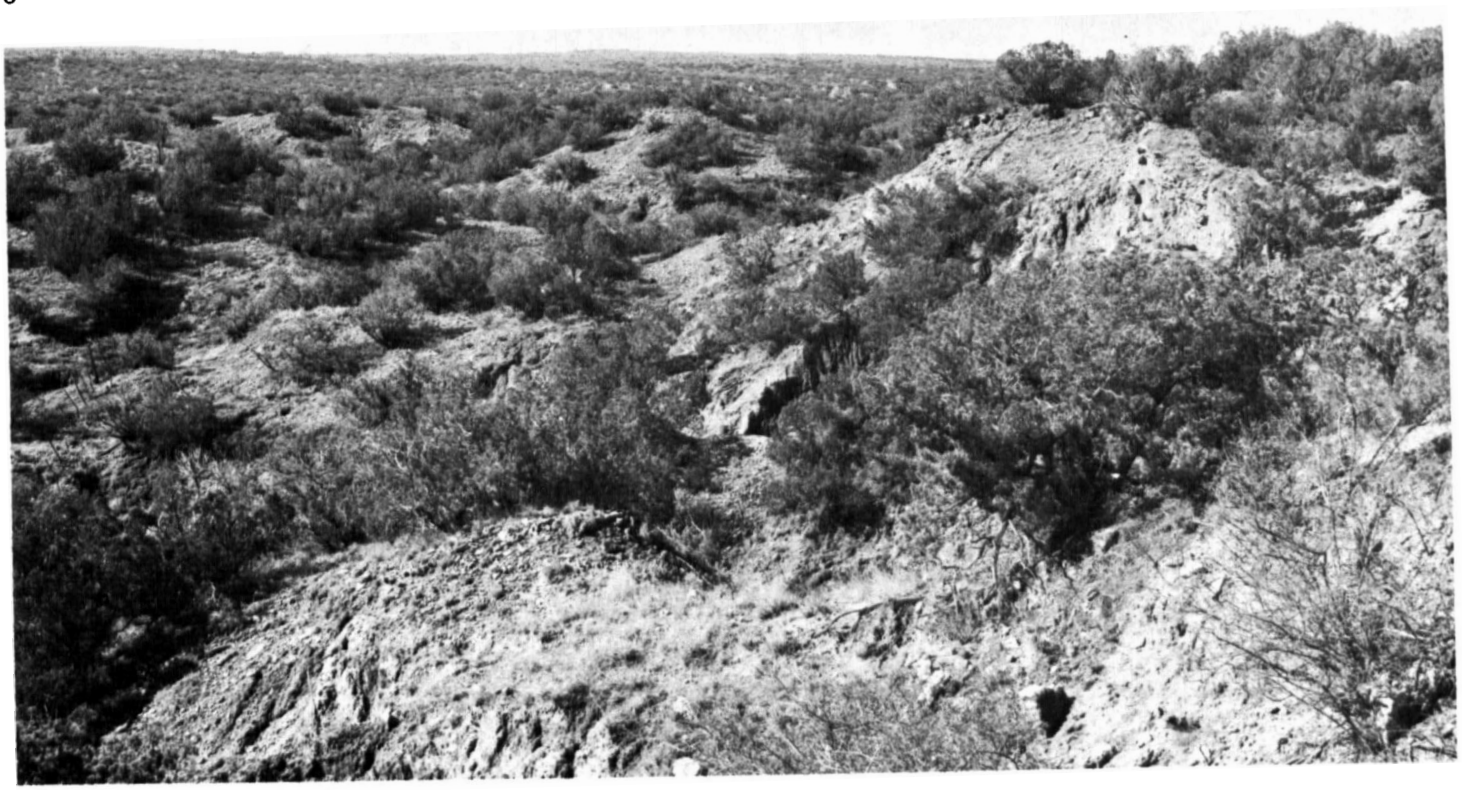

Figure 5.—Typical area of Woodward-Quinlan-Rough broken land association.

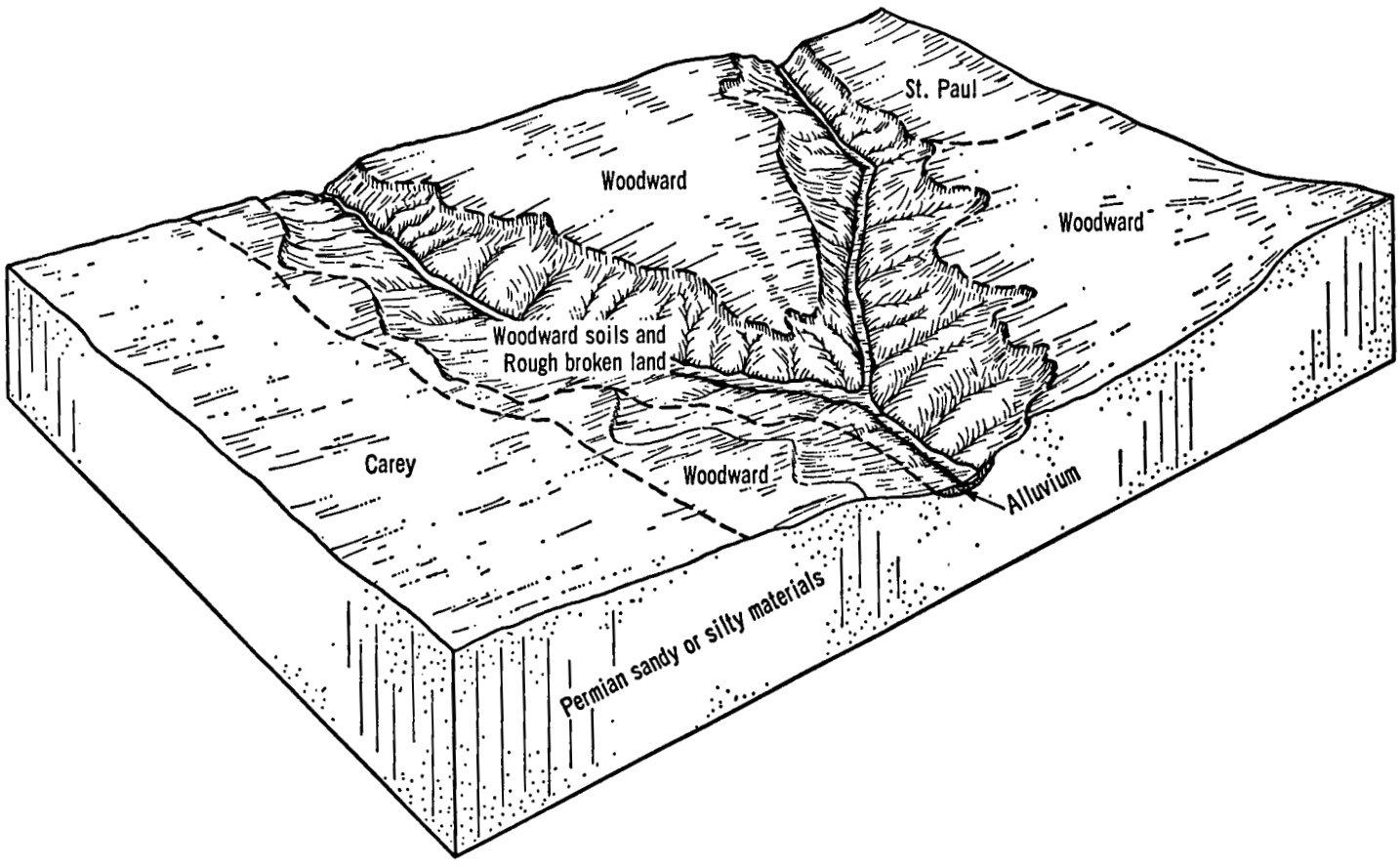

Figure 6.—Pattern of soils and parent material in the Woodward-Carey association.

Figure 7.—**Typical area of Owens-Badland association.**

Most of the acreage in this association is in native range. Much of the acreage of Heatly soils was used for crops at one time, but most of this has returned to native vegetation. The soils in this association are not well suited to crops. The hazard of soil blowing is severe, and the hazard of water erosion is slight.

8. *Talpa-Quanah association*

Gently sloping to steep, very shallow and deep, medium-textured and moderately fine textured soils on uplands

This association occupies about 2 percent of the county. Talpa soils make up about 49 percent of the association, and Quanah soils 21 percent. The remaining 30 percent consists mainly of Vernon, Tillman, Cottonwood, and Weymouth soils (fig. 9).

Talpa soils have a brown stony loam surface layer 6 inches thick over hard, fractured, dolomitic limestone.

Quanah soils have a brown silty clay loam surface layer 30 inches thick. The next layer is reddish-yellow silty clay loam about 18 inches thick. The underlying material, extending to a depth of 60 inches, is light-brown clay loam.

Most of the acreage in this association is used for range. Quanah soils generally are suited to crops, but Talpa soils are too shallow and stony for this use. Where the Talpa soils occur in a complex with Quanah soils, however, neither is suited to crops. The hazard of soil blowing is slight, and the hazard of water erosion is moderate.

Descriptions of the Soils

In this section the soils of Cottle County are described and their use and management are discussed. Each soil series is described in detail, and then, briefly, each mapping unit in that series is discussed. Unless specifically mentioned otherwise, it is to be assumed that statements about the soil series hold 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

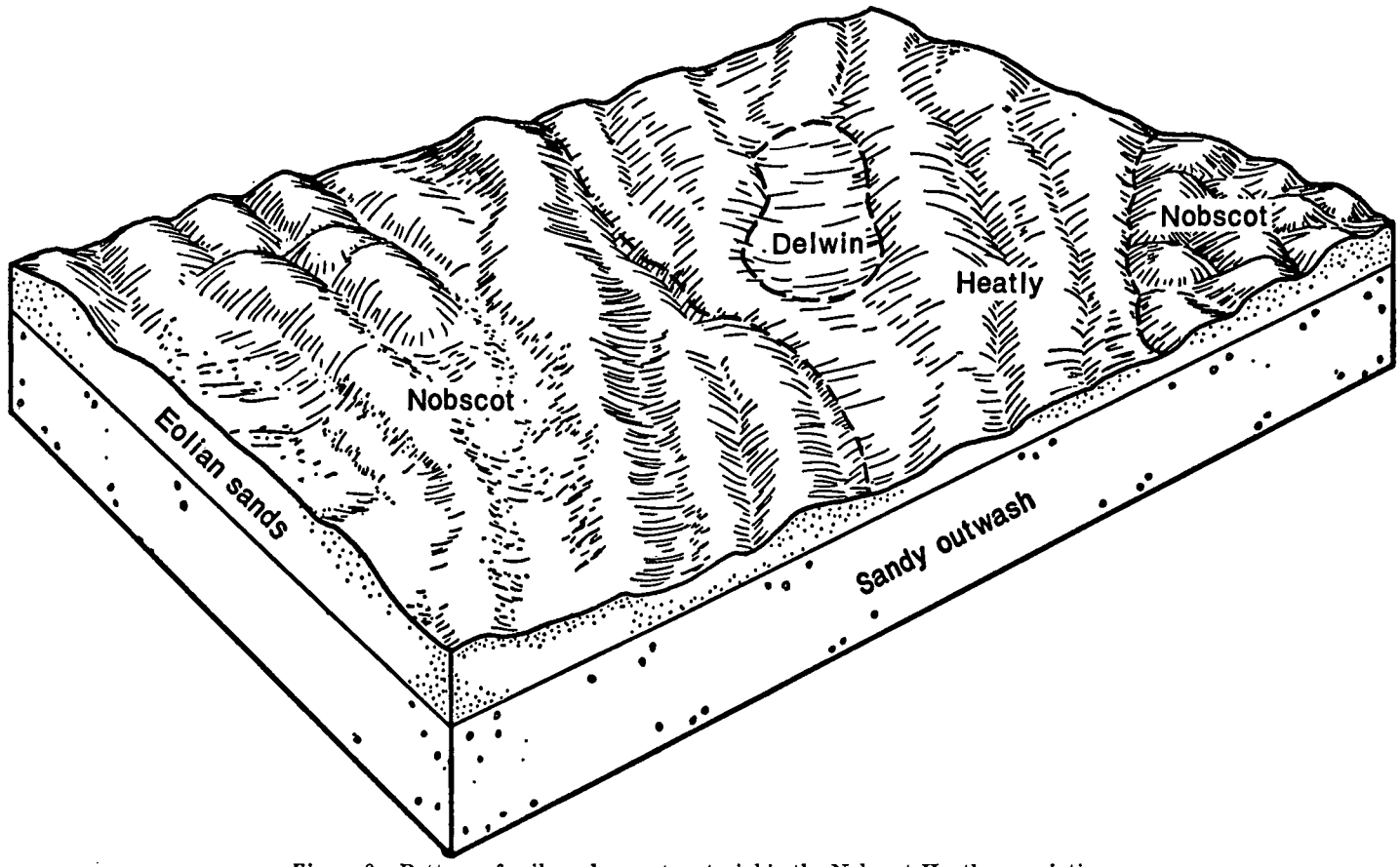

Figure 8.—**Pattern of soils and parent material in the Nobscot-Heatly association.**

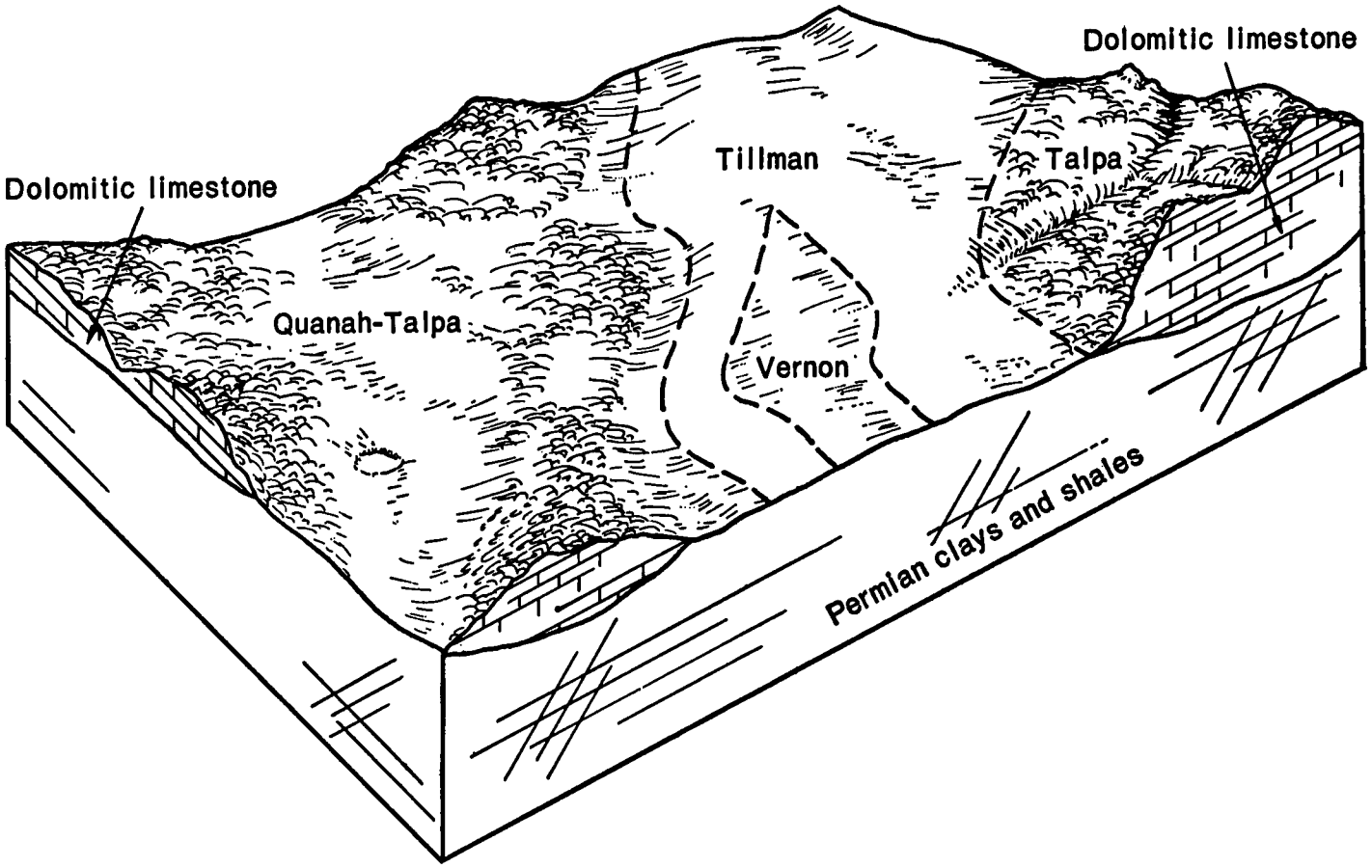

Figure 9.—**Pattern of soils and parent material in the Talpa-Quanah association.**

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. The profile described in the series is representative of 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, unless they are differences that are apparent in the name of the mapping unit. Color terms are for dry soil unless otherwise stated.

Not all mapping units are members of a soil series. Rough broken land, for example, does not belong to a soil series; nevertheless, it is listed in alphabetic order along with the soil series.

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

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*8*).[1]

Abilene Series

The Abilene series consists of deep, well-drained, moderately slowly permeable, loamy soils on uplands. These soils formed in calcareous, loamy outwash material.

In a representative profile, the surface layer is brown clay loam about 8 inches thick. Below this layer is dark grayish-brown clay loam 18 inches thick. The next layer is brown, firm clay about 12 inches thick. Below this layer is reddish-yellow clay loam about 10 inches thick. The underlying material, extending to a depth of 72 inches, is pink clay loam that contains films and threads of calcium carbonate and about 20 percent soft masses.

Representative profile of Abilene clay loam, 0 to 1 percent slopes, in a cultivated field, 150 feet south of county road, from a point 1 mile west of the intersection of county road with U.S. Highway 83, about 9 miles south of Paducah:

Ap—0 to 8 inches, brown (7.5YR 5/2) clay loam, dark brown (7.5YR 3/2) moist; weak, fine, granular structure;

[1] Italic numbers in parentheses refer to Literature Cited, p. 68.

slightly hard, friable; neutral; abrupt, smooth boundary.

B1—8 to 16 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak to moderate, medium, blocky and subangular blocky structure; hard, friable; neutral; few pores; gradual, smooth boundary.

B21t—16 to 26 inches, dark grayish-brown (10YR 4/2) clay loam, very dark brown (10YR 2/2) moist; moderate, medium, blocky structure; very hard, firm; few distinct clay films on peds; mildly alkaline; gradual, smooth boundary.

B22t—26 to 38 inches, brown (10YR 5/3) clay, dark brown (10YR 3/3) moist; moderate, medium, blocky structure; very hard, firm; distinct, continuous clay films on peds; common, small, hard calcium carbonate concretions; few films and threads of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

B3t—38 to 48 inches, reddish-yellow (5YR 6/6) clay loam, yellowish red (5YR 5/6) moist; moderate, medium, blocky structure; very hard, firm; about 3 percent, small, hard concretions; common films and threads of calcium carbonate; calcareous; moderately alkaline; clear, wavy boundary.

Cca—48 to 72 inches, pink (5YR 8/4) clay loam, light reddish brown (5YR 6/4) moist; massive (structureless); slightly hard, friable; about 20 percent soft masses, films, and threads of calcium carbonate; calcareous; moderately alkaline.

The A horizon ranges from 6 to 10 inches in thickness and from brown to dark grayish brown in color.

The B1 horizon, where present, ranges from dark grayish brown to dark brown in color. The B21t horizon ranges from 8 to 12 inches in thickness, from dark grayish brown to dark brown in color, and from clay loam to clay in texture. The B22t horizon ranges from 8 to 14 inches in thickness, from brown to dark brown in color, and from clay loam to clay in texture. The B3t horizon ranges from 10 to 26 inches in thickness, from reddish yellow to dark brown in color, and from clay to clay loam in texture.

Depth to the Cca horizon ranges from 46 to 60 inches. This horizon contains 15 to 30 percent calcium carbonate.

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

Soil	Area	Extent
	Acres	*Percent*
Abilene clay loam, 0 to 1 percent slopes	1,016	0.2
Badland and Owens soils	26,388	4.5
Bukreek loam, 0 to 1 percent slopes	15,147	2.6
Bukreek loam, 1 to 3 percent slopes	15,328	2.6
Bukreek loam, 3 to 5 percent slopes	2,120	.4
Carey loam, 0 to 1 percent slopes	1,046	.2
Carey loam, 1 to 3 percent slopes	12,074	2.1
Colorado very fine sandy loam	3,167	.6
Colorado clay loam	8,332	1.4
Colorado and Yahola soils, frequently flooded	2,067	.4
Cottonwood complex	1,030	.2
Cottonwood soils	382	.1
Delwin fine sand	4,699	.8
Enterprise very fine sandy loam, 0 to 1 percent slopes	427	.1
Enterprise very fine sandy loam, 1 to 3 percent slopes	1,912	.3
Enterprise very fine sandy loam, 3 to 5 percent slopes	963	.2
Enterprise very fine sandy loam, 5 to 12 percent slopes	1,356	.2
Hardeman fine sandy loam, 0 to 1 percent slopes	834	.1
Hardeman fine sandy loam, 1 to 3 percent slopes	1,136	.2
Hardeman fine sandy loam, 3 to 5 percent slopes	1,446	.3
Hardeman fine sandy loam, 5 to 12 percent slopes	1,347	.2
Heatly fine sand	10,042	1.7
Hilgrave very gravelly sandy loam	17,509	3.0
Lincoln soils	4,239	.7
Lincoln soils, frequently flooded	2,553	.4
Lipan clay	194	(1)
Lofton clay loam	1,184	.2
Miles loamy fine sand, 0 to 3 percent slopes	30,323	5.2
Miles loamy fine sand, 3 to 5 percent slopes	12,875	2.2
Miles fine sandy loam, 0 to 1 percent slopes	10,424	1.8
Miles fine sandy loam, 1 to 3 percent slopes	19,050	3.3
Miles fine sandy loam, 3 to 5 percent slopes	12,305	2.1
Miles fine sandy loam, 5 to 12 percent slopes	12,314	2.1
Nobscot fine sand	17,711	3.1
Owens soils and Badland	43,410	7.7
Owens, Talpa, and Vernon soils	16,347	2.8
Paducah loam, 3 to 5 percent slopes	2,676	.5
Quanah-Talpa complex	6,203	1.1
Rough broken land	16,845	2.9
Sagerton loam, 0 to 1 percent slopes	7,127	1.2
Sagerton loam, 1 to 3 percent slopes	7,307	1.3
Sagerton clay loam, 0 to 1 percent slopes	5,578	1.0
Sagerton clay loam, 1 to 3 percent slopes	4,861	.8
St. Paul silt loam	1,656	.3
Springer loamy fine sand, undulating	8,628	1.5
Springer loamy fine sand, hummocky	4,888	.8
Springer and Tivoli soils, hummocky	1,335	.2
Talpa stony loam	10,624	1.8
Tillman silty clay loam, 0 to 1 percent slopes	6,804	1.2
Tillman silty clay loam, 1 to 3 percent slopes	35,501	6.1
Tillman silty clay loam, 1 to 3 percent slopes, eroded	1,077	.2
Tivoli fine sand	2,111	.4
Veal fine sandy loam, 1 to 3 percent slopes	1,558	.3
Veal fine sandy loam, 3 to 5 percent slopes	1,804	.3
Veal fine sandy loam, 5 to 12 percent slopes	641	.1
Vernon clay loam, 1 to 3 percent slopes	14,140	2.4
Vernon clay loam, 3 to 5 percent slopes	5,219	0.9
Weymouth clay loam, 1 to 3 percent slopes	3,866	.7
Weymouth clay loam, 3 to 5 percent slopes	4,886	.8
Weymouth clay loam, 5 to 12 percent slopes	1,034	.2
Woodward loam, 1 to 3 percent slopes	10,310	1.8
Woodward loam, 3 to 5 percent slopes	22,557	3.9
Woodward soils and Rough broken land	26,320	4.5
Woodward and Quinlan loams	37,244	6.4
Yahola very fine sandy loam	7,173	1.2
Rivers and water areas	7,170	1.2
Total	579,840	100.0

[1] Less than 0.05 percent.

Abilene clay loam, 0 to 1 percent slopes (AbA).—This nearly level to slightly concave soil is on uplands. Areas are irregular to oval in shape and range from 5 to 100 acres in size. Slopes are dominantly 0.3 to 0.8 percent.

Included with this soil in mapping are small areas of Sagerton and Cottonwood soils. Also included are a few areas of Abilene clay loam that has slopes of more than 1 percent. These inclusions make up about 5 percent of the total acreage. In about 10 percent of the area, these soils have less than 15 percent calcium carbonate in the underlying material.

Surface runoff is slow, and the hazards of soil blowing and water erosion are slight. Permeability is moderately slow, but the available water capacity is high.

Most of this soil is cultivated. Cotton, small grain, and some sorghum are the major crops grown. Crop rotation,

return of adequate crop residue to the soil for improvement and protection, and timely but limited tillage are needed practices. Capability unit IIc–4; Deep Hardland range site.

Badland and Owens Soils

Badland and Owens soils (Bo) consists of rough, steep, severely dissected areas of the Pease River Breaks. The land type and soils of this unit occur in such an intermingled pattern that it was not practical to map them separately at the scale used. They do not occur in a repeating pattern. Mapped areas are large, and most of them are several thousand acres in size. Slopes range from 2 to 50 percent. This mapping unit is about 24 percent Badland and 23 percent Owens soils. The remaining 53 percent is other soils and land types.

Badland consists of nearly barren areas of clay or outcrops of red-bed shale. It occupies the steeper scarps and commonly has slopes of 10 to 50 percent. Badlands has a 5 to 10 percent cover of vegetation.

Owens soils have a surface layer of reddish-brown, calcareous clay loam about 4 inches thick. The next layer is reddish-brown, very firm clay about 10 inches thick. The underlying material is olive, calcareous clayey shale. These soils formed in the smoother, flatter areas and have slopes of less than 10 percent. They have a 30 to 40 percent cover of vegetation.

Included in mapping are areas of Cottonwood, Talpa, Vernon, Colorado, and Tillman soils and gyp outcrops.

The hazard of soil blowing is slight, but the hazard of water erosion is severe because of the slopes and the small amount of cover. Surface runoff is medium. The areas are somewhat excessively drained.

This unit is better suited to limited grazing, wildlife habitat, and recreation than to most other uses. Conservative use of grasses is needed to control erosion. Rest from grazing is needed if the vigor of grasses is low. Careful planning is needed in locating roads and other improvements so that traffic by livestock or vehicles will not create a greater hazard of erosion. Capability unit VIIs–1; Owens part in Shallow Redland range site, Badland part not placed in a range site.

Bukreek Series

The Bukreek series consists of deep, well-drained, moderately permeable, loamy soils on uplands. These soils formed in calcareous, loamy outwash material.

In a representative profile, the surface layer is reddish-brown loam about 9 inches thick. Below this is a layer of reddish-brown sandy clay loam about 23 inches thick. The next layer consists of friable sandy clay loam 34 inches thick. It is yellowish red in the upper part. It is red and has about 20 percent soft masses and concretions of calcium carbonate in the lower part. Below this layer, extending to a depth of 102 inches, is calcareous, red loam.

Representative profile of Bukreek loam, 0 to 1 percent slopes, in a cultivated field, 100 feet west of Farm Road 1038, from a point 1.8 miles south and 1.75 miles east via Farm Road 1038 from its intersection with U.S. Highway 83 on the south edge of Paducah:

Ap—0 to 9 inches, reddish-brown (5YR 4/3) loam, dark reddish brown (5YR 3/3) moist; weak, fine, granular structure; soft, very friable; few quartz pebbles; mildly alkaline; abrupt, smooth boundary.

B21t—9 to 16 inches, reddish-brown (5YR 4/3) sandy clay loam, dark reddish brown (5YR 3/3) moist; moderate, medium, subangular blocky structure; slightly hard, friable; common worm casts and pores; few pebbles; mildly alkaline; gradual, smooth boundary.

B22t—16 to 32 inches, reddish-brown (5YR 4/4) sandy clay loam, reddish brown (5YR 4/4) moist; moderate, medium, subangular blocky structure; hard, firm; common worm casts and pores; few thin clay films on ped faces; few pebbles; few films and threads of calcium carbonate in lower part; mildly alkaline; gradual, smooth boundary.

B23t—32 to 48 inches, yellowish-red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; moderate, medium, subangular blocky structure; hard, friable; few clay films; few pebbles; films and threads of calcium carbonate on ped faces; calcareous; moderately alkaline; gradual, wavy boundary.

B24tca—48 to 66 inches, red (2.5YR 5/6) sandy clay loam, red (2.5YR 4/6) moist; moderate, coarse, subangular blocky structure; hard, friable; about 20 percent, by volume, soft masses and concretions of calcium carbonate; calcareous; moderately alkaline; diffuse, irregular boundary.

B25t—66 to 89 inches, red (2.5YR 5/6) loam, red (2.5YR 4/6) moist; weak, coarse, subangular blocky structure; hard, friable; about 2 percent, by volume, soft masses and concretions of calcium carbonate; calcareous; moderately alkaline; diffuse, smooth boundary.

B26t—89 to 102 inches, red (2.5YR 5/6) loam, red (2.5YR 4/6) moist; weak, coarse, subangular blocky structure; hard, friable; less than 1 percent calcium carbonate as films and threads.

The A horizon ranges from 6 to 12 inches in thickness and from reddish brown to brown in color. Reaction ranges from neutral to mildly alkaline.

The B21t horizon ranges from 6 to 10 inches in thickness, from reddish brown to yellowish red in color, and from loam to clay loam in texture. The B22t horizon ranges from 10 to 17 inches in thickness, from reddish brown to yellowish red in color, and from sandy clay loam to clay loam in texture. The B23t horizon ranges from 8 to 20 inches in thickness, from red to yellowish red in color, and from sandy clay loam to loam in texture. The B24tca horizon ranges from 10 to 20 inches in thickness, from red to reddish brown in color, and from loam to sandy clay loam in texture. The B25t and B26t horizons range from red to yellowish red in color and from loam to sandy loam in texture.

Bukreek loam, 0 to 1 percent slopes (BuA).—This soil is on upland flats and in shallow valleys. Slopes are dominantly 0.3 to 0.5 percent. Areas are irregular in shape and 10 to 2,000 acres or more in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are areas of Miles and Sagerton soils less than 10 acres in size. Also included are small outcrops of Weymouth soils.

Available water capacity is high. The hazards of soil blowing and water erosion are slight. Runoff is slow.

All of this soil is cultivated. The main crops are cotton, sorghum, and small grain. The main need of management is to maintain good soil tilth. The cropping system should include crops that leave a large amount of residue. Management of crop residue on the surface helps to maintain soil condition and to control soil blowing (fig. 10). Capability unit IIc–5; Mixedland range site.

Bukreek loam, 1 to 3 percent slopes (BuB).—This soil is in smooth areas that are irregular in shape and range from 10 to 1,000 acres in size. Slopes are dominantly 1 to 2 percent.

Figure 10.—**Grain sorghum on Bukreek loam, 0 to 1 percent slopes. This crop is grown in rotation with cotton.**

The surface layer is reddish-brown loam about 7 inches thick. Below this is reddish-brown sandy clay loam about 34 inches thick. The next layer, about 40 inches thick, is yellowish-red, friable loam that contains about 20 percent hard and soft calcium carbonate in the upper 10 inches.

Included with this soil in mapping are small areas of Sagerton, Miles, Weymouth, and Woodward soils that occur near ridgetops.

The hazard of soil blowing is slight, and the hazard of water erosion is moderate. Available water capacity is high. Runoff is medium. A few shallow gullies and rills occur along drainageways and on the steeper slopes.

All of this soil is cultivated. Wheat is the principal crop.

The main needs of management are to maintain soil tilth and to control erosion. Proper management includes using terraces and contour cultivation and growing grain sorghum and small grain or other crops that leave a large amount of residue (fig. 11). Capability unit IIe–2; Mixedland range site.

Figure 11.—**Stubble-mulched wheat-straw residue on Bukreek loam, 1 to 3 percent slopes.**

Bukreek loam, 3 to 5 percent slopes (BuC).—This soil is on convex ridges. Most areas are less than 100 acres in size. Slopes are dominantly 3 to 4 percent.

The surface layer is reddish-brown loam about 7 inches thick. Below this layer is reddish-brown, firm sandy clay loam about 23 inches thick. The next layer is yellowish-red, friable sandy clay loam about 12 inches thick. Below this layer is red, friable loam that contains about 20 percent soft masses and concretions of calcium carbonate in the upper 18 inches.

Included with this soil in mapping are areas of Woodward and Weymouth soils that are less than 5 acres in size.

The hazard of water erosion is moderate, and the hazard of soil blowing is slight. Available water capacity is high. Runoff is medium. A few areas, mostly near drainageways, are eroded and have shallow gullies and rills.

All of this soil is cultivated. Wheat is the principal crop. The main needs in management are rotation of crops, management of crop residue on the soil surface for erosion control and soil improvement, and limited but timely tillage. Contour farming and terraces are necessary to control water erosion. Diversion terraces and grassed waterways are needed in places for safe disposal of runoff water. Capability unit IIIe–3; Mixedland range site.

Carey Series

The Carey series consists of deep, well-drained, moderately permeable, loamy soils on uplands. These soils formed in calcareous material derived from very fine grained, soft sandstone or packsand.

In a representative profile, the surface layer is reddish-brown loam about 13 inches thick. Below this layer is reddish-brown, firm sandy clay loam about 15 inches thick. The next layer is red, friable loam about 14 inches thick. Below this layer is about 30 inches of light-red, very friable very fine sandy loam that has about 5 percent soft masses and concretions of calcium carbonate. The underlying material is light-red, soft, calcareous sandstone that extends to a depth of 100 inches.

Representative profile of Carey loam, 1 to 3 percent slopes, in a cultivated field 100 feet south of Farm Road 1440 from a point 2.4 miles west of the intersection of Farm Road 1440 and U.S. Highway 83:

Ap—0 to 7 inches, reddish-brown (5YR 5/3) loam, dark reddish brown (5YR 3/3) moist; weak, fine, granular structure; soft, very friable; neutral; abrupt, smooth boundary.

A1—7 to 13 inches, reddish-brown (5YR 4/3) loam, dark reddish brown (5YR 3/3) moist; weak, fine, subangular blocky structure; slightly hard, friable; few clay films on ped faces; mildly alkaline; gradual, smooth boundary.

B21t—13 to 28 inches, reddish-brown (5YR 5/4) sandy clay loam, dark reddish brown (5YR 3/4) moist; moderate, fine and medium, subangular blocky structure; hard, firm; clay films on ped surfaces; calcareous; moderately alkaline; gradual, wavy boundary.

B22t—28 to 42 inches, red (2.5YR 5/6) loam, red (2.5YR 4/6) moist; moderate, medium, subangular blocky structure; soft, friable; few clay films on ped surfaces; few threads and films of calcium carbonate; calcareous; moderately alkaline; gradual, wavy boundary.

B3ca—42 to 72 inches, light-red (2.5YR 6/6) very fine sandy loam, red (2.5YR 4/6) moist; moderate, medium,

subangular blocky structure; soft, very friable; about 5 percent soft masses and concretions of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

C—72 to 100 inches, light-red (2.5YR 6/6), soft, calcareous sandstone.

The Ap horizon ranges from 5 to 12 inches in thickness and from reddish brown to brown in color. Reaction ranges from neutral to mildly alkaline. The A1 horizon ranges from 0 to 7 inches in thickness. Reaction is neutral to mildly alkaline.

The B21t horizon ranges from 10 to 28 inches in thickness, is reddish brown or red in color, and ranges from loam to sandy clay loam in texture. Reaction ranges from neutral to moderately alkaline. The B22t horizon ranges from 10 to 20 inches in thickness and from red to yellowish red in color. The B3ca horizon ranges from red to reddish yellow in color and from loam to very fine sandy loam in texture.

Some of these soils have secondary carbonates beginning at a depth of 36 to 40 inches, which is outside the range defined for the series. This difference does not affect their use or behavior.

Carey loam, 0 to 1 percent slopes (CaA).—This soil is on smooth upland flats or in weakly concave areas. The areas are irregular in shape. Most areas are less than 200 acres in size. Slopes are dominantly 0.3 to 0.8 percent.

The surface layer is reddish-brown loam about 8 inches thick. Below this layer is reddish-brown loam 6 inches thick. The next layer is reddish-brown sandy clay loam 22 inches thick. Below this layer is yellowish-red loam about 12 inches thick. The underlying material, extending to a depth of 70 inches, is reddish-yellow, calcareous, soft sandstone.

Included with this soil in mapping are areas, less than 5 acres in size, of St. Paul soils in slightly lower positions than this Carey soil. A few small areas of Carey loam, 1 to 3 percent slopes, are also included.

Runoff is slow. The hazards of soil blowing and water erosion are slight. Permeability is moderate, but the available water capacity is high.

Most of this soil is cultivated. Cotton and small grain are the principal crops. The main needs of management are maintaining good soil tilth and controlling soil blowing through the management of crop residue on the soil surface. Capability unit IIc–3; Mixedland range site.

Carey loam, 1 to 3 percent slopes (CaB).—This soil is in areas that are generally broad and irregular in shape and range from 10 to 1,000 acres in size. Slopes are dominantly 2.0 to 2.5 percent. This soil has the profile described as representative for the series.

Included with this soil in mapping are areas of Woodward soils that are commonly less than 5 acres in size. A few small areas of Carey loam, 0 to 1 percent slopes, are also included. All of these inclusions make up less than 10 percent of the acreage.

Permeability is moderate, and the available water capacity is high. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. Runoff is medium.

Most of this soil is cultivated. Cotton and small grain are the principal crops. The main need of management is to control water erosion. Erosion control measures include the management of crop residue on the soil surface, stripcropping, timely but limited tillage, and use of contour farming together with a system of terraces. Diversion terraces and grassed waterways may be needed where excess runoff water is a concern. Capability unit IIe–1; Mixedland range site.

Colorado Series

The Colorado series consists of deep, well-drained, moderately permeable, calcareous, loamy soils on bottom lands. These soils formed in calcareous, loamy alluvium.

In a representative profile, the surface layer is reddish-brown clay loam about 6 inches thick. The underlying material, extending to a depth of 60 inches, is reddish-brown clay loam that is stratified with slightly more sandy sediment.

Representative profile of Colorado clay loam, in a nearly level cultivated field, 100 feet west of Farm Road 104, and 0.4 mile northwest along Farm Road 104 from Lazare:

Ap—0 to 6 inches, reddish-brown (5YR 5/4) clay loam, dark reddish brown (5YR 3/4) moist; weak, fine, granular structure; slightly hard, friable; calcareous; moderately alkaline; abrupt, smooth boundary.

C1—6 to 20 inches, reddish-brown (5YR 5/4) clay loam that is stratified with thin layers or seams of slightly more sandy sediment, dark reddish brown (5YR 3/4) moist; massive; hard, friable; bedding planes partly destroyed but observable; many very fine pores; calcareous; moderately alkaline; clear, smooth boundary.

C2—20 to 60 inches, reddish-brown (5YR 5/4) clay loam, dark reddish brown (5YR 3/4) moist; massive; hard, friable; thin strata of loam and fine sandy loam; bedding planes evident; few fine pores; calcareous; moderately alkaline.

The A horizon ranges from 5 to 14 inches in thickness, from reddish brown to brown in color, and from very fine sandy loam to clay loam in texture.

The C1 horizon ranges from 10 to 24 inches in thickness, from reddish brown to yellowish red in color, and from clay loam or silt loam to loam in texture. Stratification ranges from little to much. In places the bedding planes have been partly destroyed and are scarcely observable to distinct.

The C2 horizon is dominantly clay loam or silt loam to sandy clay loam, but in most places the soils are stratified with thin layers of fine sandy loam or silty clay loam. Bedding planes in places are partly destroyed and are scarcely observable to distinct. The C2 horizon ranges from reddish brown to yellowish red in color.

Colorado very fine sandy loam (Cd).—This nearly level soil is on alluvial plains along small streams, and most areas are occasionally flooded. Slopes are dominantly less than 0.5 percent. Most mapped areas are narrow, are less than 400 acres in size, and lie parallel to the stream channels.

The surface layer is reddish-brown, calcareous very fine sandy loam 6 inches thick. The underlying material is reddish-brown clay loam stratified with thin layers or seams of very fine sandy loam to silty clay loam.

Included with this soil in mapping are small areas of Colorado clay loam and Yahola soils that make up about 10 percent of the total acreage mapped as this soil.

Runoff is slow. The hazards of soil blowing and water erosion are slight. Permeability is moderate, but the available water capacity is high.

This soil is mostly cultivated. Cotton, small grain, and sorghum are the principal crops. The main need of management is to maintain good soil tilth. Crop rotation, protection of the soil by use of crop residue, and timely but limited tillage help to maintain good tilth. Capability unit IIc–2; Bottomland range site.

Colorado clay loam (Ce).—This nearly level soil is on flood plains. Slopes are dominantly less than 0.5 percent. Most areas are narrow and parallel to stream channels. Mapped areas range from 25 to 300 acres or more in size. This soil has the profile described as representative for the series.

Included with this soil in mapping are small areas of Colorado and Yahola soils that occupy lower positions along streams and are thus more frequently flooded. Also included are small areas of soils that have a very fine sandy loam surface layer. All of these inclusions make up 5 to 10 percent of this soil.

Runoff is slow. The hazards of soil blowing and water erosion are slight. Permeability is moderate, but the available water capacity is high.

Most of this soil is cultivated. Cotton, small grain, and sorghum are the principal crops. The main need of management is to maintain good soil tilth. Crop rotation, protection of the soil by use of crop residue and growing crops, and timely but limited tillage help to maintain good tilth. Capability unit IIc–1; Valley range site.

Colorado and Yahola soils, frequently flooded (Cf).—This undifferentiated group is nearly level. It is on frequently flooded bottom lands along creeks and intermittent drainageways. The areas are low in relation to surrounding soils and are subject to flooding during high-intensity rains. New sediment is deposited during floods. The mapped areas are narrow and parallel to stream channels; most are less than 400 feet wide.

Some areas are almost entirely Colorado soils, and some are mainly Yahola soils, but most areas consist of both. A typical area is 23 percent Colorado very fine sandy loam, 52 percent Colorado silt loam, 18 percent Yahola very fine sandy loam, and 7 percent included soils.

The Colorado soils have a reddish-brown, calcareous silt loam surface layer about 10 inches thick. Below this layer is reddish-brown silt loam that is about 20 inches thick and is stratified with layers of loam to clay loam. The next layer is stratified, yellowish-red loam.

The Yahola soils have a surface layer of reddish-brown very fine sandy loam about 18 inches thick. Underlying material is reddish-yellow very fine sandy loam stratified with fine sandy loam and loam.

Included with these soils in mapping are Lincoln and Woodward soils. These inclusions are less than 5 acres in size and make up less than 10 percent of the acreage.

These soils have high available water capacity. Runoff is slow.

These soils are better suited to grazing or wildlife habitat than to most other uses.

The main need in management is to maintain a good plant cover to help control erosion. The plant species that benefit wildlife should be kept to preserve a suitable wildlife habitat. Capability unit Vw–1; Bottomland range site.

Cottonwood Series

The Cottonwood series consists of very shallow, well-drained, moderately permeable, calcareous, loamy soils on uplands. These soils formed in impure gypsum beds.

In a representative profile, the surface layer is light-brown, calcareous loam about 8 inches thick. The underlying material, extending to a depth of 36 inches, is white, soft, chalky, gypsiferous material.

Representative profile of a Cottonwood loam in an area of Cottonwood soils in a pasture 1.0 mile east from U.S. Highway 83, 4.2 miles south along U.S. Highway 83 from Paducah:

A1—0 to 8 inches, light-brown (7.5YR 6/4) loam, dark brown (7.5YR 4/4) moist; weak, fine, subangular blocky structure; soft, very friable; common fine and many very fine pores; calcareous; moderately alkaline; clear, wavy boundary.

C—8 to 36 inches, white (10YR 8/1) loam, light gray (10YR 7/1) moist; soft, chalky, gypsiferous material; becomes very compact at depth of 24 inches.

The A horizon ranges from 3 to 10 inches in thickness, from reddish brown to grayish brown in color, and from loam to silty clay loam in texture.

The C horizon ranges from white to pink to light gray in color. The materials range from gypsiferous earths to gypsite or alabaster and are weakly consolidated to strongly cemented.

Cottonwood complex (Co).—These nearly level to gently sloping soils are on uplands. They are so intermingled that it is not practical to map them separately at the scale used. Slopes are mostly 0.8 to 2.0 percent. Areas range from 50 to 300 acres in size.

About 70 percent of this complex is a soil that is similar to Cottonwood soils but is deeper. It has a surface layer of calcareous, brown loam about 12 inches thick. Below this layer is calcareous loam about 14 inches thick. The underlying material consists of pinkish-white, calcareous gypsum beds and loamy, gypsiferous earths.

About 17 percent of this complex is Cottonwood soils. The surface layer of the Cottonwood soils is brown loam about 6 inches thick. The underlying material consists of thick beds of white gypsum and calcium carbonate.

Included with these soils in mapping are areas, less than 5 acres in size, of Bukreek, Sagerton, and Abilene soils. Also included are small gypsum outcrops.

The deeper component in this complex has moderate available water capacity. Cottonwood soils have low available water capacity. Runoff is rapid. The hazard of water erosion is moderate, and the hazard of soil blowing is slight.

Most of the acreage of this complex is cultivated. Small grain, sorghum, and cotton are the principal crops. The main needs of management are controlling water erosion and maintaining tilth.

Crop rotation, leaving crop residue on the surface, timely but limited tillage, and contour farming together with use of terraces, diversions, and grassed waterways are good management practices. Capability unit IIIe–2; Deep Hardland range site.

Cottonwood soils (Ct).—These soils are gently sloping to moderately steep. Slopes are dominantly 3 to 20 percent. These soils are on the sides of drainageways (fig. 12). The areas are narrow and parallel the drainageways. Only a few areas occur in the county and most of these are less than 100 acres in size.

The Cottonwood soils in this mapping unit have the profile described as representative for the series.

Included with these soils in mapping are narrow bands of Colorado and Yahola soils that occur on the bottom of drainageways. These inclusions make up about 5 percent of the total acreage. About 10 to 15 percent

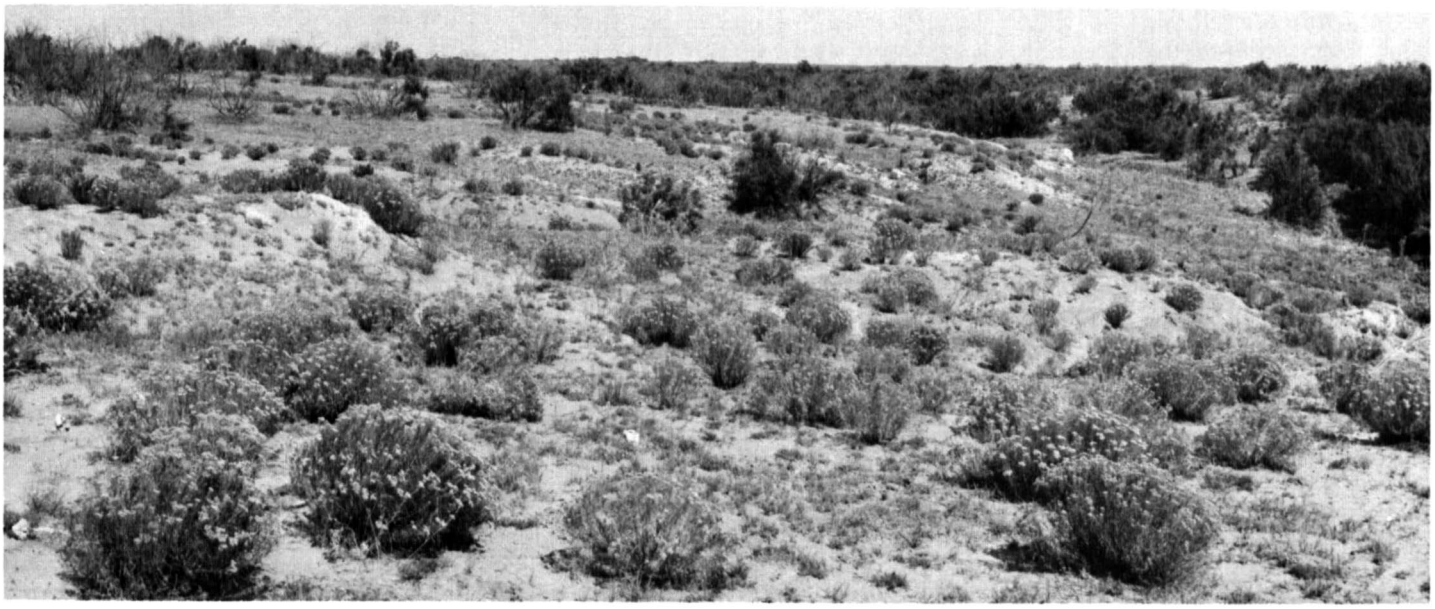

Figure 12.—An area of Cottonwood soils.

of this mapping unit consists of raw, exposed gypsum material.

These soils are well drained, and runoff is rapid. The hazard of water erosion is severe on the steeper slopes. The hazard of soil blowing is slight. The available water capacity is low.

These soils are all in range.

Good management of grasses on these soils is needed to control erosion. Deferred grazing is necessary if the vigor of grasses is low. Careful consideration is needed in locating roads and other improvements so that traffic by livestock or vehicles does not create erosion problems. Capability unit VIIs-1; Gypland range site.

Delwin Series

The Delwin series consists of deep, well-drained, moderately permeable, sandy soils on uplands. These soils formed in sandy outwash or eolian deposits.

In a representative profile, the surface layer is brown fine sand about 18 inches thick. The next layer is red, firm sandy clay loam about 48 inches thick. Below this is light-red loamy fine sand.

Representative profile of Delwin fine sand in a field, 100 feet south of county road, from a point 0.15 mile west of U.S. Highway 83 and 6 miles north of Paducah:

Ap—0 to 15 inches, brown (7.5YR 5/4) fine sand, dark brown (7.5YR 4/4) moist; single grain; loose; slightly acid; abrupt, smooth boundary.

A1—15 to 18 inches, brown (7.5YR 5/4) fine sand, dark brown (7.5YR 4/4) moist; single grain; loose; slightly acid; clear, smooth boundary.

B21t—18 to 40 inches, red (2.5YR 4/6) sandy clay loam, dark red (2.5YR 3/6) moist; moderate, coarse, prismatic structure parting to moderate, medium, subangular blocky; very hard, firm; few thin clay films on prism faces; slightly acid; gradual, smooth boundary.

B22t—40 to 66 inches, red (2.5YR 5/6) sandy clay loam, red (2.5YR 4/6) moist; weak, fine, subangular blocky structure; hard, firm; few clay films; neutral; gradual, smooth boundary.

B3—66 to 72 inches, light-red (2.5YR 6/6) loamy fine sand, red (2.5YR 5/6) moist; single grain; soft, firm; mildly alkaline.

The A horizon ranges from 8 to 20 inches in thickness and from light brown to light yellowish brown in color. Reaction is slightly acid to neutral.

The B21t horizon ranges from 10 to 24 inches in thickness and from red to reddish brown in color. The B22t horizon ranges from 15 to 26 inches in thickness and from red to reddish yellow in color. Depth to the B3 horizon ranges from 60 to 75 inches.

Delwin fine sand (De).—This nearly level to gently sloping soil is on uplands. Areas are irregular in shape and range from 10 to 500 acres in size. Slopes are dominantly 0.3 to 3 percent. About 70 percent of the cultivated areas of this soil have been deep plowed to a depth of 12 to 24 inches.

Included with this soil in mapping are small areas, generally less than 5 acres in size, of Heatly, Miles, Springer, and Nobscot soils.

The hazard of soil blowing is severe, but the hazard of water erosion is slight. The soil has moderate available water capacity. Runoff is very slow.

This soil is suitable for cultivation if it is properly managed. Cotton and sorghum are the principal crops. Management of crop residue on the surface helps to control soil blowing. Deep plowing increases the clay content of the surface layer and helps to reduce susceptibility to soil blowing. Where these practices are used, cotton can be grown in alternate strips with sorghum, but tillage should be limited to that essential for crop production. Capability unit IVe-6; Deep Sand range site.

Enterprise Series

The Enterprise series consists of deep, well-drained, moderately rapidly permeable, loamy soils on uplands. These soils formed in eolian deposits blown from channels of rivers.

In a representative profile, the surface layer is reddish-brown very fine sandy loam about 18 inches thick.

The next layer is reddish-brown very fine sandy loam, about 22 inches thick, that contains films and threads of calcium carbonate. The underlying material, extending to a depth of 60 inches, is reddish-brown, calcareous very fine sandy loam.

Representative profile of Enterprise very fine sandy loam, 0 to 1 percent slopes, in a cultivated field, 50 feet west of county road, from a point 0.8 mile north of Farm Road 1278, 1.9 miles west of Chalk:

Ap—0 to 10 inches, reddish-brown (5YR 5/4) very fine sandy loam, dark reddish brown (5YR 3/4) moist; massive; soft, very friable; mildly alkaline; abrupt, smooth boundary.

A1—10 to 18 inches, reddish-brown (5YR 5/4) very fine sandy loam, dark reddish brown (5YR 3/4) moist; weak, fine, subangular blocky and granular structure; soft, very friable; mildly alkaline; gradual, smooth boundary.

B—18 to 40 inches, reddish-brown (5YR 5/4) very fine sandy loam, reddish brown (5YR 4/4) moist; weak, fine, subangular blocky structure; slightly hard, friable; common white threads and films of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

C—40 to 60 inches, reddish-brown (5YR 5/4) very fine sandy loam, yellowish red (5YR 4/6) moist; massive; slightly hard, friable; few faint films and threads of calcium carbonate in upper part; calcareous; moderately alkaline.

The A horizon ranges from 10 to 26 inches in thickness and from light reddish brown to reddish brown in color. It is mildly alkaline to moderately alkaline and is calcareous in places.

The B horizon ranges from 12 to 26 inches in thickness, from reddish brown to reddish yellow in color, and from very fine sandy loam to loam in texture.

Depth to the C horizon ranges from 24 to 45 inches. The C horizon ranges from reddish brown to reddish yellow in color and from very fine sandy loam to fine sandy loam in texture. It is several feet thick in most places; however, in a few places there are buried horizons of contrasting materials at a depth of 3 to 6 feet.

Enterprise very fine sandy loam, 0 to 1 percent slopes (EnA).—This soil is on uplands. Areas are irregularly shaped, longer than they are wide, and range from 15 to 100 acres in size.

This soil has the profile described as representative for the series.

Included with this soil in mapping are narrow bands, less than 5 acres in size, of Enterprise very fine sandy loam, 1 to 3 percent slopes, and Hardeman soils that occupy slightly higher parts of the landscape. A few areas of this Enterprise soil contain waterworn pebbles.

The hazards of soil blowing and water erosion are slight. Permeability is moderately rapid, but the available water capacity is high. Runoff is slow.

Nearly all of this soil is cultivated. Cotton, small grain, and sorghum are the principal crops. The main need in management is maintaining soil tilth. The management of crop residue on the soil surface helps to maintain soil tilth. Capability unit IIc–3; Mixedland range site.

Enterprise very fine sandy loam, 1 to 3 percent slopes (EnB).—This soil is on uplands. Most areas are irregular or oblong in shape and range from 10 to 500 acres or more in size.

The surface layer of reddish-brown very fine sandy loam is about 16 inches thick. The next layer is reddish-brown, friable very fine sandy loam about 22 inches thick and contains threads and films of calcium carbonate. The underlying material is reddish-yellow very fine sandy loam.

Included with this soil in mapping are narrow bands, less than 5 acres in size, of Enterprise very fine sandy loam, 0 to 1 percent slopes, and Hardeman soils that occupy the base of some of the gently sloping ridges. A few areas have quartz pebbles throughout the surface layer and subsoil.

The hazard of soil blowing is slight, and the hazard of water erosion is moderate. The available water capacity is high. Runoff is medium.

Most of this soil is cultivated. Cotton and small grain are the major crops. The main need of management is to control water erosion. Management of crop residue on the soil surface, stripcropping, timely but limited tillage, and use of contour farming together with a system of terraces are good management practices. Diversion terraces and grassed waterways may also be needed where excess runoff water is a concern. Capability unit IIe–1; Mixedland range site.

Enterprise very fine sandy loam, 3 to 5 percent slopes (EnC).—This soil is on uplands. Areas are irregular in shape and range from 10 to 200 acres in size.

The surface layer is reddish-brown very fine sandy loam about 12 inches thick. The next layer is reddish-brown, friable very fine sandy loam that is about 17 inches thick and contains common to numerous films and threads of calcium carbonate. The underlying material is reddish-brown very fine sandy loam.

Included with this soil in mapping are narrow bands of Enterprise very fine sandy loam, 1 to 3 percent slopes, and Enterprise very fine sandy loam, 5 to 12 percent slopes. These soils are on ridgetops and in narrow valleys between ridges. Also included are areas of Hardeman soils.

Available water capacity is high. Runoff is medium. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. A few U-shaped gullies, more than 400 feet apart, that are 1 to 8 feet deep and 4 to 12 feet wide occur in some unprotected cultivated fields along natural drainageways.

Most of this soil is cultivated. Small grain is the major crop. Needed management practices are crop rotation, management of crop residue on the soil surface, limited but timely tillage, and contour farming together with use of terraces. Diversion terraces and grassed waterways may be needed in some areas for safe disposal of runoff water. Capability unit IIIe–3; Mixedland range site.

Enterprise very fine sandy loam, 5 to 12 percent slopes (EnD).—This soil is in irregular areas that range from 25 to 300 acres or more in size. Slopes are dominantly 6 to 10 percent.

The surface layer is reddish-brown very fine sandy loam about 10 inches thick. Below this is reddish-yellow very fine sandy loam about 20 inches thick. The underlying material is reddish-yellow very fine sandy loam.

Included with this soil in mapping are areas, commonly less than 5 acres in size, of Enterprise very fine sandy loam, 3 to 5 percent slopes, and of Hardeman, Woodward, and Quinlan soils. Also included are Rough broken land and gullied areas that make up somewhat less than 5 percent of this mapping unit.

Available water capacity is high. The hazard of soil blowing is slight, and the hazard of water erosion severe. Runoff is medium. Most areas of this soil are dissected by deep, U-shaped gullies that are 4 to 20 feet deep and from a few feet to 30 feet wide. A few of these gullies are active along drainageways and on the steeper scarps, but most of them are now stabilized with a good growth of grass.

The soil is used for range. A permanent grass cover and good grazing management are needed to help control water erosion. Capability unit VIe–4; Mixedland range site.

Hardeman Series

The Hardeman series consists of deep, well-drained, moderately rapidly permeable, loamy soils on uplands. These soils formed in eolian deposits.

In a representative profile, the surface layer is reddish-brown fine sandy loam about 18 inches thick. The next layer is reddish-brown, very friable fine sandy loam that is about 18 inches thick and contains films and threads of calcium carbonate. The underlying material, extending to a depth of 60 inches, is reddish-yellow fine sandy loam.

Representative profile of Hardeman fine sandy loam, 1 to 3 percent slopes, in a cultivated field, 100 feet east of U.S. Highway 83, from a point 0.3 mile south of the Middle Pease River bridge, 13.8 miles north of Paducah:

Ap—0 to 7 inches, reddish-brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak, fine, granular structure; soft, very friable; calcareous; moderately alkaline; abrupt, smooth boundary.

A1—7 to 18 inches, reddish-brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak, fine, subangular blocky and granular structure; soft, very friable; calcareous; moderately alkaline; diffuse, smooth boundary.

B—18 to 36 inches, reddish-brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak, fine, subangular blocky structure; soft, very friable; common films and threads of calcium carbonate; calcareous; moderately alkaline; diffuse, smooth boundary.

C—36 to 60 inches, reddish-yellow (5YR 6/6) fine sandy loam, yellowish red (5YR 4/6) moist; massive; slightly hard, very friable; few films and threads of calcium carbonate that decrease with depth; calcareous; moderately alkaline.

The A horizon ranges from 8 to 24 inches in thickness and from light brown to reddish brown in color. It is mildly alkaline to moderately alkaline.

The B horizon ranges from 12 to 24 inches in thickness, from reddish brown to reddish yellow in color, and from fine sandy loam to very fine sandy loam in texture.

The C horizon occurs at a depth of 30 to 45 inches. It ranges from reddish brown to yellowish red and reddish yellow in color and from fine sandy loam to very fine sandy loam in texture.

Hardeman fine sandy loam, 0 to 1 percent slopes (HaA).—This soil is on uplands. Areas are irregularly shaped, longer than they are wide, and commonly less than 100 acres in size.

The surface layer is reddish-brown fine sandy loam about 16 inches thick. The next layer is reddish-brown fine sandy loam about 24 inches thick and contains threads and films of calcium carbonate. The underlying material is reddish-brown fine sandy loam.

Included with this soil in mapping are narrow bands, less than 5 acres in size, of Hardeman fine sandy loam, 1 to 3 percent slopes. Also included are small areas of Enterprise soils.

Runoff is slow. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. Gullies 1 to 4 feet deep form rapidly where water concentrates in unprotected areas. In cultivated areas some fence rows have accumulations of soil, 1 to 2 feet deep, that has blown from the fields. Permeability is moderately rapid, and the available water capacity is moderate.

Most of this soil is cultivated. Cotton, small grain, and sorghum are the major crops.

Crop residue managed on the soil surface helps to control soil blowing and maintain soil tilth. Contour farming is needed if row crops are grown. Diversions and grassed waterways are also needed where runoff is excessive. Capability unit IIIe–5; Sandy Loam range site.

Hardeman fine sandy loam, 1 to 3 percent slopes (HaB).—This soil is on uplands. Most areas are longer than they are wide and range from 10 to 150 acres in size. The profile of this soil is the one described as representative for the series.

Included with this soil in mapping are narrow bands, less than 5 acres in size, of Hardeman fine sandy loam, 3 to 5 percent slopes. This soil is on the slightly higher parts of the landscape. Also included are a few small areas of Enterprise soils.

Runoff is medium. Permeability is moderately rapid, and the available water capacity is moderate. The hazard of water erosion is slight, and the hazard of soil blowing is moderate. In cultivated areas some fence rows have accumulations of soil, 1 to 2 feet deep, deposited by wind.

Most of this soil is cultivated. Cotton, small grain, and sorghum are the major crops. Crop residue needs to be managed on the soil surface to help control soil blowing and maintain soil tilth. Contour farming and terracing are needed if row crops are grown. Diversions and grassed waterways are also needed where runoff is excessive. Capability unit IIIe–5; Sandy Loam range site.

Hardeman fine sandy loam, 3 to 5 percent slopes (HaC).—This soil commonly is in relatively narrow bands along natural drainageways. Most areas range from 10 to 75 acres in size.

The surface layer is reddish-brown fine sandy loam about 15 inches thick. The next layer is reddish-yellow fine sandy loam that is about 20 inches thick and contains threads and films of calcium carbonate. The underlying material is reddish-yellow fine sandy loam.

Included with this soil in mapping are narrow bands of Hardeman fine sandy loam, 1 to 3 percent slopes, and Enterprise soils that occupy the ridgetops and some of the narrow valleys between ridges. Also included are gravel outcrops on some of the ridgetops.

Runoff is medium. The hazards of soil blowing and water erosion are moderate. This soil gullies readily where water concentrates in unprotected areas. A few U-shaped gullies, about 300 feet apart, that are 1 to 5 feet deep and 4 to 12 feet wide appear in some unprotected cultivated fields along natural drainageways. Permeability is moderately rapid, and the available water capacity is high. In cultivated areas some of the fence

rows have accumulations of soil, 1 to 2 feet deep, that has blown from the fields.

Most of this soil is cultivated. Sorghum and small grain are the principal crops. Crop residue managed on the soil surface helps to control soil blowing and maintain soil tilth. Contour farming and terraces are needed to control water erosion. Capability unit IVe-8; Sandy Loam range site.

Hardeman fine sandy loam, 5 to 12 percent slopes (HaD).—This soil occupies small, scattered upland areas. Slopes are dominantly 5 to 8 percent. Most areas are less than 100 acres in size.

The surface layer is reddish-brown fine sandy loam about 12 inches thick. The next layer is reddish-yellow fine sandy loam about 18 inches thick. The underlying material is reddish-brown fine sandy loam.

Included with this soil in mapping are areas, commonly less than 5 acres in size, of Hardeman fine sandy loam, 3 to 5 percent slopes; Enterprise soils; and Springer soils. Gravel outcrops commonly occur throughout these areas.

Runoff is rapid, and the available water capacity is moderate. The hazard of soil blowing is moderate, and the hazard of water erosion is severe. Numerous gullies 3 to 10 feet deep and 10 to 30 feet across are along drainageways.

This soil is used for range. A good cover of grasses is needed to help control soil blowing and water erosion. Capability unit VIe-5; Sandy Loam range site.

Heatly Series

The Heatly series consists of deep, well-drained, moderately permeable, sandy soils on uplands. These soils formed in sandy outwash material.

In a representative profile, the surface layer is light-brown fine sand about 28 inches thick. Below this layer is reddish-brown, friable sandy loam about 6 inches thick. The next layer is red, friable sandy clay loam about 30 inches thick. Below this layer is reddish-brown, friable sandy clay loam about 10 inches thick. The next layer, extending to a depth of 80 inches, is yellowish-red sandy clay loam.

Representative profile of Heatly fine sand in a field 790 feet north of county road and 0.45 mile west of its intersection with U.S. Highway 83, 8.1 miles north of Paducah:

Ap—0 to 28 inches, light-brown (7.5YR 6/4) fine sand, brown (7.5YR 5/4) moist; single grain; loose; slightly acid; abrupt, smooth boundary.

B1—28 to 34 inches, reddish-brown (5YR 5/4) sandy loam, reddish brown (5YR 4/4) moist; weak, coarse, subangular blocky structure; hard, friable; neutral; gradual, smooth boundary.

B21t—34 to 52 inches, red (2.5YR 5/5) sandy clay loam, red (2.5YR 4/5) moist; moderate, coarse, subangular blocky structure; very hard, friable; few clay films on vertical ped surfaces; neutral; diffuse, smooth boundary.

B22t—52 to 64 inches, red (2.5YR 5/5) sandy clay loam, red (2.5YR 4/5) moist; weak, coarse, subangular blocky structure; hard, friable; few clay films on vertical ped faces; neutral; diffuse, smooth boundary.

B23t—64 to 74 inches, reddish-brown (5YR 5/4) sandy clay loam, reddish brown (5YR 4/4) moist; weak, coarse, subangular blocky structure; hard, friable; few clay films on vertical ped faces; neutral; gradual, smooth boundary.

B24t—74 to 80 inches, yellowish-red (5YR 5/5) sandy clay loam, yellowish red (5YR 4/5) moist; moderate, coarse, subangular blocky structure; very hard, firm; few clay films on vertical ped surfaces; neutral.

The A horizon ranges from 20 to 32 inches in thickness and from light brown to light reddish brown in color. Reaction is neutral to slightly acid.

The B1 horizon, where present, ranges from 4 to 12 inches in thickness and from brown to reddish brown in color.

The B2t horizon ranges from red to reddish brown in color.

Heatly fine sand (He).—This nearly level to gently sloping soil occupies areas that are irregular in shape. Areas range from 10 to 1,000 acres in size but are dominantly more than 300 acres in size.

Included with this soil in mapping are smaller areas, commonly less than 5 acres in size, of Nobscot, Delwin, Miles, and Springer soils. Also included are outcrops of dolomitic limestone on ridgetops and areas of soils that are underlain by limestone at a depth of 2 to 5 feet.

The hazard of soil blowing is severe, and the hazard of water erosion is slight. In some areas the surface is billowy because of shifting and blowing of the surface layer. Small dunes up to 2 or 3 feet in height are common, and fence rows bordering cultivated fields have accumulations 4 to 10 feet high. Permeability is moderate, and the available water capacity is low. Runoff is very slow.

This soil is better suited to range than to most other uses. Many areas were once cultivated, but most of these areas are now idle or have been reseeded to permanent grasses. About 70 percent of the cultivated areas have been deep plowed to a depth of 12 to 24 inches. A good cover of grasses is needed on this soil to help control soil blowing. Capability unit VIe-2; Deep Sand range site.

Hilgrave Series

The Hilgrave series consists of deep, well-drained, moderately rapidly permeable, gravelly soils on uplands. These soils formed in stratified gravelly and sandy outwash.

In a representative profile, the surface layer is reddish-brown very gravelly sandy loam about 7 inches thick. Below this layer is red very gravelly loam about 9 inches thick. The next layer is red very gravelly sandy clay loam about 10 inches thick. Below this layer is red gravelly loamy sand that is about 14 inches thick and contains films and threads of calcium carbonate. The underlying material, extending to a depth of 60 inches, is reddish-yellow coarse sand.

Representative profile of Hilgrave very gravelly sandy loam 30 feet west of ranch road, from a point 1.3 miles southwest via ranch road from a windmill 12.9 miles west via ranch road from the Matador Wildlife Refuge Headquarters, approximately 12 airline miles northwest of Paducah:

A1—0 to 7 inches, reddish-brown (2.5YR 4/4) very gravelly sandy loam, dark reddish brown (2.5YR 3/4) moist; weak, fine, granular structure; soft, very friable; many grass roots; 60 percent, by volume, waterworn siliceous gravel; neutral; clear smooth boundary.

B21t—7 to 16 inches, red (2.5YR 5/6) very gravelly loam, red (2.5YR 4/6) moist; weak, fine, subangular blocky structure; soft, friable; common grass roots; clay bridging between sand grains; 65 percent, by

volume, waterworn siliceous gravel; neutral; gradual, smooth boundary.

B22t—16 to 26 inches, red (2.5YR 5/6) very gravelly sandy clay loam, red (2.5YR 4/6) moist; weak, fine, subangular blocky structure; slightly hard, friable; few grass roots; clay films and bridging between sand grains; 75 percent, by volume, waterworn siliceous gravel; mildly alkaline; abrupt, smooth boundary.

B3ca—26 to 40 inches, red (2.5YR 5/6) gravelly loamy sand, red (2.5YR 4/6) moist; single grain (structureless); cohesive when dry; soft, very friable; few grass roots; 30 percent, by volume, siliceous gravel in upper part, grading to 52 percent in lower part; few films and threads of calcium carbonate, and thin coatings of calcium carbonate on some of the pebbles; calcareous; moderately alkaline; abrupt, smooth boundary.

C—40 to 60 inches, reddish-yellow (5YR 6/6) coarse sand, yellowish red (5YR 4/6) moist; single grain (structureless); soft, very friable; few scattered pebbles; calcareous; moderately alkaline.

The A horizon ranges from 6 to 10 inches in thickness and from reddish brown to brown in color. Reaction is slightly alkaline to moderately alkaline, but the horizon is noncalcareous. Content of organic matter is less than 1 percent.

The Bt horizon ranges from 14 to 26 inches in thickness, from red to reddish brown in color, and from gravelly sandy loam to very gravelly sandy clay loam in texture. Reaction ranges from slightly acid to moderately alkaline, but the horizon is noncalcareous in the upper part.

The B3 horizon ranges from 6 to 14 inches in thickness. It ranges from noncalcareous to calcareous in the matrix and in places contains segregated calcium carbonate in the form of films and threads or coatings of calcium carbonate on the pebbles.

The depth to the C horizon ranges from 22 to 50 inches. It is gravel-free sand to highly stratified gravel beds that contain strata of reddish earth.

Hilgrave very gravelly sandy loam (Hg).—This soil is on dissected hills (fig. 13). Gravel pits are in some areas. Slopes are 3 to 50 percent. Areas are irregular in shape, longer than they are wide, and range mostly from 25 to 1,000 acres in size.

Included with this soil in mapping are small areas, less than 5 acres in size, of Miles and Springer soils that are mainly on the outer edges and in some of the narrow valleys between areas of Hilgrave soils. A few areas of Woodward and Quinlan soils and Rough breaks are also included. All of these inclusions make up less than 10 percent of the total acreage.

Runoff is medium to rapid, and the available water capacity is low. The hazard of soil blowing is slight, and the hazard of water erosion is moderate.

All areas of this soil are in native range. A good cover of grasses is needed to help control water erosion. Capability unit VIs–1; Gravelly range site.

Lincoln Series

The Lincoln series consists of deep, somewhat excessively drained, rapidly permeable, sandy soils on bottom lands. These soils formed in calcareous sandy alluvium.

In a representative profile, the surface layer is yellowish-red fine sandy loam about 13 inches thick. The under-

Figure 13.—Typical area of Hilgrave very gravelly sandy loam.

lying material, extending to a depth of 60 inches, is reddish-yellow fine sand stratified with sand, loamy sand, and fine sandy loam.

Representative profile of a Lincoln fine sandy loam in an area of Lincoln soils, on the flood plain of the North Pease River, 100 feet east of U.S. Highway 83 from a point 200 feet south along U.S. Highway 83 from the North Pease River bridge, 18 miles north along U.S. Highway 83 from Paducah:

A1—0 to 13 inches, yellowish-red (5YR 5/6) fine sandy loam, yellowish red (5YR 4/6) moist; single grain; soft, very friable; thin strata of loamy sand; calcareous; moderately alkaline; clear, smooth boundary.

C—13 to 60 inches, reddish-yellow (5YR 6/6) fine sand, yellowish red (5YR 5/6) moist; single grain; stratified with layers of sand, fine sandy loam, and loamy sand ¼ inch to 4 inches thick; bedding planes are evident; calcareous; moderately alkaline.

The A1 horizon ranges from 6 to 15 inches in thickness, from reddish brown to reddish yellow in color, and from very fine sandy loam to loamy fine sand in texture.

The C horizon ranges from loamy fine sand to fine sand and contains thin strata of very fine sandy loam, fine sandy loam, loamy sand, sand, and fine gravel. It ranges from pink to reddish yellow in color.

Lincoln soils (Lc).—These nearly level to gently undulating soils are on flood plains along major rivers. Most areas are narrow and are parallel to the stream channels. Areas range from 15 to 300 acres or more in size. These soils have the profile described as representative for the series.

Included with these soils in mapping are narrow bands of Yahola and Tivoli soils. These inclusions make up about 22 percent of the total acreage.

The hazard of soil blowing is severe, and the hazard of water erosion is slight. Runoff is slow, and the available water capacity is low. A water table is at a depth of 3 to 6 feet in many areas during the wet seasons. A few areas in cultivation have been eroded by soil blowing, and this gives them a billowy surface.

Most areas of these soils are in range, but a few areas are cultivated.

These soils are better suited to range, recreation land, or wildlife habitat than to most other uses. A good cover of grasses is needed to help control soil blowing. Capability unit Vw–2; Sandy Bottomland range site.

Lincoln soils, frequently flooded (Lf).—These nearly level soils occupy low flood plains along the major streams. These soils are on the first bottoms, 1 to 4 feet above the stream channels. Most areas are subject to flooding. Areas are narrow and are parallel to the stream channels. Most areas are 25 to 200 acres in size.

The surface layer is stratified, reddish-brown very fine sandy loam to loamy fine sand about 10 inches thick. The texture of the surface layer changes with each flood, as new sediments are deposited. The underlying material, to a depth of 60 inches, is stratified loamy sand or sand intermixed with fine gravel. The water table is at a depth of 2 to 4 feet in many areas, but it fluctuates from season to season and from year to year, depending on rainfall. Some areas are saline.

Included with these soils in mapping are small areas of soils that have a loam or clay loam surface layer. The more clayey soils are in areas where flood waters are retarded and stand on the soils for longer periods. Also included are small areas of Yahola soils.

Runoff is slow and available water capacity is low. The hazard of soil blowing is severe, and the hazard of water erosion is slight.

These soils are better suited to range, recreation, or wildlife habitat than to most other uses. A good cover of grasses is needed to help control soil blowing. Capability unit Vw–2; Sandy Bottomland range site.

Lipan Series

The Lipan series consists of deep, moderately well drained, very slowly permeable, clayey soils on uplands. These soils formed in calcareous old alluvium or outwash.

In a representative profile, the surface layer is gray clay about 18 inches thick. The next layer is gray, very firm, calcareous clay about 24 inches thick. The underlying material extending to a depth of 70 inches, is grayish-brown, calcareous clay.

Representative profile of Lipan clay in a cultivated field, 0.15 mile west of rural road, from a point 1.7 miles east and 0.2 mile north, by rural road, from Farm Road 2278, 0.95 mile north of Delwin:

A—0 to 18 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; weak, fine, blocky structure and moderate, fine, blocky structure; extremely hard, very firm, very sticky and very plastic; mildly alkaline; gradual, smooth boundary.

AC—18 to 42 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; weak, fine, blocky structure; extremely hard, very firm, very sticky and very plastic; few very fine pores; few very fine calcium carbonate concretions; calcareous; moderately alkaline; diffuse, wavy boundary.

C—42 to 70 inches, grayish-brown (10YR 5/2) clay; dark grayish-brown (10YR 4/2) moist; massive; extremely hard, very firm; few fine calcium carbonate concretions; calcareous; moderately alkaline.

The A horizon ranges from 13 to 20 inches in thickness. Its reaction is mildly alkaline to moderately alkaline. Cracks that form on drying are from ½ inch to 2 inches wide at the soil surface and extend to a depth of 2 feet or more.

The AC horizon ranges from 18 to 40 inches in thickness and from dark gray to grayish brown in color.

The C horizon is at a depth of 40 to 66 inches and is dark gray to brown in color. Few to common calcium carbonate concretions occur.

Lipan clay (Ln).—This nearly level soil occupies slightly depressional areas on uplands. Areas are round to oval in shape and range from 2 to 40 acres in size.

Included with this soil in mapping are small areas of Abilene and Lofton soils in slightly higher spots or on the outer edges of the slightly depressional areas. These inclusions make up less than 5 percent of the acreage mapped as this Lipan soil.

Available water capacity is high. Runoff is slow or minimal, and water stands on the surface for extended periods following heavy rains. Planting and harvesting of crops are delayed because water is ponded or the soil is wet. The hazards of soil blowing and water erosion are slight.

Most areas of this soil are used for range, and a few areas are cultivated. Maintaining a good cover of grass or managing crop residue on the soil surface helps to maintain soil tilth. Capability unit IIIw–1; Deep Hardland range site.

Lofton Series

The Lofton series consists of deep, moderately well drained, very slowly permeable, loamy soils on uplands. These soils formed in clayey Permian red beds and clayey outwash.

In a representative profile, the surface layer is dark grayish-brown clay loam about 8 inches thick. Below this is dark grayish-brown, firm silty clay about 10 inches thick. The next layer is dark grayish-brown, very firm clay about 12 inches thick. Below this is a 40-inch layer that is grayish-brown, very firm clay in the upper part and very firm silty clay in the lower part. The underlying material, extending to a depth of 85 inches, is light brownish-gray silty clay.

Representative profile of Lofton clay loam in a cultivated field, 0.2 mile south of county road, from a point 0.8 mile north and 0.6 mile east on county road from its intersection with Farm Road 2532, 4.3 miles via Farm Road 2532 from Farm Road 104:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; hard, friable; mildly alkaline; abrupt, smooth boundary.

B21t—8 to 18 inches, dark grayish-brown (10YR 4/2) silty clay, very dark brown (10YR 2/2) moist; weak to moderate, fine, blocky structure and subangular blocky structure; very hard, firm; mildly alkaline; gradual, smooth boundary.

B22t—18 to 30 inches, dark grayish-brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; moderate, fine, blocky structure; very hard, very firm; many clay films; mildly alkaline; gradual, smooth boundary.

B23t—30 to 45 inches, grayish-brown (10YR 5/2) clay, very dark grayish brown (10YR 3/2) moist; moderate, fine, blocky structure; very hard, very firm; few clay films; few fine calcium carbonate concretions and films; calcareous; moderately alkaline; diffuse, smooth boundary.

B24t—45 to 70 inches, grayish-brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) moist; weak, medium, blocky structure; very hard, very firm; few thin clay films; few calcium carbonate concretions and threads; calcareous; moderately alkaline; diffuse, smooth boundary.

C—70 to 85 inches, light brownish-gray (10YR 6/2) silty clay, dark grayish brown (10YR 4/2) moist; massive; few films of calcium carbonate; calcareous; moderately alkaline.

The A horizon ranges from 6 to 10 inches in thickness and from dark gray to dark grayish brown in color.

The B21 horizon ranges from 26 to 64 inches in thickness, is brown to very dark grayish brown in color, and is silty clay to clay in texture.

The C horizon occurs at a depth that ranges from 32 to 70 inches, but it is below 72 inches in most profiles.

Some of these soils have colors that are too red (hue of 7.5YR, chroma of 3. or both) to be within the range defined for the series. This difference does not alter the usefulness or behavior of these soils.

Lofton clay loam (Lo).—This soil is on upland flats. Areas are irregular in shape and slightly concave. The soil is in a position to receive extra water from surrounding soils. Slopes are mostly less than 0.5 percent but are as much as 1 percent. These areas range from 20 to 100 acres in size.

Included with this soil in mapping are areas of Tillman soils, less than 5 acres in size, on slightly higher parts of the landscape. Also included are a few potholes of Lipan clay. All of these inclusions amount to about 10 percent of the total acreage.

Runoff is very slow. The hazards of soil blowing and water erosion are slight. Permeability is very slow, and the available water capacity is high.

Most of this soil is cultivated. Cotton, small grain, and sorghum are the major crops. The main need of management is to maintain good soil tilth. Rotation of crops, management of crop residue, and timely but limited tillage help to maintain good soil tilth. Capability unit IIc–4; Deep Hardland range site.

Miles Series

The Miles series consists of deep, well-drained, moderately permeable, loamy and sandy soils on uplands. These soils formed in outwash or old alluvial material.

In a representative profile, the surface layer is brown loamy fine sand about 17 inches thick. Below this layer is reddish-brown sandy clay loam about 34 inches thick. The next layer is yellowish-red, friable sandy clay loam about 18 inches thick. The underlying material, to a depth of 85 inches, is red loam.

Representative profile of Miles loamy fine sand, 0 to 3 percent slopes, in a cultivated field 100 feet east of U.S. Highway 83, from a point 1.3 miles north of Paducah via U.S. 83:

Ap—0 to 17 inches, brown (7.5YR 5/4) loamy fine sand, dark brown (7.5YR 3/4) moist; single grain; loose; few pebbles on surface; neutral; abrupt, smooth boundary.

B21t—17 to 33 inches, reddish-brown (5YR 4/4) sandy clay loam, dark reddish brown (5YR 3/4) moist; weak to moderate, coarse, prismatic structure parting to moderate, medium, subangular blocky structure; hard, firm; few fine pores; few thin clay films; few pebbles; mildly alkaline; gradual, smooth boundary.

B22t—33 to 51 inches, reddish-brown (5YR 5/4) sandy clay loam, dark reddish brown (5YR 3/4) moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky structure; slightly hard, friable; few thin clay films; few pebbles; mildly alkaline; gradual, smooth boundary.

B3t—51 to 69 inches, yellowish-red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; moderate, medium, subangular blocky structure; slightly hard, friable; few thin clay films; few pebbles; mildly alkaline; gradual, smooth boundary.

C—69 to 85 inches, red (2.5YR 5/6) loam, red (2.5YR 4/6) moist; massive; soft, very friable; few pebbles; calcareous; moderately alkaline.

The A horizon ranges from 7 to 20 inches in thickness, from reddish brown to brown in color, and from fine sandy loam to loamy fine sand in texture. Reaction is slightly acid to neutral.

The B1 horizon, where present, ranges from 4 to 8 inches in thickness and from loam to sandy clay loam in texture. The B21t horizon is 10 to 24 inches thick and red to reddish brown. Reaction is neutral to mildly alkaline. The B22t horizon is 15 to 22 inches thick and red to yellowish red. Reaction is neutral to moderately alkaline. The B2t horizon is 12 to 18 inches thick, reddish brown to reddish yellow, and sandy clay loam to loam.

The C horizon is 60 to 80 inches thick, red to reddish yellow, and sandy clay loam to loamy fine sand.

Miles loamy fine sand, 0 to 3 percent slopes (MeB).—This soil is on uplands. Slopes are dominantly 0.6 to 2 percent. Areas are irregular in shape and range from 25 to 1,000 acres in size. Fence rows bordering cultivated fields commonly have accumulations of sand 3 to 6 feet in height. The profile of this soil is the one described as representative for the series.

Included with this soil in mapping are small areas of Miles fine sandy loam and of Springer, Woodward, and Veal soils. Areas of these soils are mostly less than 5 to 10 acres in size and make up about 5 to 10 percent of the total acreage. Also included are small areas of soils that are eroded. The surface layer is thinner in these areas, and in some of them the subsoil is exposed.

The hazard of water erosion is slight, and the hazard of soil blowing is severe. Runoff is slow, and the available water capacity is high.

Most areas of this soil are cultivated. Cotton and sorghum are the major crops. This soil is better suited to grass or forage production than to most other uses. A few areas once cultivated have been seeded to native grass. Management of crop residue on the soil surface helps to control soil blowing. Deep plowing can be useful in increasing clay content of the surface layer and reducing susceptibility to soil blowing. Most areas in cultivation have been deep plowed. Tillage should be limited to that required for crop production. Capability unit IVe–6; Sandyland range site.

Miles loamy fine sand, 3 to 5 percent slopes (MeC).—This soil is on convex ridges and side slopes along large drainageways. Most areas are less than 100 acres in size, but a few areas are up to 300 acres in size. Slopes are dominantly 3.5 to 4.0 percent.

The surface layer is reddish-brown loamy fine sand about 10 inches thick. Below this layer is reddish-brown sandy clay loam about 24 inches thick. The next layer is reddish-brown sandy clay loam about 34 inches thick. The underlying material is red loam.

Included with this soil in mapping are small areas of Springer, Woodward, Veal, and Hilgrave soils and of Miles fine sandy loam, 0 to 3 percent slopes. Most of these areas are less than 15 acres in size. A few areas of soils that have slopes of up to 6 percent are also included.

The hazard of soil blowing is severe, and the hazard of water erosion is moderate. The available water capacity is high. Most areas of this soil in cultivation have been slightly to moderately eroded by water, and shallow rills and gullies are numerous. Winnowing by wind has removed the finer separates in cultivated areas.

This soil is better suited to native grass than to most other uses. About 25 to 50 percent of it has been cultivated, but much of this is no longer cultivated. A good grass cover is needed to protect this soil from soil blowing. Capability unit VIe–1; Sandyland range site.

Miles fine sandy loam, 0 to 1 percent slopes (MfA).—This soil is on smooth upland plains. Areas are irregular in shape and range from 10 acres to several hundred acres in size.

The surface layer is reddish-brown fine sandy loam about 10 inches thick. Below this layer is reddish-brown, firm sandy clay loam about 20 inches thick. The next layer is red, firm sandy clay loam about 22 inches thick. The underlying material is reddish-yellow sandy clay loam.

Included with this soil in mapping are small areas of Miles loamy fine sand, 0 to 3 percent slopes. This soil is in areas less than 5 acres in size and on the slightly higher parts of the landscape. Also included are areas of Miles fine sandy loam, 1 to 3 percent slopes, and Bukreek soils. All of these soils make up less than 10 percent of the total acreage mapped as this Miles soil.

Runoff is slow. The hazard of water erosion is slight, and the hazard of soil blowing is moderate. Permeability is moderate, and the available water capacity is high.

Almost all of this soil is cultivated. Cotton and sorghum are the major crops. Management of crop residue on the soil surface helps to control soil blowing. Diversions and grassed waterways may be needed if excess runoff water becomes a concern. Capability unit IIIe–4; Sandy Loam range site.

Miles fine sandy loam, 1 to 3 percent slopes (MfB).—This soil is on upland plains. Slopes are dominantly 1.5 to 2.0 percent. Areas are irregular in shape and range from 10 to 1,000 acres in size.

The surface layer is reddish-brown fine sandy loam about 9 inches thick. Below this layer is reddish-brown sandy clay loam about 23 inches thick. The next layer is reddish-brown sandy clay loam about 40 inches thick. Below this layer is reddish-yellow loam.

Included with this soil in mapping are small areas of Miles loamy fine sand, 0 to 3 percent slopes; Miles fine sandy loam, 0 to 1 percent slopes; and Bukreek soils that have slopes of 3 to 5 percent. Also included are small areas of Woodward and Veal soils. All of these soils make up about 8 percent of the total acreage mapped as this Miles soil.

The hazards of soil blowing and water erosion are moderate. There are a few rills and gullies in some places. Permeability is moderate, and available water capacity is high. Runoff is medium.

Most of this soil is cultivated. Cotton, sorghum, and small grain are major crops. A few areas are irrigated. Management of crop residue on the soil surface is needed to help control soil blowing. Contour farming and terracing help to control water erosion. Diversions and grassed waterways may be needed if excess runoff water becomes a concern. Capability unit IIIe–4; Sandy Loam range site.

Miles fine sandy loam, 3 to 5 percent slopes (MfC).—This soil is mostly on the side slopes of convex ridges. It is associated with Miles fine sandy loam, 1 to 3 percent slopes. Slopes are dominantly 3 to 4 percent. Areas are oblong to irregular in shape and 200 acres or less in size.

The surface layer is reddish-brown fine sandy loam about 7 inches thick. Below this is reddish-brown sandy clay loam about 46 inches thick. The next layer is reddish-yellow sandy clay loam about 12 inches thick. The underlying material is red fine sandy loam.

Included with this soil in mapping are small areas of Miles fine sandy loam, 1 to 3 percent slopes; Miles fine sandy loam, 5 to 12 percent slopes; and Miles loamy fine sand that has 3 to 5 percent slopes. Also included are areas of Woodward and Veal soils. All of these soils make up about 10 percent of the total acreage mapped as this Miles soil.

Available water capacity is high. The hazards of soil blowing and water erosion are moderate. Runoff is medium. Most areas of this soil in cultivation have a few shallow gullies that are more than 300 feet apart and are crossable with farm machinery.

Most of this soil is cultivated. Sorghum and small grain are the major crops. It is better suited to grasses

than to most other uses. Managing crop residue on the soil surface and limiting tillage help to control soil blowing. Terraces are needed to control water erosion. Diversion terraces may be needed to control water from adjacent areas. Capability unit IVe–4; Sandy Loam range site.

Miles fine sandy loam, 5 to 12 percent slopes (MfD).—This soil is mostly along small drainageways. Slopes are mostly 5 to 8 percent. The areas are 10 acres to several hundred acres in size, irregular in shape, and parallel to the drainageways.

The surface layer is reddish-brown fine sandy loam about 7 inches thick. Below this is reddish-brown sandy clay loam about 42 inches thick. The next layer is reddish-yellow loam about 17 inches thick. The underlying material is red loam.

Included with this soil in mapping are small areas of Miles fine sandy loam, 3 to 5 percent slopes, and Miles loamy fine sand that has 3 to 5 percent slopes. Small areas of Veal, Hilgrave, and Woodward soils are also included. Eroded areas make up about 10 to 15 percent of the total acreage.

Runoff is medium. The hazard of soil blowing is moderate, and the hazard of water erosion is severe. The few areas of this soil that were once cultivated, or that are still cultivated, are eroded. There are numerous gullies, and some of these are uncrossable with farm machinery. The available water capacity is high.

This soil is better suited to range than to most other uses. A good cover of grasses is needed to help control water erosion and soil blowing. Capability unit VIe–5; Sandy Loam range site.

Nobscot Series

The Nobscot series consists of deep, well-drained, moderately rapidly permeable, sandy soils on uplands. These soils formed in eolian sands.

In a representative profile, the surface layer is fine sand about 22 inches thick. It is brown in the upper part and light brown in the lower part. The next layer is yellowish-red, very friable sandy loam about 30 inches thick. The underlying material is yellowish-red loamy fine sand.

Representative profile of Nobscot fine sand in a pasture, 150 feet south of rural road, from a point 2.4 miles west by rural road from its intersection with U.S. Highway 83 in Dunlap:

A1—0 to 6 inches, brown (7.5YR 5/2) fine sand, dark brown (7.5YR 4/2) moist; single grain; loose; many grass roots; slightly acid; gradual, smooth boundary.

A2—6 to 22 inches, light-brown (7.5YR 6/4) fine sand, brown (7.5YR 5/4) moist; single grain; loose; common grass roots; slightly acid; clear, smooth boundary.

B2t—22 to 52 inches, yellowish-red (5YR 5/6) sandy loam, yellowish red (5YR 4/6) moist; weak, medium, subangular blocky structure; slightly hard, very friable; few grass roots; clay bridges between sand grains; slightly acid; clear, smooth boundary.

B3—52 to 76 inches, yellowish-red (5YR 5/6) loamy fine sand, yellowish red (5YR 4/6) moist; single grain; slightly acid.

The A1 horizon ranges from 4 to 6 inches in thickness and from brown to grayish brown in color. Reaction is medium acid to slightly acid.

The A2 horizon ranges from 16 to 36 inches in thickness and from brown to light yellowish brown in color. Reaction is medium acid to slightly acid.

The Bt horizon ranges from 10 to 30 inches in thickness, from red to reddish yellow in color, and from fine sandy loam to loamy fine sand in texture. Reaction is medium acid to slightly acid. The B3 horizon is at a depth of 50 to 80 inches. It ranges from red to yellowish red in color and from sandy loam to fine sand in texture.

Nobscot fine sand (No).—This sloping soil is on uplands. Topography generally is undulating, but a few areas are hummocky. Areas are irregular in shape and range in size from 50 to 2,000 acres or more.

Included with this soil in mapping are small areas of Heatly, Delwin, Springer, and Miles soils. Also included are small blowouts that are severely eroded. All of these inclusions make up about 20 percent of the total acreage mapped as this Nobscot soil.

About 40 to 50 percent of this soil was cultivated at one time, but most of it has been reseeded to grass or has been idle for several years. Runoff is very slow. The hazard of soil blowing is severe, and the hazard of water erosion is slight. Most of the cultivated areas are slightly to moderately eroded. In the eroded areas, there are dunes 2 to 10 feet high and blowouts 1 to 5 feet deep. Wind-deposited soil accumulations from 1 to 3 feet in height are along fence rows or other obstructions in most cultivated or formerly cultivated fields. This soil is moderately rapidly permeable and has a low available water capacity.

This soil is better suited to range than to most other uses. A good cover of grasses is needed to help control soil blowing. Capability unit VIe–2; Deep Sand range site.

Owens Series

The Owens series consists of shallow, well-drained, very slowly permeable, clayey soils on uplands. These soils formed in clayey Permian red beds.

In a representative profile, the surface layer is reddish-brown clay about 7 inches thick. The next layer is reddish-brown, very firm clay about 6 inches thick. The underlying material, to a depth of 30 inches, is olive clayey shale.

Representative profile of an Owens clay in an area of Owens soils and Badland, 0.1 mile west of county road from a point 1.2 miles north via county road from a point on Farm Road 2532, 1.0 mile north of Ogden Gin:

A1—0 to 7 inches, reddish-brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; weak, fine, subangular blocky structure and moderate, fine, blocky structure; very hard, very firm; many roots and fine pores; few siliceous pebbles; few small calcium carbonate concretions; calcareous; moderately alkaline; clear, smooth boundary.

Bca—7 to 13 inches, reddish-brown (5YR 4/3) clay, dark reddish brown (5YR 3/4) moist; weak, fine and medium, blocky structure; extremely hard, very firm; few roots; few soft masses and small concretions of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

C—13 to 30 inches, olive (5Y 5/4) clayey shale; massive; few fine roots between shale fragments; few soft masses and concretions of calcium carbonate in crevices; calcareous; moderately alkaline.

The A1 horizon ranges from 4 to 10 inches in thickness, from reddish brown to red in color, and from clay loam to clay in texture.

The Bca horizon ranges from 4 to 10 inches in thickness, from reddish brown to olive in color, and from clay loam to clay in texture. Calcium carbonate content ranges from a

few visible films to about 5 percent, by volume, soft masses. Depth to the C horizon ranges from 12 to 20 inches. It is reddish brown to olive, clayey, shaly red beds mottled with various shades of gray and blue.

Owens soils and Badland (Ob).—This undifferentiated group consists of gently sloping to steep areas on uplands (fig. 14). Areas are irregular in shape and range in size from 10 to 2,000 acres or more. They do not occur in repeating patterns. This mapping unit averages about 39 percent Owens soils, 38 percent Badland, and 23 percent included soils. The Owens soils are gently sloping and in most places are below areas of Badland. The Badland is gently sloping to steep and is on erosion scarps and on foot slopes below the scarps.

The materials in which these soils formed vary from one area to another, especially in respect to gypsum content. In the Pease River Breaks, as well as in some other areas of the county, clays and shales are interbedded with various forms of gypsum.

The profile of Owens soils is the one described as representative for the series. Badland consists of nearly barren outcrops of red-bed shale or clay.

Included in some areas of this mapping unit are narrow bands of Colorado soils along the larger drains. Narrow ledges and small hilltops of Talpa soils are also included. Other inclusions are mainly Vernon and Cottonwood soils and gypsum outcrops.

Much of this mapping unit is severely eroded as a result of geologic erosion. The hazard of water erosion is severe, and the hazard of soil blowing is slight. Surface runoff is rapid.

This mapping unit is suitable only for limited grazing and for wildlife habitat. It is all in range. A good cover of grasses is needed to control erosion. Recovery of vegetation is very slow. Resting from grazing is needed if the vigor of grasses is low. Careful consideration is also needed in locating roads and other improvements so that traffic by livestock or vehicles does not create erosion problems. Capability unit VIIs–1; Owens part in Shallow Redland range site, Badland not assigned to range site.

Owens, Talpa, and Vernon soils (Ot).—The gently sloping to moderately steep soils in this undifferentiated group are on uplands. Slopes range from 1 to 15 percent. This mapping unit averages about 35 percent Owens soils, 30 percent Talpa stony loam, and 19 percent Vernon soils. The remaining 16 percent is included soils and land types.

The topography of these soils consists of a series of steep scarps and steplike benches dissected by intermittent streams and gullies (fig. 15). The Talpa soils are on the scarps, ledges, or hilltops. Most areas of Talpa soils range from 1 to 10 acres in size. There is limestone about 1 to 6 feet thick in most areas. The Owens and Vernon soils are on the less sloping benches and on the lower part of scarp faces below the limestone ledges. Limestone fragments are on the surface of the Owens and Vernon soils in places, especially below ridges of Talpa soils.

The Owens soils have a surface layer of reddish-brown clay about 5 inches thick. The subsoil is red, firm clay about 7 inches thick. The underlying material is olive, calcareous, clayey shale.

The Talpa soils have a grayish-brown stony loam surface layer, about 6 inches thick, that contains about 20

***Figure 14.*—Typical area of Owens soils and Badland. The area in the foreground is mostly Badland.**

Figure 15.—**Typical area of Owens, Talpa, and Vernon soils. Fragments on surface are limestone.**

percent coarse limestone fragments. The underlying material is hard, fractured limestone.

The Vernon soils have a surface layer of reddish-brown clay loam about 6 inches thick. The subsoil is reddish-brown clay about 12 inches thick. Beneath this is red clay about 8 inches thick. The underlying material is olive-gray, calcareous, clayey shale.

Included with these soils in mapping are some areas of Badland on some of the steep scarp faces. Also included are a few narrow areas of Colorado soils along some of the larger drains. Other inclusions are Tillman, Quanah, and Cottonwood soils and gypsum outcrops.

The hazard of water erosion is severe, and the hazard of soil blowing is slight. These soils are well drained. Surface runoff is rapid.

These soils are suitable only for range, wildlife habitat, and recreational use. Vegetation is sparse in most areas, which have 25 to 50 percent bare ground. A good cover of grass is needed to control erosion. Rest from grazing is necessary where the vigor of grasses is low. Careful consideration is also needed in locating roads and other improvements where traffic by livestock or vehicles may create erosion problems. Capability unit VIIs–1; Owens and Vernon parts in Shallow Redland range site, Talpa part in Very Shallow range site.

Paducah Series

The Paducah series consists of deep, well-drained, moderately permeable, loamy soils on uplands. These soils formed in material weathered from calcareous, weakly cemented sandstone or siltstone.

In a representative profile, the surface layer is reddish-brown loam about 8 inches thick. Below this layer is about 8 inches of reddish-brown, friable loam. The next layer is reddish-brown, friable clay loam about 11 inches thick. Below this is about 17 inches of red, friable loam. The underlying material is about 28 inches of light-red very fine sandy loam over red, soft, sandy, calcareous red beds that extend to a depth of 90 inches.

Representative profile of Paducah loam, 3 to 5 percent slopes, in a cultivated field 100 feet north of a point on Farm Road 1440, that is 2.75 miles west of its intersection with U.S. Highway 83, about 14 miles north of Paducah:

Ap—0 to 8 inches, reddish-brown (5YR 5/4) loam, dark reddish brown (5YR 3/4) moist; weak, fine, granular structure; soft, friable; mildly alkaline; abrupt, smooth boundary.

B1t—8 to 16 inches, reddish-brown (5YR 4/4) loam, dark reddish brown (5YR 3/4) moist; weak to moderate, fine, subangular blocky structure; slightly hard, friable; few clay films on ped faces; mildly alkaline; gradual, smooth boundary.

B2t—16 to 27 inches, reddish-brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) moist; weak to moderate, fine and medium, subangular blocky structure; hard, friable; ped faces have thin clay films; mildly alkaline; gradual, smooth boundary.

B3—27 to 44 inches, red (2.5YR 4/6) loam, dark red (2.5YR 3/6) moist; weak, fine and medium, subangular blocky structure; slightly hard, friable; few films

and threads of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

C1ca—44 to 72 inches, light-red (2.5YR 6/6) very fine sandy loam, red (2.5YR 5/6) moist; massive; soft, very friable; few concretions of calcium carbonate and about 5 percent soft masses; calcareous; moderately alkaline; diffuse, smooth boundary.

C2—72 to 90 inches, red (2.5YR 5/6), soft, sandy Permian red beds; massive; calcareous; moderately alkaline.

The A horizon ranges from 6 to 10 inches in thickness, from reddish brown to brown in color, and from neutral to mildly alkaline in reaction.

The B1t horizon ranges from 0 to 10 inches in thickness, from loam to sandy clay loam in texture, and from neutral to moderately alkaline in reaction. The B2t horizon ranges from 10 to 18 inches in thickness, from reddish brown to reddish yellow in color, from loam to clay loam in texture, and from neutral to moderately alkaline in reaction. The B3 horizon ranges from 12 to 20 inches in thickness, from red to reddish yellow in color, and from very fine sandy loam to sandy clay loam in texture.

The C1ca horizon ranges from 4 to 30 inches in thickness. Carbonates range from few films and threads to 15 percent soft masses and concretions. The C2 horizon is weakly cemented sandstone or siltstone.

Paducah loam, 3 to 5 percent slopes (PaC).—This soil is on ridges. Most areas are less than 300 acres in size. Slopes are dominantly 3 to 4 percent. The areas are commonly narrow and occupy the sides of ridges.

Included with this soil in mapping are areas of Woodward and Carey soils that are generally less than 10 acres in size.

Runoff is medium. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. Available water capacity is high.

This soil is mostly cultivated. Cotton and grain sorghum are grown most extensively. Crop rotation, crop residue managed on the soil surface, and limited but timely tillage are necessary management practices. Contour farming and terraces are needed to control water erosion. Diversion terraces and grassed waterways are needed in places for safe disposal of runoff water. Capability unit IIIe–3; Mixedland range site.

Quanah Series

The Quanah series consists of deep, well-drained, moderately permeable, calcareous, loamy soils on uplands. These soils formed in calcareous, loamy to clayey material.

In a representative profile, the surface layer is brown silty clay loam about 10 inches thick. Below this layer is about 20 inches of brown, friable silty clay loam. The underlying material is reddish-yellow silty clay loam in the upper part and light-brown clay loam in the lower part. The upper part contains 15 to 25 percent soft masses and hard concretions of calcium carbonate.

Representative profile of Quanah silty clay loam in an area of Quanah-Talpa complex in a pasture 50 feet east of county road, from a point 0.6 mile east, 0.35 mile north, 0.45 mile east, and 0.1 mile south via county road from its intersection with Farm Road 104, 1.3 miles south of intersection of Farm Roads 1033 and 104:

A1—0 to 10 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) moist; weak, fine, subangular blocky structure and weak, fine, granular structure; hard, friable; many grass roots; many very fine pores; calcareous; moderately alkaline; clear, smooth boundary.

B21—10 to 19 inches, brown (7.5YR 5/4) silty clay loam, dark brown (7.5YR 4/3) moist; moderate, fine to medium, subangular blocky structure; hard, friable; many fine pores and common medium pores; calcareous; moderately alkaline; gradual, smooth boundary.

B22—19 to 30 inches, brown (7.5YR 5/4) silty clay loam, dark brown (7.5YR 4/4) moist; moderate, fine to medium, subangular blocky structure; hard, friable; many very fine pores; few, fine, calcium carbonate concretions; calcareous; moderately alkaline; gradual, smooth boundary.

C1ca—30 to 48 inches, reddish-yellow (5YR 6/6) silty clay loam, yellowish red (5YR 5/6) moist; massive; hard, friable; contains an estimated 15 to 25 percent, by volume, soft masses and concretions of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

C2—48 to 60 inches, light-brown (7.5YR 6/4) clay loam, brown (7.5YR 5/4) moist; massive; very hard, firm; many films and threads of calcium carbonate; calcareous; moderately alkaline.

The A horizon ranges from 7 to 11 inches in thickness, is brown to dark grayish brown in color, and is clay loam or silty clay loam in texture.

The B21 horizon ranges from 7 to 22 inches in thickness, is reddish brown to dark grayish brown in color, and is clay loam or silty clay loam in texture. A few threads, films, and small masses of calcium carbonate occur in some places. The B22 horizon ranges from 7 to 22 inches in thickness, is reddish brown to brown in color, and is clay loam or silty clay loam in texture. Calcium carbonate content ranges from few to common, fine, soft masses, films, or fine, hard concretions.

Depth to the C1ca horizon is 24 to 40 inches. This horizon is reddish yellow to light brown in color. Films, soft masses, or hard concretions of calcium carbonate make up from 15 to 30 percent, by volume, of this horizon. Color of the C2 horizon ranges from light brown to reddish brown.

Quanah-Talpa complex (Qt).—The soils in this complex are on uplands. Areas range from 5 acres to about 400 acres in size but are dominantly about 30 to 60 acres. About 47 percent of this complex is Quanah soils, and 38 percent is Talpa soils. The remaining 15 percent is included soils. The gently sloping Quanah soils occupy valleys or foot slopes and meander between areas of gently sloping to sloping Talpa soils on hilltops and ridges.

The profile of the Quanah soils is the one described as representative for the series. The Talpa soils have a surface layer of brown stony loam about 8 inches thick. It is about 20 percent, by volume, limestone fragments. The underlying material is hard, fractured limestone.

Included with these soils in mapping are narrow bands of Vernon, Weymouth, and Cottonwood soils, which occur just below the Talpa soils and above the Quanah soils. Also included are small areas of Tillman soils in some of the wider valleys.

Surface runoff is medium to rapid. The hazard of water erosion is moderate, and the hazard of soil blowing is slight.

Almost all of this complex is in range. The Quanah soils in this complex are suited to cultivation, but they are so intermingled with the nonarable Talpa soils that most areas are not practical to cultivate. A good cover of grasses is needed to control erosion. Rest from grazing is needed if the vigor of grasses is low. Careful planning is also needed in locating roads and other improvements so that traffic by livestock or vehicles does not create erosion problems. Capability unit VIIs–1; Quanah part in Deep Hardland range site. Talpa part in Very Shallow range site.

Quinlan Series

The Quinlan series consists of shallow, well-drained, moderately rapidly permeable loamy soils on uplands. These soils formed in calcareous, weakly consolidated sandstone.

In a representative profile, the surface layer is yellowish-red loam about 5 inches thick. The next layer is about 8 inches of light-red loam. The underlying material, extending to a depth of 60 inches, is red, weakly cemented, fine-grained sandstone.

Quinlan soils are mapped only in an undifferentiated group with Woodward soils.

Representative profile of Quinlan loam in an area of Woodward and Quinlan loams 0.1 mile south of county road, from a point 1.2 miles west, 1.0 mile south, and 1.0 mile west via county road from its intersection with Farm Road 1440, about 1.0 mile west of Cee Vee:

A1—0 to 5 inches, yellowish-red (5YR 5/6) loam, yellowish red (5YR 4/6) moist; weak, medium, granular and subangular blocky structure; soft, very friable; calcareous; moderately alkaline; gradual, smooth boundary.

B—5 to 13 inches, light-red (2.5YR 6/6) loam, red (2.5YR 4/6) moist; weak, medium, subangular blocky structure; slightly hard, very friable; few small fragments of soft sandstone; calcareous; moderately alkaline; gradual, wavy boundary.

C—13 to 60 inches, red (2.5YR 5/8), weakly cemented, calcareous, fine-grained sandstone.

The A horizon ranges from 4 to 10 inches in thickness and from reddish brown to yellowish red in color.

The B horizon ranges from 4 to 10 inches in thickness and from reddish brown to reddish yellow in color.

The C horizon ranges from weakly cemented, fine-grained sandstone to packsand. Depth to the C horizon ranges from 10 to 20 inches.

Rough Broken Land

Rough broken land (Ro) consists of rough, steep, and broken areas (fig. 16). This land type occurs mainly along the transition or divide between soils that developed in clayey red beds. The divide is a steep escarpment. There are also some deep drainageways or gullies. Mapped areas range from 100 to 1,000 acres or more in size. Most areas are narrow and occur along the escarpment and gullies.

The topography is steep. Slopes are 20 to 45 percent. The difference in elevation from top to bottom of the escarpment ranges from 35 to 100 feet but is commonly 40 to 60 feet. Gullies lie below the escarpment, and finger-like gullies extend back into the escarpment in most areas to produce a very rough, irregular topography.

Figure 16.—Typical area of Rough broken land in the Pease River Breaks.

This mapping unit is variable, but it is consistent from one area to another. A cap of limestone rock at the top or rim of the escarpment ranges from 3 to 6 feet in thickness. Immediately below this cap is a layer of soft, sandy red beds that ranges from 6 to 20 feet in thickness. Below the sandy red beds are silty and clayey red beds that are intermixed in places with thin strata of gypsum. Stone fragments that have broken off the limestone cap occur on the upper slopes.

Included with this land type in mapping are areas of Quinlan, Talpa, Cottonwood, and Owens soils and of Badland.

Vegetation is sparse in most areas. The ground is bare in 70 to 90 percent of the area. Most of the vegetation grows on the upper slopes of the sandy red beds. The hazard of water erosion is severe, but the hazard of soil blowing is slight. This land type is better suited to limited grazing and wildlife habitat than to most other uses. A good grass cover is needed to control water erosion on these soils. Locations of roads, pens, and other improvements need to be planned carefully to reduce erosion hazards. Wildlife habitat should be preserved to the extent needed to provide food and cover. Capability unit VIIs–2; Rough Breaks range site.

Sagerton Series

The Sagerton series consists of deep, well-drained, moderately slowly permeable, loamy soils on uplands. These soils formed in calcareous outwash or old alluvial material.

In a representative profile, the surface layer is brown clay loam about 7 inches thick. Below this layer is about 8 inches of brown, firm clay. The next layer is reddish-brown, very firm clay about 10 inches thick. Below this layer is about 11 inches of yellowish-red, very firm clay loam. The next layer is pink, friable clay loam that is about 26 inches thick and is about 30 to 40 percent soft masses and concretions of calcium carbonate. Below this layer, extending to a depth of 84 inches, is light-red, firm clay loam.

Representative profile of Sagerton clay loam, 1 to 3 percent slopes, 200 feet south of county road, from a point 1.0 mile east, 0.55 mile north, and 1.55 miles east via county road from its intersection with Farm Road 1038, 1.8 miles east and 2.6 miles south of the intersection of Farm Road 1038 and U.S. Highway 83 on the south edge of Paducah:

Ap—0 to 7 inches, brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) moist; weak, fine, granular structure; slightly hard, friable; few fine roots; few siliceous pebbles; mildly alkaline; abrupt, smooth boundary.

B21t—7 to 15 inches, brown (7.5YR 4/2) clay, dark brown (7.5Y 3/2) moist; moderate, medium and fine, subangular blocky structure; very hard, firm; few fine roots; few fine pores; thin, distinct clay films on peds; few siliceous pebbles; mildly alkaline; gradual, smooth boundary.

B22t—15 to 25 inches, reddish-brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; moderate, medium, blocky structure; very hard, very firm; few roots; thin, distinct clay films on peds; common worm

casts; noncalcareous; moderately alkaline; gradual, smooth boundary.

B23t—25 to 36 inches, yellowish-red (5YR 5/6) clay loam, yellowish red (5YR 4/6) moist; moderate, medium, blocky structure; very hard, very firm; few thin clay films on peds; few films and threads and common soft and strongly cemented calcium carbonate concretions; calcareous; moderately alkaline; clear, wavy boundary.

B24ca—36 to 62 inches, pink (5YR 7/4) clay loam, reddish brown (5YR 5/4) moist; weak, medium, subangular blocky structure; slightly hard, friable; contains estimated 30 to 40 percent soft calcium carbonate masses; strongly cemented concretions ¼ to 1 inch in diameter; calcareous; moderately alkaline; clear, smooth boundary.

B25t—62 to 84 inches, light-red (2.5YR 6/6) clay loam, red (2.5YR 5/6) moist; weak, medium, subangular blocky structure; slightly hard, firm; few thin clay films on peds; contains 3 to 5 percent calcium carbonate by volume; few siliceous pebbles; calcareous; moderately alkaline.

The A horizon ranges from 5 to 12 inches in thickness, from brown to reddish brown in color, and from loam to clay loam in texture.

The B21t and B22t horizons range from 14 to 26 inches in thickness, from reddish brown to brown in color, and from clay loam to clay in texture. Reaction is mildly alkaline to moderately alkaline. The B23t horizon ranges from 5 to 12 inches in thickness, from reddish brown to yellowish red in color, and from clay loam to clay in texture. The B24t horizon ranges from 12 to 28 inches in thickness and from reddish brown to reddish yellow in color. This horizon contains 20 to 40 percent calcium carbonate. The B25t horizon ranges from red to reddish yellow in color.

Sagerton loam, 0 to 1 percent slopes (SaA).—This soil has slopes that are dominantly about 0.5 percent. The areas are broad and irregular in shape and from 15 to 1,000 acres in size.

The surface layer is reddish-brown loam about 11 inches thick. Below this layer is reddish-brown clay loam about 26 inches thick. The next layer is yellowish-red clay loam about 12 inches thick. Beneath this is reddish-yellow clay loam that is about 20 inches thick and has about 20 percent calcium carbonate.

Included with this soil in mapping are small areas of Sagerton clay loam and Bukreek, Abilene, and Weymouth soils. Also included are soils in which the zone of secondary carbonates is at a depth of more than 28 inches. A few areas of soils that are similar to this Sagerton soil but have a surface layer of fine sandy loam are also included.

Available water capacity is high. Surface runoff is slow. The hazards of water erosion and soil blowing are slight.

Most of this soil is cultivated. Cotton, small grain, and some sorghum are the major crops. The main need of management is to maintain soil tilth. Crop rotation, management of crop residue on the soil surface, and timely but limited tillage help to maintain tilth. Capability unit IIc–4; Deep Hardland range site.

Sagerton loam, 1 to 3 percent slopes (SaB).—This soil has slopes that are dominantly 1.5 to 2.0 percent. Areas are irregular in shape and range from 10 to 500 acres in size.

The surface layer is reddish-brown loam about 6 inches thick. Below this layer is reddish-brown clay loam about 26 inches thick. The next layer, to a depth of 80 inches, is red clay loam that contains calcium carbonate accumulations at a depth of 50 inches.

Included with this soil in mapping are small areas of Bukreek and Weymouth soils and Sagerton clay loam, 1 to 3 percent slopes. Also included are soils in which the zone of secondary carbonates is at a depth of more than 28 inches. A few small areas of soils that are similar to this Sagerton soil but have a surface layer of fine sandy loam are also included.

Available water capacity is high. Runoff is medium. The hazard of water erosion is moderate, and the hazard of soil blowing is slight. A few gullies occur along drainageways. The surface layer is thinner near these gullies, and the subsoil is exposed in some areas.

Most of this soil is cultivated. Small grain and some cotton and sorghum are grown. The main needs of management are crop rotation, leaving crop residue on the surface to control erosion and maintain soil tilth, and timely but limited tillage. Contour farming and use of terraces, diversions, and grassed waterways are also needed. Capability unit IIe–2; Deep Hardland range site.

Sagerton clay loam, 0 to 1 percent slopes (ScA).—This soil has slopes that are dominantly 0.3 to 0.8 percent. The areas are irregular in shape and range from 25 to 1,000 acres or more in size.

The surface layer is brown clay loam about 7 inches thick. Below this layer is brown clay about 8 inches thick. The next layer is reddish-brown clay about 15 inches thick. The next layer is about 11 inches of yellowish-red clay loam. Below this layer is pink clay loam that is about 21 inches thick and contains about 40 percent calcium carbonate. This layer is underlain by light-red clay loam.

Included with this soil in mapping are areas of Sagerton loam, 0 to 1 percent slopes, and Abilene soils. These soils are in areas less than 10 acres in size. Soils that have secondary carbonates beginning at a depth of more than 28 inches are also included.

Available water capacity is high. Runoff is slow. The hazards of soil blowing and water erosion are slight.

Most of this soil is cultivated. Cotton, small grain, and some sorghum are the major crops. The main need of management is to maintain good soil tilth. Rotation of crops, management of crop residue on the soil surface, and timely but limited tillage all help to maintain soil tilth. Capability unit IIc–4; Deep Hardland range site.

Sagerton clay loam, 1 to 3 percent slopes (ScB).—This soil has convex slopes that are dominantly 1.5 to 2.0 percent. Areas are irregular in shape and range from 10 to 300 acres in size. The profile of this soil is the one described as representative for the series.

Included with this soil in mapping are small areas of Sagerton loam, 1 to 3 percent slopes, and Weymouth and Abilene soils. Also included are small areas along drainageways that have been moderately eroded by water. These areas are narrow and occur in unprotected sloping areas. Soils in which the zone of secondary carbonates is more than 28 inches below the surface are also included.

Available water capacity is high. The hazard of water erosion is moderate, and the hazard of soil blowing is slight. Runoff is medium.

Most of this soil is cultivated. Small grain and some cotton and sorghum are grown. The main needs of management are rotation of crops, management of crop residue on the soil surface to control erosion and maintain soil

tilth, and timely but limited tillage. Contour farming and use of terraces, diversions, and grassed waterways are also needed. Capability unit IIe–2; Deep Hardland range site.

St. Paul Series

The St. Paul series consists of deep, well-drained, moderately slowly permeable, loamy soils on uplands. These soils formed in old alluvial deposits.

In a representative profile, the surface layer is brown silt loam about 10 inches thick. The next layer is dark-brown clay loam about 34 inches thick. Below this is grayish-brown clay loam that is about 28 inches thick and has 5 percent calcium carbonate. It is underlain by gray clay loam that extends to a depth of about 84 inches.

Representative profile of St. Paul silt loam in a cultivated field 300 feet north of Farm Road 1440, from a point 0.4 mile east of Cee Vee:

Ap—0 to 10 inches, brown (7.5YR 5/2) silt loam, dark brown (7.5YR 3/2) moist; weak, granular structure; soft, very friable; neutral; abrupt, smooth boundary.

B1t—10 to 16 inches, dark-brown (7.5YR 4/2) clay loam, very dark brown (7.5YR 2/2) moist; moderate, subangular blocky structure; slightly hard, friable; few thin clay films; mildly alkaline; gradual, smooth boundary.

B2t—16 to 34 inches, dark-brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) moist; moderate, medium, blocky structure; very hard, firm; few thin clay films on peds; mildly alkaline; gradual, smooth boundary.

B3t—34 to 44 inches, dark-brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) moist; weak, medium, subangular blocky structure; hard, firm; few thin clay films; few threads and films of calcium carbonate; calcareous; moderately alkaline; gradual, wavy boundary.

C1ca—44 to 72 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, friable; about 5 percent soft masses, films, and threads of calcium carbonate; calcareous; moderately alkaline; diffuse, wavy boundary.

C2—72 to 84 inches, gray (10YR 5/1) clay loam, dark gray (10YR 4/1) moist; massive, soft, old alluvial materials; calcareous; moderately alkaline.

The A horizon ranges from 7 to 10 inches in thickness and from dark brown to brown in color. Reaction is neutral to mildly alkaline.

The B1t horizon ranges from 5 to 12 inches in thickness, from dark brown to brown in color, and from loam to silty clay loam in texture. The B2t horizon ranges from 12 to 20 inches in thickness, from brown to reddish brown in color, and from clay loam to silty clay loam in texture. The B3t horizon, where present, ranges from reddish brown to brown in color, from 6 to 15 inches in thickness, and from loam to clay loam or sandy clay loam in texture.

The C horizon ranges from reddish yellow to gray in color. Depth to the Cca horizon ranges from 30 to 45 inches. This horizon ranges from brown to yellowish red in color and from loam to clay loam in texture. Calcium carbonate content ranges from 3 to 25 percent.

St. Paul silt loam (Sp).—This nearly level soil is on upland flats. Areas are irregular in shape and are dominantly 25 to 400 acres in size.

Included with this soil in mapping are areas of Carey soils less than 5 acres in size. Also included are outcrops of gypsum materials. A few small areas of soils that occur mostly along drainageways and have slopes greater than 1 percent are also included.

Available water capacity is high. Runoff is slow, and the hazards of soil blowing and water erosion are slight.

All of this soil is cultivated. Cotton, small grain, and grain sorghum are the major crops. The main need of management is to maintain good soil tilth. Management of crop residue on the soil surface helps to maintain soil tilth. Capability unit IIc–3; Deep Hardland range site.

Springer Series

The Springer series consists of deep, well-drained, moderately rapidly permeable, sandy soils on uplands. These soils formed in sandy outwash sediment.

In a representative profile, the surface layer is reddish-brown loamy fine sand about 16 inches thick. Below this layer is reddish-brown, friable fine sandy loam about 15 inches thick. The next layer is yellowish-red, very friable fine sandy loam about 26 inches thick. Below this is about 18 inches of red, very friable fine sandy loam. The underlying material, extending to a depth of 92 inches, is reddish-brown loamy fine sand (fig. 17).

Representative profile of Springer loamy fine sand, undulating, in a pasture 100 feet north of county road, from a point 0.6 mile west of Matador Wildlife Refuge Headquarters, 3.0 miles west via county road from its intersection with U.S. Highway 83, which is 7.0 miles north of Paducah:

A1—0 to 16 inches, reddish-brown (5YR 5/4) loamy fine sand, reddish brown (5YR 4/4) moist; single grain; loose; neutral; clear, smooth boundary.

B21t—16 to 31 inches, reddish-brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky structure; soft, friable; few fine pores; clay bridges between sand grains; mildly alkaline; gradual, smooth boundary.

B22t—31 to 51 inches, yellowish-red (5YR 5/6) fine sandy loam, yellowish red (5YR 4/6) moist; weak, medium, subangular blocky structure; soft, very friable; some clay bridging between sand grains; mildly alkaline; diffuse, smooth boundary.

B3t—57 to 75 inches, red (2.5YR 5/6) fine sandy loam, red (2.5YR 4/6) moist; weak, medium, granular structure; soft, very friable; mildly alkaline; diffuse, smooth boundary.

C—75 to 92 inches, reddish-brown (5YR 5/4) loamy fine sand, reddish brown (5YR 4/4) moist; single grain; loose; mildly alkaline.

The A horizon ranges from 8 to 20 inches in thickness and from brown to light reddish brown in color.

The B2t horizon ranges from 20 to 50 inches in thickness and from red to yellowish red in color. Reaction ranges from neutral to moderately alkaline. The B3t horizon, where present, ranges from 12 to 24 inches in thickness, from fine sandy loam to loamy fine sand in texture, and from red to yellowish red in texture.

The C horizon ranges from fine sandy loam to loamy fine sand in texture and from red to reddish yellow in color.

Springer loamy fine sand, undulating (SrB).—This soil is nearly level to gently sloping. Slopes are dominantly 1.0 to 2.5 percent. Areas are irregular in shape and 25 to 1,000 acres or more in size. The profile of this soil is the one described as representative for the series.

Included with this soil in mapping are areas of Nobscot and Miles soils. Also included in small areas along drainageways and in low areas are soils that are similar to Springer soils but have a fine sandy loam surface layer. Small gravel outcrops and soils that have gravel strata at a depth of 2 to 4 feet are also included.

The hazard of water erosion is slight, and the hazard of soil blowing is severe. Available water capacity is moderate. Runoff is slow. Accumulations of windblown soil a few inches to several feet in height have formed along fence rows or other obstructions in most cultivated fields. There are a few gullies, 1 to 5 feet deep and 5 to 30 feet across, along the drainageways. Small dues and blowouts occur in cultivated fields. The blowouts are 1 to 3 feet deep, and the dunes are 2 to 5 feet high.

Most of this soil is cultivated. Cotton and sorghum are the major crops. Only crops should be grown that leave protective amounts of residue on the surface to control soil blowing. This includes drilled or close-spaced sorghum, small grain, and grasses. Tillage needs to be held to a minimum. Capability unit IVe–3; Sandyland range site.

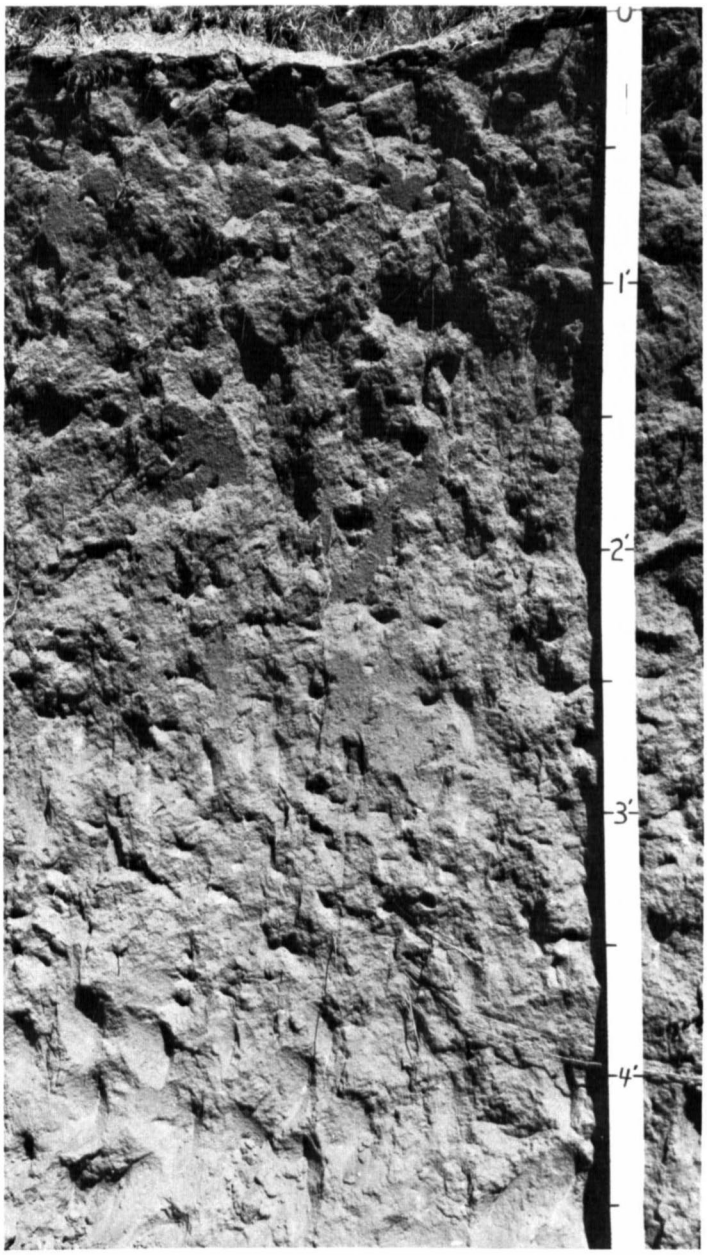

Figure 17.—**Profile of a Springer loamy fine sand.**

Springer loamy fine sand, hummocky (SrD).—This soil is on ridges. Slopes are dominantly 3 to 6 percent, but there are a few areas where slopes are as much as 8 percent. The areas are elongated to irregular in shape and range from 10 to 800 acres in size.

The surface layer is brown loamy fine sand about 17 inches thick. Below this layer is yellowish-red fine sandy loam about 45 inches thick. The next layer is reddish-yellow, loose loamy fine sand.

Included with this soil in mapping are small areas of Miles and Nobscot soils and small outcrops of gravel on some ridgetops.

The hazard of water erosion is moderate, and the hazard of soil blowing is severe. Available water capacity is moderate. Runoff is slow. There are a few gullies, 2 to 8 feet deep and 10 to 30 feet across, along drainageways. A few dunes and blowouts occur in some cultivated areas. Fence rows around fields have accumulations of windblown soil 3 to 10 feet in height.

These soils are better suited to range than to most other uses. A good cover of grass is needed for the control of soil blowing and water erosion. Capability unit VIe–1; Sandyland range site.

Springer and Tivoli soils, hummocky (StD).—The gently sloping to sloping soils in this undifferentiated group occur in areas of abandoned cropland. Most areas range from 25 to 300 acres in size. This mapping unit averages about 70 percent Springer soils, 17 percent Tivoli soils, and 13 percent other soils.

The Springer soils have a brown, loamy fine sand surface layer about 8 inches thick. Below this layer is reddish-brown fine sandy loam about 30 inches thick. The next layer is yellowish-red fine sandy loam about 24 inches thick. Below this is reddish-yellow, loose loamy fine sand.

The Tivoli soils have a brown fine sand surface layer about 6 inches thick. The underlying material is light reddish-brown fine sand.

Included with these soils in mapping are areas of Nobscot and Miles soils.

Runoff is slow. The hazard of soil blowing is severe, and the hazard of water erosion is moderate. The surface has been wind drifted and has formed hummocks or small dunes, most of which are 1 to 6 feet higher than the original surface. A few shallow to deep gullies, uncrossable with farm machinery, occur in a few places along natural drainageways.

Most areas of these soils are used as range. These soils are better suited to range, recreation, and wildlife habitat than to most other uses. The main need of management is to control soil blowing and water erosion. A good cover of grasses helps to accomplish this. Capability unit VIe–1; Sandyland range site.

Talpa Series

The Talpa series consists of very shallow, well-drained, moderately permeable, loamy soils on uplands. These soils formed in dolomitic limestone.

In a representative profile, the surface layer is brown stony loam about 6 inches thick. It is underlain by white, fractured, dolomitic limestone.

Representative profile of Talpa stony loam in a pasture 200 feet south of Farm Road 104, from a point 0.15 mile east along Farm Road 104 from the junction of Farm Roads 104 and 1033:

A1—0 to 6 inches, brown (7.5YR 4/2) stony loam, dark brown (7.5YR 3/2) moist; weak, granular structure and moderate, fine, subangular blocky structure; soft, friable; many very fine pores; many hard dolomitic limestone fragments, mostly less than 15 inches across the longest axis, make up about 20 percent of the horizon; calcareous; moderately alkaline; abrupt, irregular boundary.

Rca—6 to 12 inches, white (10YR 8/2), hard, fractured dolomitic limestone rock that has reprecipitated calcium carbonate coatings in crevices and on fragments.

The A horizon ranges from 5 to 10 inches in thickness, from loam to clay loam in texture, and from brown to grayish brown in color. The coarse fragments range from 10 to 30 percent, by volume, of this horizon.

The Rca layer ranges from 4 inches to several feet in thickness. In some places it is interbedded with red-bed clay or shale.

Talpa stony loam (Ta).—This gently sloping to strongly sloping soil is on ridges and knolls. Most areas are on ridges or side slopes above large drains. Areas are irregular in shape and range from 10 to 1,000 acres or more in size. Slopes range from 3 to 12 percent. The profile of this soil is the one described as representative for the series.

Included with this soil in mapping are areas, less than 5 acres in size, of Vernon, Quanah, and Tillman soils in narrow valleys and the lower parts of the landscape. Also included are areas in which the limestone rock is exposed at the surface. Small areas of Owens soils and Badlands are also included. All of these inclusions make up about 12 to 15 percent of the total acreage.

Runoff is rapid, and the hazard of water erosion is moderate. The hazard of soil blowing is slight. The available water capacity is low.

This soil is all in range. A good cover of grass is needed to control erosion. Deferred grazing is needed if the vigor of grasses is low. Careful planning is also needed to locate roads and other improvements so that traffic by livestock or vehicles does not create erosion problems. Capability unit VIIs–1; Very Shallow range site.

Tillman Series

The Tillman series consists of deep, well-drained, slowly permeable, loamy soils on uplands. These soils formed in ancient alluvium washed from red-bed clays and shales.

In a representative profile, the surface layer is brown silty clay loam about 6 inches thick. Below this layer is about 32 inches of very firm clay that is dark reddish brown in the upper part and reddish brown in the lower part. The next layer is red, very firm clay about 22 inches thick. Below this layer is about 9 inches of dark-red gravelly clay. The next layer is dark reddish-brown clay about 12 inches thick. The underlying material, to a depth of more than 90 inches, is variegated grayish-green and dark reddish-brown clay.

Representative profile of Tillman silty clay loam, 1 to 3 percent slopes, in a cultivated field 600 feet east of Farm Road 2532 and 0.1 mile north of an east-west county road, 1.0 mile west of its intersection with Farm Road 2564, 1.0 mile north of the intersection of Farm Road 2564 with U.S. Highway 70, 11.5 miles northeast of Paducah:

Ap—0 to 6 inches, brown (7.5YR 4/4) silty clay loam, dark brown (7.5YR 3/2) moist; weak, medium, subangular blocky structure; very hard, firm; common roots; few strongly cemented calcium carbonate concretions up to ¼ inch in diameter; few siliceous pebbles and cobblestones on the surface and in the soil; mainly noncalcareous in matrix but weakly effervescent surrounding calcium carbonate concretions; abrupt, smooth boundary.

B21t—6 to 14 inches, dark reddish-brown (5YR 3/2) clay, dark reddish brown (5YR 3/3) moist; weak, coarse, prismatic structure parting to moderate, medium and fine, angular blocky structure; very hard, very firm; few roots; few strongly cemented calcium carbonate concretions as much as ¼ inch in diameter; few siliceous pebbles; cracks extend through lower boundary; mildly alkaline; clear, smooth boundary.

B22t—14 to 23 inches, reddish-brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; strong, coarse, prismatic structure parting to strong, medium and fine, angular blocky structure; extremely hard, very firm; few fine roots; few strongly cemented and weakly cemented calcium carbonate concretions; few siliceous pebbles; cracks extend through lower boundary; mildly alkaline; gradual, smooth boundary.

B23t—23 to 38 inches, reddish-brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; strong, coarse, prismatic structure parting to strong, coarse and medium, angular blocky structure; extremely hard, very firm; few fine roots, mainly between peds; few strongly cemented and weakly cemented calcium carbonate concretions; few siliceous pebbles; cracks extend through lower boundary; calcareous; moderately alkaline; gradual, smooth boundary.

B24t—38 to 49 inches, red (2.5YR 4/6) clay, dark red (2.5YR 3/6) moist; streaks of dark reddish brown on faces of peds; interiors of peds are red (2.5YR 4/6) moist; moderate, coarse, prismatic structure parting to moderate, coarse and medium, angular blocky structure; extremely hard, very firm; few fine roots; few strongly cemented and weakly cemented calcium carbonate concretions; few siliceous pebbles; cracks extend to lower boundary; calcareous; moderately alkaline; clear, wavy boundary.

B25tca—49 to 60 inches, red (2.5YR 5/6) clay, red (2.5YR 4/6) moist; red (5YR 4/6) calcium carbonate coatings and dark reddish-brown (5YR 3/22) clay coatings on faces of peds; moderate, medium and coarse, blocky structure; extremely hard, very firm; stringers or chimneys of calcium carbonate that is yellowish-red (5YR 5/6) moist up to 6 inches apart and ½ inch in diameter; cracks extend to tops of the stringers of calcium carbonate; estimated 5 percent visible powdery calcium carbonate and few strongly cemented concretions; few dark pellets; few siliceous pebbles; calcareous; moderately alkaline; gradual, wavy boundary.

B26tca—60 to 69 inches, dark-red (2.5YR 3/6) gravelly clay, dark red (2.5YR 3/6) moist; light-red (2.5YR 6/6) coatings of calcium carbonate 1 to 2 millimeters thick; moderate, coarse, angular blocky structure; very hard, very firm; few fine roots; more piping of calcium carbonate in form of powdery yellowish-red (5YR 4/6) bodies than in horizon above; about 15 percent strongly cemented calcium carbonate concretions make up most of the gravel; few siliceous pebbles; few calcareous cobblestones; few dark pellets; few gypsum crystals; calcareous; moderately alkaline; abrupt, wavy boundary.

B27tca—69 to 76 inches, dark reddish-brown (2.5YR 3/4) clay, dark reddish brown (2.5YR 2/4) moist; moderate, medium, angular blocky structure; extremely hard, very firm; black, discontinuous coatings on faces of peds; a layer high in coarse fragments con-

tains carbonate pebbles up to 3 inches in diameter, 15 percent siliceous pebbles, and a few cobblestones of both carbonate and siliceous rocks; few gypsum crystals; calcareous; moderately alkaline; abrupt, wavy boundary.

IIB3ca—76 to 81 inches, dark reddish-brown (2.5YR 3/4) clay, yellowish red (5YR 4/6) moist; fine mottles of olive gray; moderate, medium, subangular blocky structure; extremely hard, very firm; few fine roots; calcareous coatings 1 to 2 millimeters thick; few gypsum crystals; few tongues extend into the IIC horizon; calcareous; moderately alkaline; abrupt, wavy boundary.

IIC—81 to 90 inches, variegated grayish-green (5GY 5/1) moist and dark reddish-brown (2.5YR 3/4) moist clay; weak, platy or blocky structure, retains part of apparent original rock structure; reddish-yellow stains and thin seams of calcium carbonate; clay coats on some faces; few gypsum crystals; noncalcareous in matrix; calcareous coats; moderately alkaline.

The A horizon ranges from 5 to 8 inches in thickness and from brown to reddish brown in color. Reaction is neutral to mildly alkaline.

A B1t horizon is present in 25 to 40 percent of the areas. It ranges from 3 to 7 inches in thickness and from clay loam to clay in texture. The B2t horizon ranges from 55 inches to more than 90 inches in thickness, from clay loam to clay in texture, and from reddish brown to red in color. It is mildly alkaline to moderately alkaline.

Depth to the horizon of calcium carbonate accumulation ranges from 24 to 54 inches. The thickness of this horizon ranges from 10 to 40 inches. Calcium carbonate content ranges from about 5 to 50 percent by volume. Color ranges from dark reddish brown to dark red, and there are mottles in shades of red, brown, gray, green, yellow, and olive.

The C horizon ranges from reddish brown to red and is mottled with various shades of green, yellow, blue, and gray. Buried, darkened layers are at a depth of 4 to 6 feet in places.

Tillman silty clay loam, 0 to 1 percent slopes (TmA).—This soil is on upland flats. Slopes are dominantly 0.5 to 0.8 percent. Areas are irregular in shape and 400 acres or less in size.

The surface layer is reddish-brown silty clay loam about 8 inches thick. Below this layer is reddish-brown clay about 40 inches thick. The next layer is red clay about 9 inches thick. Below this is grayish-green and red clay about 18 inches thick. The underlying material is variegated reddish-brown and grayish-green clayey shale.

Included with this soil in mapping are small areas of Lofton soils and Tillman silty clay loam, 1 to 3 percent slopes. These inclusions make up about 5 percent of this mapping unit. About 10 percent of the acreage of the Tillman soils are calcareous to the surface.

This soil is droughty during years of below-normal rainfall. The hazards of soil blowing and water erosion are slight. Surface runoff is slow, and available water capacity is high.

Most of this soil is cultivated. Cotton and wheat are the main crops. The main need of management is to maintain or improve soil tilth. Soil-improving crops such as winter peas, cowpeas, and sweetcover help to improve soil tilth. Moisture-conserving practices such as terracing, contour farming, and managing crop residue on or near the surface also help to maintain soil tilth. Grassed waterways are needed in some places where excess runoff water is a concern. Capability unit IIIs–1; Deep Hardland range site.

Tillman silty clay loam, 1 to 3 percent slopes (TmB).—This soil has smooth to rolling slopes. Slopes are dominantly 1.5 to 2.0 percent. Areas are irregular in shape and range from 25 to several thousand acres in size. The profile of this soil is the one described as representative for the series.

Included with this soil in mapping are small areas of Vernon and Lofton soils and Tillman silty clay loam, 0 to 1 percent slopes. Also included along drains are a few areas of Tillman silty clay loam, 1 to 3 percent slopes, eroded. About 25 percent of this soil is calcareous to the surface. These calcareous areas occur along with numerous outcrops and ridges of Vernon soils.

The hazard of soil blowing is slight, and the hazard of water erosion is moderate. Runoff is medium. There are a few shallow gullies, 4 to 12 inches deep and more than 300 feet apart, in some unprotected cultivated fields. Available water capacity is high.

This soil is mostly in cultivation. Wheat and other small grain are grown extensively. In some areas cotton is also grown. The main concerns of management are controlling water erosion and maintaining or improving soil tilth. Managing residue on or near the surface helps to control erosion and to improve soil tilth. Soil-improving crops such as winter peas, cowpeas, and sweetclover also help to improve the tilth of the soil. Terracing and contour farming help to control water erosion. Grassed waterways protect terrace outlets in areas that are not already vegetated. Capability unit IIIe–1; Deep Hardland range site.

Tillman silty clay loam, 1 to 3 percent slopes, eroded (TmB2).—This soil occurs in small, narrow, scattered areas along drainageways and the side slopes of the steeper ridges. Slopes are 1.5 to 3.0 percent. Most areas are less than 200 acres in size.

The surface layer is reddish-brown silty clay loam about 5 inches thick. Below this layer is reddish-brown clay about 56 inches thick. The next layer is variegated red, reddish-brown, and greenish-blue clay about 24 inches thick. The underlying material is greenish-blue clayey shale that has yellowish stains.

The hazard of water erosion is severe, and the hazard of soil blowing is slight. Gullies 1 to 3 feet deep and 10 to 30 feet across occur.

This soil is better suited to range than to most other uses. A few areas are cultivated. Sorghum and small grain are the principal crops. The main need of management is to control water erosion. Crop residue should be managed on the soil surface to help control erosion and improve soil tilth. Terraces and contour farming are needed to control water erosion. Capability unit IVe–1; Deep Hardland range site.

Tivoli Series

The Tivoli series consists of deep, excessively drained, rapidly permeable, sandy soils on uplands. These soils formed in loose eolian sands along the larger streams.

In a representative profile, the surface layer is reddish-brown fine sand about 12 inches thick. The underlying material, to a depth of 60 inches, is light reddish-brown, loose fine sand.

Representative profile of Tivoli fine sand in a pasture, 1.0 mile west of ranch road and 2.5 miles south of U.S.

Highway 70 along the Swenson Ranch road, 10.6 miles west of Paducah:

A1—0 to 12 inches, reddish-brown (5YR 5/3) fine sand, reddish brown (5YR 4/3) moist; single grain; loose; calcareous; moderately alkaline; clear, smooth boundary.

C—12 to 60 inches, light reddish-brown (5YR 6/4) fine sand, reddish brown (5YR 5/4) moist; single grain, loose; calcareous; moderately alkaline.

The A horizon ranges from 6 to 14 inches in thickness and from light brown to brown and reddish brown in color. Reaction ranges from neutral to moderately alkaline.

The C horizon is several feet to many feet thick and ranges from light reddish brown to reddish yellow in color. Reaction ranges from neutral to moderately alkaline.

Some of these soils are outside the range defined for the series because they are calcareous above a depth of 40 inches. This difference does not alter the use or behavior of the soils.

Tivoli fine sand (Tv).—This soil is in hummocky to duny areas on uplands. Most areas are much longer than they are wide, and most are from 10 to several hundred acres in size.

Included with this soil in mapping are small areas of Hardeman, Springer, and Lincoln soils. These amount to less than 10 percent of the total acreage.

Runoff is very slow. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The available water capacity is low.

Almost all of this soil is in range. The main need of management is to control soil blowing. This can be accomplished by maintaining a good cover of grass. Capability unit VIIe–1; Deep Sand range site.

Veal Series

The Veal series comprises deep, well-drained, moderately permeable, loamy soils on uplands. These soils formed in loamy, calcareous outwash material.

In a representative profile, the surface layer is light reddish-brown fine sandy loam about 8 inches thick. Below this layer is reddish-brown, very friable loam about 12 inches thick. The next layer is pink loam that is about 40 inches thick and has a high calcium carbonate content. It is underlain to a depth of about 72 inches by reddish-yellow fine sandy loam.

Representative profile of Veal fine sandy loam, 3 to 5 percent slopes, in a cultivated field 300 feet west of U.S. Highway 83, from a point 3.5 miles south of a bridge over Middle Pease River, about 13 miles north of Paducah:

Ap—0 to 8 inches, light reddish-brown (5YR 6/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak, fine, granular structure; soft, very friable; few calcium carbonate concretions on the surface; calcareous; moderately alkaline; abrupt, smooth boundary.

B21—8 to 20 inches, reddish-brown (5YR 5/4) loam, reddish brown (5YR 4/4) moist; weak, fine, subangular blocky structure; soft, very friable; many pores; few films and threads of calcium carbonate, few soft calcium carbonate masses and concretions; few pebbles; calcareous; moderately alkaline; gradual, smooth boundary.

B22ca—20 to 60 inches, pink (5YR 7/4) loam, reddish brown (5YR 5/4) moist; massive; soft, friable; about 18 percent, by volume, visible soft masses and concretions of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

B23ca—60 to 72 inches, reddish-yellow (5YR 6/6) fine sandy loam outwash materials, yellowish red (5YR 5/6) moist; calcareous; moderately alkaline.

The A horizon ranges from 5 to 10 inches in thickness and reddish yellow in color.

The B21 horizon ranges from 6 to 13 inches in thickness, from loam to sandy clay loam in texture, and from brown to reddish brown in color. Depth to the B22ca horizon ranges from 12 to 20 inches. This horizon commonly is distinct and contains 15 to 40 percent visible calcium carbonate. It ranges from 12 to 40 inches in thickness and from pink to light reddish brown. The B23ca horizon is mostly sandy outwash material at a depth of 3 to 5 feet. It ranges from pink to reddish yellow in color.

Some of these soils have colors that are too red (hue of 5YR) to be within the range defined for the series. This difference does not alter the use or behavior of the soils.

Veal fine sandy loam, 1 to 3 percent slopes (VeB).—This soil is on convex ridges. Areas range from 5 to 50 acres in size. Slopes are dominantly 1.5 to 2.5 percent.

The surface layer is brown fine sandy loam about 6 inches thick. Below this layer is brown sandy clay loam about 13 inches thick. The next layer is pink fine sandy loam that has a high calcium carbonate content to a depth of 40 inches. The underlying material is light-red fine sandy loam.

Included with this soil in mapping were areas of Weymouth and Miles soils. These inclusions are commonly less than 5 acres in size.

The hazards of soil blowing and water erosion are moderate. Runoff is medium. Available water capacity is high.

Most of this soil is cultivated. Cotton and small grain are the main crops. The main concerns of management are soil blowing and water erosion. Management of crop residue on the soil surface is needed to help control soil blowing and water erosion. Tillage should be held to a minimum. Terraces are needed to support contour farming. Diversion terraces and grassed waterways are needed in places to safely dispose of water from adjacent areas or of excess accumulations of water. Capability unit IIIe–6; Sandy Loam range site.

Veal fine sandy loam, 3 to 5 percent slopes (VeC).—This soil is on convex ridges. Areas are oblong to irregular in shape and 5 to 80 acres in size. Slopes are dominantly 3 to 4 percent. This soil has the profile described as representative for the series.

Included with this soil in mapping are areas of Weymouth and Miles soils.

The hazards of soil blowing and water erosion are moderate. There are a few shallow gullies. Runoff is medium. Available water capacity is high.

Most of this soil is cultivated. Sorghum and small grain are the main crops. Some areas that were once cultivated have been returned to native vegetation. The main need of management is to control soil blowing and water erosion. The use of close-spaced or drilled sorghum and small grain helps to protect the soil. Limited tillage and the management of crop residue on the soil surface help to control soil blowing and water erosion. Contour farming and terraces are needed to support the cropping system for erosion control. Capability unit IVe–5; Sandy Loam range site.

Veal fine sandy loam, 5 to 12 percent slopes (VeD).—This soil occurs mostly along drainageways. Slopes are dominantly 5 to 8 percent. Most areas are irregular in shape and range from 5 to 50 acres in size.

The surface layer is light reddish-brown fine sandy loam about 5 inches thick. Below this layer is reddish-

brown loam about 10 inches thick. The next layer is pink loam that is high in calcium carbonate and extends to a depth of 30 inches. The underlying material is reddish-yellow fine sandy loam.

Included with this soil in mapping were small areas of Woodward, Colorado, and Yahola soils.

The hazard of soil blowing is moderate, and the hazard of water erosion is severe. Available water capacity is high. Runoff is medium.

Most of this soil is in range. The main need of management is to control water erosion and soil blowing. A good cover of grass helps to accomplish this. Capability unit VIe–3; Sandy Loam range site.

Vernon Series

The Vernon series consists of moderately deep, well-drained, very slowly permeable, loamy soils on uplands. These soils formed in calcareous, clayey and shaley red beds.

In a representative profile, the surface layer is reddish-brown clay loam about 6 inches thick. Below this layer is about 22 inches of reddish-brown very firm clay. The underlying material is reddish-brown clayey shale that contains about 10 percent calcium carbonate in the upper 12 inches and is mottled with light greenish gray in the lower part.

Representative profile of Vernon clay loam, 1 to 3 percent slopes, in a cultivated field 50 feet west of Farm Road 2564, from a point 1.4 miles north via farm road from its intersection with U.S. Highway 70, about 11 miles east of Paducah:

Ap—0 to 6 inches, reddish-brown (5YR 5/4) clay loam, dark reddish brown (5YR 3/4) moist; weak, medium, granular structure; hard, friable; few calcium carbonate concretions on surface; calcareous; moderately alkaline; abrupt, smooth boundary.

B2—6 to 17 inches, reddish-brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) moist; moderate, fine and very fine, blocky to irregular blocky structure; very hard, very firm; few fine calcium carbonate concretions and few lime-coated shale fragments; calcareous; moderately alkaline; gradual, smooth boundary.

B3—17 to 28 inches, reddish-brown (2.5YR 5/4) clay, reddish brown (2.5YR 4/4) moist; weak, medium, blocky structure; very hard, very firm; few fine pores and roots; few light greenish-gray (5BG 7/1) shale fragments; few small calcium carbonate concretions; films and threads of calcium carbonate; calcareous; moderately alkaline; clear, wavy boundary.

C1ca—28 to 40 inches, reddish-brown (5YR 4/4) clayey shale, dark reddish brown (5YR 3/4) moist; weak, blocky structure; very hard, very firm; common blue and olive shale fragments; 10 percent soft masses and concretions of calcium carbonate; few gypsum crystals; calcareous; moderately alkaline; gradual, wavy boundary.

C2—40 to 60 inches, reddish-brown (5YR 4/4) clayey shale that is mottled with light greenish gray (5BG 7/1); massive; small pockets of gypsum crystals; few weakly cemented concretions and soft masses of calcium carbonate; calcareous; moderately alkaline.

The A horizon ranges from 4 to 8 inches in thickness, from brown to reddish brown in color, and from clay loam to clay in texture.

The B horizon ranges from 10 to 24 inches in thickness and from red to reddish brown in color.

The C horizon ranges from red to reddish brown in color and from massive clay to silty or clayey shale in texture. The number of olive, gray, or light greenish-gray mottles ranges from few to many. The amount of calcium in the upper part of the horizon ranges from little to about 10 percent.

Vernon clay loam, 1 to 3 percent slopes (VnB).—This soil occupies smooth convex areas on ridgetops. Areas are irregular to oval in shape. They commonly range from 10 to 100 acres in size, but there are a few areas of up to 300 acres. Slopes are dominantly 1.5 to 2.5 percent. The profile of this soil is the one described as representative for the series.

Included with this soil in mapping were Tillman, Weymouth, Quanah, Talpa, and Owens soils and Badland. All of these inclusions amount to less than 15 percent of the total acreage mapped as this Vernon soil.

Runoff is rapid. The hazard of water erosion is moderate, and the hazard of soil blowing is slight. Permeability is very slow, and the available water capacity is moderate.

About 30 percent of this soil is cultivated. Wheat is the principal crop. The main needs of management are controlling water erosion and maintaining or improving soil tilth. The management of crop residue on the soil surface helps to improve soil tilth and reduce erosion. Terracing and contour farming are needed to help control water erosion. Capability unit IVe–7; Shallow Redland range site.

Vernon clay loam, 3 to 5 percent slopes (VnC).—This soil is on uplands. Areas are irregular to oval in shape and range from 10 to 500 acres in size. Slopes are dominantly 3 to 4 percent.

The surface layer is reddish-brown clay loam about 5 inches thick. Below this layer is reddish-brown, very firm clay about 10 inches thick. The next layer is red, very firm clay about 11 inches thick. The underlying material is mottled, red clayey shale. Most cultivated areas of this soil have a few shallow gullies and numerous rills, and in some areas the subsoil is exposed.

Included with this soil in mapping are areas of Owens, Talpa, and Weymouth soils.

Runoff is rapid. The hazard of water erosion is severe, and the hazard of soil blowing is slight. Permeability is very slow, but available water capacity is high.

This soil is mostly in range, but a few areas are cultivated. Wheat is the main crop. The main need of management is to control water erosion. A good cover of grass is needed for this. Trails and roads may also need to be relocated or have small dams or diversions constructed across them to break up water concentrations. Capability unit IVe–7; Shallow Redland range site.

Weymouth Series

The Weymouth series consists of deep, well-drained, moderately permeable, loamy soils on uplands. These soils formed in calcareous, loamy, alluvial red-bed material.

In a representative profile, the surface layer is reddish-brown clay loam about 7 inches thick. Below this layer is reddish-brown, friable clay loam about 12 inches thick. The next layer is pink, friable clay loam that is about 17 inches thick and is about 35 percent calcium carbonate. The underlying material, extending to a depth of 60 inches, is reddish-brown clay loam.

Representative profile of Weymouth clay loam, 1 to 3 percent slopes, in a cultivated field, 120 feet west of county road, from a point 1.2 miles north of the intersection of county road and Farm Road 104, 1.1 miles east via Farm Road 104 from its intersection with Farm Road 1033:

Ap—0 to 7 inches, reddish-brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) moist; weak, fine, granular structure; slightly hard, friable; few fine calcium carbonate concretions; calcareous; moderately alkaline; abrupt, smooth boundary.

B2—7 to 19 inches, reddish-brown (5YR 5/4) clay loam, reddish brown (5YR 4/4) moist; weak to moderate, fine, subangular blocky and granular structure; hard, friable; many very fine and fine pores; few films, soft masses, and fine calcium carbonate concretions; many worm casts; calcareous; moderately alkaline; gradual, smooth boundary.

B3ca—19 to 36 inches, pink (5YR 7/4) clay loam, reddish yellow (5YR 6/6) moist; weak, fine, subangular blocky structure; slightly hard, friable; about 35 percent, by volume, soft masses and hard calcium carbonate concretions; calcareous; moderately alkaline; gradual, smooth boundary.

C—36 to 60 inches, reddish-brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) moist; massive; few soft masses of calcium carbonate; calcareous; moderately alkaline.

The A horizon ranges from 4 to 8 inches in thickness and from brown to reddish brown in color.

The B2 horizon ranges from 6 to 15 inches in thickness, from reddish brown to yellowish red in color, and from loam to clay loam in texture. The B3ca horizon ranges from 10 to 24 inches in thickness and from reddish brown to yellowish red in color. Estimated content of calcium carbonate ranges from 15 to 35 percent by volume.

The C horizon is old alluvial or outwash sediments of clay loam or partly weathered silty or clayey red beds. Color is reddish brown or red.

Weymouth clay loam, 1 to 3 percent slopes (WeB).—This soil is on ridges, hilltops, and side slopes flanking natural drains on uplands. Areas are irregular in shape and range dominantly from 10 to 300 acres in size. The profile of this soil is the one described as representative for the series.

Included in mapping are small areas of Vernon, Tillman, Sagerton, Talpa, and Woodward soils.

Runoff is medium. The hazard of water erosion is moderate, and the hazard of soil blowing is slight. A few shallow gullies up to 11 inches deep occur in some areas. Permeability is moderate and the available water capacity is high.

About 50 to 60 percent of this soil is cultivated. Small grain, grain sorghum, and cotton are the main crops. The main need of management is to control water erosion. Crop residue should be managed on the soil surface. Terraces and contour farming are needed if row crops are grown. Excess water can be safely carried off by diversions and grassed waterways. Capability unit IIIe–7; Shallow Redland range site.

Weymouth clay loam, 3 to 5 percent slopes (WeC).—This soil occupies scattered areas on uplands. Areas are oblong to irregular in shape. They range from 10 to 300 acres in size but are commonly less than 100 acres. Slopes are dominantly 3 to 4 percent.

The surface layer is reddish-brown clay loam about 6 inches thick. Below this layer is about 8 inches of reddish-brown, friable clay loam. The next layer is pink, friable clay loam that is about 18 inches thick and contains about 30 percent calcium carbonate. The underlying material is reddish-brown clay loam.

Included in mapping are areas of Weymouth clay loam, 1 to 3 percent slopes; of Woodward, Vernon, Talpa, and Owens soils; and of gypsiferous rock.

Runoff is medium. The hazard of water erosion is severe, and the hazard of soil blowing is slight. Available water capacity is high.

Most of this soil is cultivated. The main crops are wheat, grain sorghum, and some cotton. Some areas that were once cultivated have been returned to native vegetation. The main need of management is to control water erosion. The management of crop residue on the soil surface helps to control erosion. Tillage should be limited to conserve crop residue. Contour farming and terraces are needed if row crops are grown. Diversion terraces and grassed waterways are also needed in places as part of a runoff water disposal system. Capability unit IVe–2; Shallow Redland range site.

Weymouth clay loam, 5 to 12 percent slopes (WeD).—This soil is mainly in drainageways. Slopes are dominantly 5 to 8 percent. Most areas are irregular and oblong. Areas range from 25 to 300 acres in size but are commonly less than 100 acres.

The surface layer is reddish-brown clay loam about 5 inches thick. Below this layer is reddish-brown, friable clay loam about 9 inches thick. The next layer is pink, friable clay loam that is about 16 inches thick and contains about 25 percent calcium carbonate. The underlying material is red clay loam.

Included with this soil in mapping are areas of Weymouth clay loam, 3 to 5 percent slopes; of Woodward, Quinlan, Veal, Vernon, Talpa, Owens, and Colorado soils; and of Badland. These inclusions make up less than 15 percent of the total acreage.

Surface runoff is rapid. The hazard of water erosion is severe, and the hazard of soil blowing is slight. Available water capacity is high.

Most of this soil is in range. The main need of management is to control water erosion. A good cover of grass helps to accomplish this. Capability unit VIe–4; Shallow Redland range site.

Woodward Series

The Woodward series consists of moderately deep, well-drained, moderately permeable, loamy soils on uplands. These soils formed in calcareous, fine-grained, soft sandstone, packsand, or silty red-bed materials.

In a representative profile, the surface layer is reddish-brown loam about 8 inches thick. Below this layer is reddish-brown, very friable loam about 14 inches thick. The next layer is red, very friable loam about 8 inches thick. The underlying material, extending to a depth of 60 inches, is red very fine sandy loam that contains olive-gray flecks.

Representative profile of Woodward loam, 3 to 5 percent slopes, in a field, 100 feet west of U.S. Highway 83, from a point 1.1 miles south along U.S. Highway 83 from the Cottle-Childress county line.

Ap—0 to 8 inches, reddish-brown (5YR 5/4) loam, dark reddish brown (5YR 3/4) moist; weak, fine, granular structure; soft, very friable; few fine calcium carbonate concretions on the surface; calcareous; moderately alkaline; abrupt, smooth boundary.

B2—8 to 22 inches, reddish-brown (5YR 5/4) loam, reddish brown (5YR 4/3) moist; weak, fine, subangular blocky structure; soft, very friable; few threads and films of calcium carbonate; calcareous; moderately alkaline; gradual, wavy boundary.

B3ca—22 to 30 inches, red (2.5YR 5/6) loam, red (2.5YR 4/6) moist; weak, medium, granular structure; soft, very friable; contains about 5 to 10 percent, by volume, soft masses and concretions of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

C—30 to 60 inches, red (2.5YR 5/6), weakly consolidated very fine sandy loam, dark red (2.5YR 3/6) moist; massive; soft, sandy red beds with many olive-gray flecks; calcareous; moderately alkaline.

The A horizon ranges from 7 to 12 inches in thickness, from reddish brown to light reddish brown in color, and from loam to very fine sandy loam in texture.

The B2 horizon ranges from 7 to 30 inches in thickness, from red to reddish brown in color, and from loam to very fine sandy loam in texture. Few to common films, threads, soft masses, or concretions of calcium carbonate are in this horizon in places. The B3ca horizon ranges from 2 to 10 inches in thickness, from loam to very fine sandy loam in texture, and from red to reddish yellow in color.

The C horizon is at a depth of 20 to 45 inches. It is fine-grained, soft sandstone, packsand, or silty red beds.

Woodward loam, 1 to 3 percent slopes (WoB).—This soil occupies convex ridges, hilltops, and side slopes flanking natural drains on uplands. Areas are irregular in shape and range from 10 to 200 acres in size.

The surface layer is reddish-brown loam about 8 inches thick. Below this layer is red, very friable loam about 16 inches thick. The next layer is red, very friable loam about 10 inches thick. The underlying material is red, soft, fine-grained sandstone.

Included with this soil in mapping are areas of Woodward loam, 3 to 5 percent slopes, and Carey, Bukreek, and Sagerton soils. Also included are small outcrops of alabaster gypsum rock and small areas of Weymouth soils.

Available water capacity is moderate. Runoff is medium. The hazard of water erosion is moderate, and the hazard of soil blowing is slight. A few gullies up to 12 inches deep occur in some areas.

Most of this soil is cultivated. Cotton and grain sorghum are the main crops. The main need of management is to control water erosion. The management of crop residue on the soil surface, stripcropping, timely but limited tillage, and contour farming together with a system of terraces help to control water eroison. Diversion terraces and grassed waterways may be needed where excess runoff water is a concern. Capability unit IIe–1; Mixedland range site.

Woodward loam, 3 to 5 percent slopes (WoC).—This soil is on uplands. Areas are irregular in shape. In most places they follow the contour of the slope above drainageways and on convex hilltops or ridges. They range from 10 to 600 acres or more in size but most are less than 200 acres. This soil has the profile described as representative for the series.

Included with this soil in mapping are small areas of Woodward loam, 1 to 3 percent slopes; of Carey, Bukreek, Sagerton, Quinlan, and Weymouth soils; and of outcrops of alabaster gypsiferous rock.

Surface runoff is medium and available water capacity is moderate. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. A few gullies 6 to 24 inches deep and more than 300 feet apart appear in some places.

Most areas of this soil are in cultivation, but some are in native range. Some cultivated areas have been seeded to grass. Cotton and grain sorghum are the principal crops. The main need of management is to control water erosion. Crop residue managed on the soil surface helps to accomplish this. Contour farming together with use of terraces is also needed to control water erosion. Diversion terraces and grassed waterways are needed in places for safe disposal of runoff water. Capability unit IIIe–3; Mixedland range site.

Woodward soils and Rough broken land (Wr).—This undifferentiated group consists of a vast network of gullies and associated soils that formed in Permian sandy red beds. It lies along drainageways. The gullies were produced by geological erosion cutting deeply into the red beds. Areas are commonly several hundred acres to several thousand acres in size.

Areas of this mapping unit are characterized by a main gully that has many secondary gullies. Most of these gullies also have many fingerlike branches that run back from the secondary gullies. In some areas the gullies have cut back to the top of the ridges above. The gullies range from 10 to 50 feet in depth and from 30 to 500 feet in width. Most of them also have flat alluvial bottoms that range from 10 to 200 feet or more in width (fig 18).

The composition of areas of this mapping unit is variable. Woodward soils make up about 15 to 50 percent of the mapping unit; Rough broken land, 10 to 50 percent; Quinlan soils, 10 to 40 percent; and Colorado and Yahola soils, 5 to 25 percent. The average composition is Woodward soils, 33 percent; Rough broken land, 30 percent; Quinlan soils, 25 percent; and Colorado and Yahola soils, 12 percent.

The Woodward soils have smooth slopes of 5 to 15 percent. These soils lie immediately above the rims of the gullies. The surface layer is reddish-brown very fine sandy loam about 7 inches thick. Below this layer is reddish-brown, very friable very fine sandy loam about 16 inches thick. The next layer is red, very friable very fine sandy loam about 10 inches thick. The underlying material is fine-grained sandstone.

Rough broken land consists of the steep side slopes and escarpments of the gullies. It has slopes of 25 to 45 percent. The materials are unweathered, soft Permian sandstone and packsand. There are strata of gypsum and silty red beds. Vegetation is sparse. Many areas of Rough broken land are inaccessible to livestock.

Included with this undifferentiated group in mapping are areas of Colorado, Yahola, Cottonwood, and Carey soils. Also included are soils that are less than 10 inches deep and are underlain by fine-grained sandstone or siltstone.

The hazard of water erosion is severe, and the hazard of soil blowing is slight. Runoff is rapid.

This mapping unit is best suited to range, wildlife habitat, and recreational uses.

A good cover of grass is needed to control erosion. Deferred grazing is necessary if the vigor of grasses is low. Careful planning is needed to locate roads and other improvements so that traffic by livestock or vehicles will not increase the hazard of erosion. Capability unit

Figure 18.—An area of Woodward soils and Rough broken land.

VIIs–1; Woodward part in Mixedland range site, Rough broken land part in Rough Breaks range site.

Woodward and Quinlan loams (Wu).—These sloping to strongly sloping soils are commonly in areas above drainageways or on convex ridges. Areas are irregular in shape and range from 25 to 2,000 acres or more in size, but most are less than 300 acres in extent. Slopes are dominantly 5 to 8 percent, but in some areas slopes are as much as 12 percent. These two soils are so closely associated that it is impractical to map them separately. The Woodward soils occupy side slopes and areas between ridges, and the Quinlan soils occupy ridgetops above the Woodward soils.

The composition of areas of this mapping unit is variable. Woodward soils make up about 40 to 80 percent of this mapping unit, and Quinlan soils 10 to 50 percent. The average composition is Woodward soils, 64 percent; Quinlan soils, 26 percent; and included soils, 10 percent.

The surface layer of the Woodward soils is reddish-brown loam about 7 inches thick. Below this layer is red, very friable very fine sandy loam about 14 inches thick. The next layer is reddish-yellow, very friable very fine sandy loam about 10 inches thick. The underlying material is red very fine sandy loam.

The profile of the Quinlan soils is the one described as representative for the series.

Included with this undifferentiated group in mapping are areas of Weymouth and Cottonwood soils. A few areas of soils that are less than 10 inches deep and are underlain by fine-grained sandstone occur along with outcrops of alabaster gypsum, mostly near ridgetops.

The hazard of water erosion is severe, and the hazard of soil blowing is slight. A few gullies, 6 inches to 3 feet in depth and more than 200 feet apart, occur in some places along natural drains. Runoff is rapid.

All of this mapping unit is in range. The few areas that were once cultivated have been restored to native grass. A good cover of grass is needed to help control water erosion, and good grazing management is needed to maintain grass stands. Capability unit VIe–4; Mixedland range site.

Yahola Series

The Yahola series consists of deep, well-drained, moderately rapidly permeable, loamy soils on bottom lands. These soils formed in recent, calcareous, loamy alluvium.

In a representative profile, the surface layer is reddish-brown very fine sandy loam about 12 inches thick. The underlying material to a depth of 60 inches is reddish-brown very fine sandy loam that is stratified with thin layers of fine sandy loam and loam.

Representative profile of Yahola very fine sandy loam, on a flood plain 200 feet east of county road, from a point 3.9 miles north via county road from its intersection with Farm Road 1440, 2.2 miles east of Cee Vee:

A1—0 to 12 inches, reddish-brown (5YR 5/4) very fine sandy loam, dark reddish brown (5YR 3/4) moist; weak, fine, granular and subangular blocky structure; soft, very friable; calcareous; moderately alkaline; diffuse, smooth boundary.

C—12 to 60 inches, reddish-brown (5YR 5/4) very fine sandy loam, reddish brown (5YR 4/4) moist; massive; soft, very friable; stratified with thin layers of fine sandy loam and loam; calcareous; moderately alkaline.

The A1 horizon ranges from 8 to 20 inches in thickness and from reddish brown to reddish yellow in color.

The C horizon ranges from reddish brown to reddish yellow

in color and from very fine sandy loam to loam in texture. This horizon is stratified with thin layers of silt loam to fine sandy loam and loamy fine sand. In many places dark buried layers are at a depth of 3 to 6 feet.

Yahola very fine sandy loam (Ya).—This nearly level soil is on flood plains along the larger streams in the county. Areas are much longer than they are wide and are roughly parallel to the river channels. Areas range from 25 acres to several hundred acres in size.

Included with this soil in mapping were narrow bands of Colorado and Enterprise soils.

Runoff is slow and the hazards of soil blowing and water erosion are slight. Some of the lower areas of this soil are occasionally overflowed. Available water capacity is high.

About half of this soil is cultivated. Cotton and grain sorghum are the principal crops. The main need of management is to maintain good soil tilth. Crop rotation, protection of the soil by use of crop residue, and timely but limited tillage help to maintain soil tilth. Capability unit IIc–2; Bottomland range site.

Use and Management of the Soils

Conservation management of the soils modifies the hazards involved in their use and improves the response of crops grown. The climate of Cottle County limits the choice of crops. Cotton, wheat, oats, barley, guar, and most grain and forage sorghums are all suited to the soils and the climate, and all can be dryfarmed. Garden crops and orchard crops need to be irrigated. The chief limitations to farming the soils of Cottle County result from the high winds, low annual rainfall, drought, and the high intensity of some rains. The purposes of management, then, are to conserve moisture, to protect the soils against both soil blowing and water erosion, to improve the tilth of the soils, and to maintain productivity.

In this section the classification of the soils according to the system used by the Soil Conservation Service is briefly explained. Next is given estimated yields of the principal crops grown in the county under a high level of management. Finally the use of the soils for range, in engineering works, and for wildlife is discussed.

Capability Grouping

Some readers, particularly those who practice large-scale farming, may find it practical to use and manage alike some of the different kinds of soil on their farms. These readers can make good use of the capability classification system.

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. Soils are grouped according to their limitations when used for field crops, the risk of damage when they are so 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 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 this system all the kinds of soil are grouped at three levels, into capability class, subclass, and unit.

Capability Classes are in the broadest grouping and are designated by Roman numerals I through VIII. In class I are the soils that have few limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products.

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 subclass indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though 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, IIc–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.

The eight classes in the capability system and the subclasses and units in this county are briefly described in the list that follows.

Class I. Soils that have few limitations that restrict their use. (None in Cottle County.)

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

Subclass IIe. Soils subject to slight to moderate erosion if they are not protected.

Unit IIe–1. Deep and moderately deep, gently sloping, moderately permeable to moderately rapidly permeable calcareous to noncalcareous loams to very fine sandy loams.

Unit IIe–2. Deep, gently sloping, moderately permeable to moderately slowly permeable, noncalcareous loams to clay loams.

Subclass IIc. Soils subject to slight climatic limitations or dry climate.

Unit IIc–1. Deep, nearly level, moderately permeable, calcareous clay loams.

Unit IIc–2. Deep, nearly level, moderately permeable to moderately rapidly permeable, calcareous very fine sandy loams.

Unit IIc–3. Deep, nearly level, moderately slowly permeable to moderately rapidly permeable, noncalcareous very fine sandy loams to silt loams.

Unit IIc–4. Deep, nearly level, very slowly permeable to moderately slowly permeable, noncalcareous loams to clay loams.

Unit IIc–5. Deep, nearly level, moderately permeable, noncalcareous loams.

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

Subclass IIIe. Soils subject to moderate to severe erosion if they are cultivated and not protected.

Unit IIIe–1. Deep, gently sloping, slowly permeable, noncalcareous silty clay loams.

Unit IIIe–2. Deep, nearly level to gently sloping, moderately permeable, calcareous loams.

Unit IIIe–3. Deep and moderately deep, gently sloping, moderately permeable to moderately rapidly permeable, calcareous to noncalcareous loams to very fine sandy loams.

Unit IIIe–4. Deep, nearly level to gently sloping, moderately permeable, noncalcareous fine sandy loams.

Unit IIIe–5. Deep, nearly level to gently sloping, moderately rapidly permeable, calcareous fine sandy loams.

Unit IIIe–6. Deep, gently sloping, moderately permeable, calcareous fine sandy loams.

Unit IIIe–7. Deep, gently sloping, moderately permeable, calcareous clay loams.

Subclass IIIw. Soils that have severe limitations because of excess water.

Unit IIIw–1. Deep, nearly level, very slowly permeable, noncalcareous clays.

Subclass IIIs. Soils that have severe limitations of permeability or tilth.

Unit IIIs–1. Deep, nearly level, slowly permeable, noncalcareous silty clay loams.

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

Subclass IVe. Soils subject to moderate to severe erosion if they are cultivated and not protected.

Unit IVe–1. Deep, gently sloping, slowly permeable, noncalcareous, eroded silty clay loams.

Unit IVe–2. Deep, gently sloping, moderately permeable, calcareous clay loams.

Unit IVe–3. Deep, nearly level to gently sloping, moderately rapidly permeable, noncalcareous loamy fine sands.

Unit IVe–4. Deep, gently sloping, moderately permeable, noncalcareous fine sandy loams.

Unit IVe–5. Deep, gently sloping, moderately permeable, calcareous fine sandy loams.

Unit IVe–6. Deep, nearly level to gently sloping, moderately permeable, noncalcareous fine sands to loamy fine sands.

Unit IVe–7. Moderately deep, gently sloping, very slowly permeable, calcareous clay loams.

Unit IVe–8. Deep, gently sloping, moderately rapidly permeable, calcareous fine sandy loams.

Class V. Soils that are not likely to erode but have other limitations, impractical to remove without major reclamation, that limit their use largely to pasture, range, or wildlife food and cover.

Subclass Vw. Soils that are restricted in use for cultivated crops by flooding.

Unit Vw–1. Deep, nearly level, moderately permeable to moderately rapidly permeable, calcareous silt loams to very fine sandy loams.

Unit Vw–2. Deep, nearly level to gently undulating, rapidly permeable, calcareous fine sandy loams to very fine sandy loams.

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

Subclass VIe. Soils that are severely limited, chiefly by risk of erosion, if protective cover is not maintained.

Unit VIe–1. Deep, gently sloping to sloping, rapidly permeable to moderately rapidly permeable, calcareous to noncalcareous fine sands to loamy fine sands.

Unit VIe–2. Deep, nearly level to gently sloping, moderately permeable to moderately rapidly permeable, noncalcareous fine sands.

Unit VIe–3. Deep, sloping to strongly sloping, moderately permeable, calcareous fine sandy loams.

Unit VIe–4. Deep to shallow, sloping to strongly sloping, moderately permeable to moderately rapidly permeable, calcareous to noncalcareous very fine sandy loams to clay loams.

Unit VIe–5. Deep, sloping to strongly sloping, moderately permeable to moderately rapidly permeable, calcareous to noncalcareous fine sandy loams.

Subclass VIs. Soils that are generally unsuitable for cultivation and are limited for other uses by moisture capacity and gravel.

Unit VIs–1. Deep, gently sloping to very steep, moderately rapidly permeable, noncalcareous very gravelly sandy loams.

Class VII. Soils that have very severe limitations that make them unsuitable for cultivation without major reclamation and that restrict their use largely to grazing or wildlife habitat.

Subclass VIIe. Soils that are very severely limited, chiefly by risk of erosion, if protective cover is not maintained.

Unit VIIe–1. Deep, hummocky to duny, rapidly permeable, calcareous fine sands.

Subclass VIIs. Soils that are very severly limited by moisture capacity, stones, or other features.

Unit VIIs–1. Very shallow to deep, gently sloping to very steep, very slow to moderately permeable, calcareous very fine sandy loams to clays and areas of Badland and of Rough broken land.

Unit VIIs–2. Rough, broken, steep or very steep eroded and gullied areas.

Estimated Yields

Crops yields over a period of years reflect the management the soil has received. Generally, continued high yields are a result of good management and an indication that the soil has been improved or is being kept in good condition. In table 2 are estimated average acre yields, based on seeded areas, for the principal crops grown on the soils that are cultivated in Cottle County. Yields are given for a high level of management of dryland soils. No yields are predicted for irrigated soils, because use of irrigation is limited in the county. Crops grown under irrigation in Cottle County can normally be expected to yield two to three times as much as those grown under dryland farming.

A high level of management for dryland soils in this county includes the following practices.

1. Rainfall is conserved by using all necessary conservation measures. This includes a properly maintained terrace system, contour farming, and stubble-mulch tillage.
2. Crop residue is managed for effective erosion control.
3. Soil tilth is adequately maintained by using the following practices.
   a. Cropping systems that maintain an adequate supply of organic matter are followed.
   b. All tillage, harvesting, and grazing operations are performed at optimum soil moisture to avoid soil compaction.
   c. Minimum but timely tillage is performed, consistent with weed control and seedbed preparation.
   d. Depth of tillage is varied.
4. Timely insect, disease, and weed control measures are consistently used.

The figures given in table 2 are based on information obtained from farmers, on observations and comparisons made by those familiar with the soils, and on research.

Range [2]

Ranching and livestock farming are important enterprises in Cottle County. Seventy-five percent of the ranches and livestock farms include varying amounts of cropland. This cropland is used primarily for producing grazing or hay crops such as sorghum and small grain. The sorghum is often processed as silage and stored for use during drought periods.

Native grass covers 397,489 acres in the county. Several kinds of grassland are in the county. The Sandyland

[2] By JOE B. NORRIS, range conservationist, Soil Conservation Service.

TABLE 2.—*Estimated yields for principal crops under a high level of management*

[Only the arable soils are listed in this table. Absence of data indicates that crop generally is not grown on the soil named]

Soil	Cotton	Wheat	Grain sorghum
	Lb. of lint	*Bu.*	*Lb.*
Abilene clay loam, 0 to 1 percent slopes	250	20	1,500
Bukreek loam, 0 to 1 percent slopes	225	20	1,500
Bukreek loam, 1 to 3 percent slopes	215	20	1,250
Bukreek loam, 3 to 5 percent slopes	200	10	1,000
Carey loam, 0 to 1 percent slopes	300	20	1,500
Carey loam, 1 to 3 percent slopes	275	20	1,300
Colorado very fine sandy loam	270	20	1,400
Colorado clay loam	320	24	1,600
Cottonwood complex	170	10	1,000
Delwin fine sand	190	----	1,200
Enterprise very fine sandy loam, 0 to 1 percent slopes	300	20	1,500
Enterprise very fine sandy loam, 1 to 3 percent slopes	260	20	1,300
Enterprise very fine sandy loam, 3 to 5 percent slopes	210	10	1,000
Hardeman fine sandy loam, 0 to 1 percent slopes	250	15	1,500
Hardeman fine sandy loam, 1 to 3 percent slopes	225	15	1,400
Hardeman fine sandy loam, 3 to 5 percent slopes	190	10	1,000
Heatly fine sand	160	----	900
Lofton clay loam	225	20	1,500
Miles loamy fine sand, 0 to 3 percent slopes	225	15	1,400
Miles loamy fine sand, 3 to 5 percent slopes	170	10	950
Miles fine sandy loam, 0 to 1 percent slopes	250	15	1,500
Miles fine sandy loam, 1 to 3 percent slopes	225	15	1,400
Miles fine sandy loam, 3 to 5 percent slopes	185	15	1,150
Nobscot fine sand	150	----	850
Paducah loam, 3 to 5 percent slopes	200	----	1,000
Sagerton loam, 0 to 1 percent slopes	225	20	1,500
Sagerton loam, 1 to 3 percent slopes	180	15	1,400
Sagerton clay loam, 0 to 1 percent slopes	250	20	1,600
Sagerton clay loam, 1 to 3 percent slopes	180	15	1,300
St. Paul silt loam	300	20	1,500
Springer loamy fine sand, undulating	190	15	1,000
Springer loamy fine sand, hummocky	160	----	900
Tillman silty clay loam, 0 to 1 percent slopes	190	20	1,400
Tillman silty clay loam, 1 to 3 percent slopes	160	15	1,200
Tillman silty clay loam, 1 to 3 percent slopes, eroded	140	15	950
Veal fine sandy loam, 1 to 3 percent slopes	170	15	950
Veal fine sandy loam, 3 to 5 percent slopes	140	10	900
Vernon clay loam, 1 to 3 percent slopes	----	10	----
Vernon clay loam, 3 to 5 percent slopes	----	10	----
Weymouth clay loam, 1 to 3 percent slopes	150	10	900
Weymouth clay loam, 3 to 5 percent slopes	130	10	850
Woodward loam, 1 to 3 percent slopes	265	----	1,300
Woodward loam, 3 to 5 percent slopes	190	----	1,000
Yahola very fine sandy loam	270	15	1,400

range site, mainly in the west-central part of the county, produces tall grasses. Smaller areas of this site also occur in the southeastern and southwestern parts of the county. The Deep Hardland range site produces short and mid grasses. This site consists mainly of areas in the eastern and south-central parts of the county. Smaller areas are in the north-central, northeastern, and southeastern parts of the county. Areas of the more loamy soils, which produce mid grasses, are in the northwestern part of the county. Areas of the rugged Rough Breaks range site run from east to west across the northern half of the county and are mainly adjacent to the Middle and North Pease Rivers. They also occur along the Pease River, which is formed below the junction of these streams. Small areas of shallow soils, which are scattered throughout the county, produce sparse vegetation.

Range sites and condition classes

A range site is a distinctive kind of range that differs from other kinds of range in its potential to produce native plants.

Range sites differ from each other in their ability to produce significant differences in kinds or proportions of plant species or in total annual production. Significant differences are those great enough to require some variation in management, such as a different rate of stocking.

Differences in kinds, proportion, and production of plants that different sites are capable of supporting are due in large measure to differences in environmental factors such as soil, terrain, and climate. Range sites can be identified by the kinds of soil known to be capable of producing the distinctive climax, or potential, plant community that characterizes a specific site.

Most of the native grasslands of Cottle County have been heavily grazed for several generations, and their original plant cover has been materially altered. *Range condition* is the present state of the vegetation of a range site in relation to the climax plant cover for that site. *Range condition classes* measure the degree to which the present plant composition, expressed as a percentage, resembles that of the climax plant community of a range site. Four range condition classes are recognized. A range is in *excellent condition* if 76 to 100 percent of the vegetation is the same kind as that in the original stand; it is in *good* condition if 51 to 75 percent; in *fair* condition if 26 to 50 percent; and in *poor* condition if 25 percent or less.

In determining present range condition class, plants are grouped according to their response to the kind of grazing use on specific range sites.

Some plants in the climax plant community decrease in relative abundance when such a community is subjected to continued moderately heavy to heavy grazing. Most of these plants have a high grazing preference and decrease from excessive use. The total of all such species is counted in determining range condition class.

Increasers are plants in the climax plant community that normally increase in relative abundance when the community is subjected to continued moderately heavy to heavy grazing. Some increasers with moderately high grazing preference may initially increase and then decrease as grazing pressure continues. Others of low grazing preference may continue to increase either in actual plant numbers or in relative proportion. Only the percentage of increaser plants normally expected to occur in the climax plant community is counted in determining range condition.

Invaders are not members of the climax plant community for the site. They invade the community as a result of various kinds of disturbance. They may be annuals or perennials and may be grasses, weeds, or woody plants. Some have relatively high grazing value but many are worthless. Invader plants are not counted in determining range condition class.

For most range sites and most range livestock operations, the higher the range condition class, the greater the quality and amount of available forage.

Descriptions of the range sites

Thirteen range sites have been identified and described in Cottle County.

In several instances in the county, soils identified with different range sites occur in such an intermingled pattern that their individual delineation is not practical. In such cases, the soils in the complex are in more than one range site. One example is the Quanah-Talpa complex. In this instance, the Quanah soils are in Deep Hardland range site and the Talpa soils are in Very Shallow range site, even though they are mapped together (fig. 19).

The Badland part of mapping units Badland and Owens soils and Owens soils and Badland has little or no grazing value and has not been placed in a range site.

BOTTOMLAND RANGE SITE

This site consists of lowlands along the major creeks and intermittent streams, in small draws, and adjacent to the Pease River. These areas are subject to overflow. They receive runoff from higher lying soils. Although flooded frequently, they are under water for only short periods. Any change to vegetation is ordinarily from sedimentation rather than from wetness.

This site is capable of producing an abundance of tall and mid grasses if it is in good to excellent condition. Trees, such as elm, hackberry, and cottonwood, are scattered along the banks of the major streams. The vegetation deteriorates rapidly following prolonged overuse. Tall grasses are the first to vanish under the heavy grazing pressure. The mid grasses are then replaced by perennial weeds, numerous annuals, and heavy stands of brush. Eventually, with complete deterioration, all grazeable forage vanishes.

The composition of the climax vegetation varies from place to place, depending on the origin of the alluvial deposits. About 70 percent consists of big bluestem, sand bluestem, little bluestem, indiangrass, switchgrass, Canada wildrye, and side-oats grama. Other grasses making up the other 30 percent of the vegetation are western wheatgrass, vine-mesquite, silver bluestem, blue grama, and buffalograss.

If the climax vegetation is not maintained, the site is invaded by noxious plants that develop from seed washed in from large outlying areas. Among invaders, ordinarily annuals common in cultivated fields, are sunflower, cocklebur, buffalo-bur, hairy caltrop, common broomweed, crotons, thistles, and sandbur. Other common invaders are mesquite, sand dropseed, three-awn, windmill-

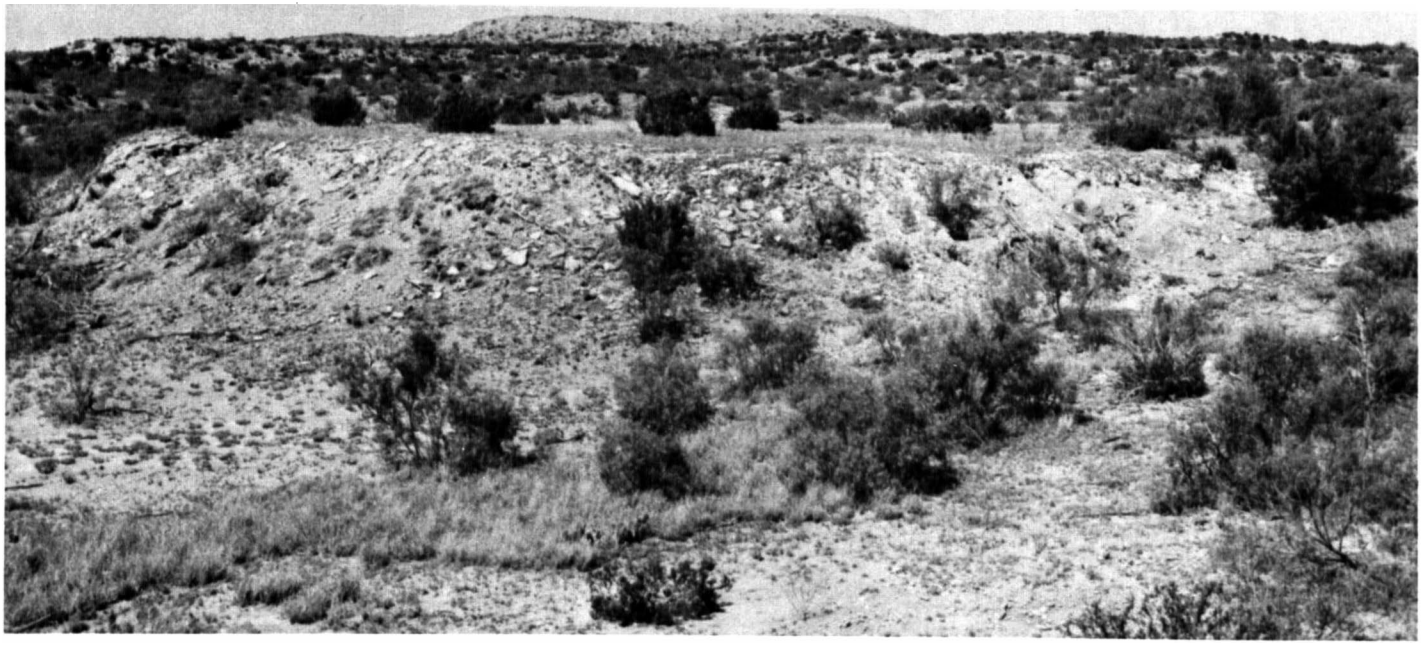

Figure 19.—**An area of Quanah-Talpa complex. The Quanah soils, which are in the valleys and on the foot slopes, are in the Deep Hardland range site. The Talpa soils, which are on ridgetops, are in the Very Shallow range site.**

grass, Texas grama, hairy tridens, inland saltgrass (in saline areas), and perennial forbs.

Because of the natural selection of this site by livestock for grazing and the loss of competitive grasses, mesquite and other brush invade. The most effective means of controlling this brush is by basal treatment with oil or a combination of oil and chemical herbicide. Dozing is often used on the more open stands.

This site responds favorably to range seeding where flooding is not a hazard. The extra water received on the site makes seeding less hazardous than on upland sites.

If the range is in excellent condition, the total production per acre of air-dry herbage ranges from 2,000 pounds in years of unfavorable rainfall to 3,600 pounds in years of favorable rainfall. About two-thirds of this production can be considered suitable forage for cattle.

DEEP HARDLAND RANGE SITE

The site consists mainly of smooth, nearly level to gently sloping soils on upland plains. It is accessible to livestock and is a favorable grazing area.

The potential plant community consists of mid and short grasses. Blue grama makes up about 70 percent of the original vegetation. Other species growing in limited amounts are western wheatgrass, vine-mesquite, white tridens, side-oats grama, buffalograss, and silver bluestem.

Continuous overgrazing results in a thinning of side-oats grama followed by a thickening of blue grama, buffalograss, and tobosagrass. Further deterioration of the range results in invasion by perennial three-awn, hairy tridens, sand dropseed, Texas grama, tumblegrass, pricklypear, mesquite, lotebush, and many annuals.

If the range is in fair to poor condition or in a year that has a wet spring, invading annuals occupy the bare spots. The most common invaders are Texas filaree, evax, various plantains, bladderpod, plains greenthread, bitterweed actinea, common broomweed, little barley, and Japanese brome. Common perennial forbs that invade this site are western ragweed, silverleaf nightshade, and Dakota verbena.

This site is capable of only limited production. Large amounts of litter and cover are necessary to reduce surface crusting and to control erosion. Once the range is in poor condition, recovery is very slow because of the crusted soils, lack of desirable seed plants, and heavy infestation by mesquite.

If the range is in excellent condition, the total production per acre of air-dry herbage ranges from 1,500 pounds in years of unfavorable rainfall to 2,500 pounds in years of favorable rainfall. Approximately 85 percent of this production can be considered forage for livestock and wildlife. (fig. 20).

DEEP SAND RANGE SITE

This site consists of nearly level to gently sloping and hummocky to duny soils. Many areas give the appearance of stabilized dunes, particularly those along old fence rows.

The climax vegetation is predominantly tall grass and lesser amounts of mid grasses. Sand bluestem, indiangrass, little bluestem, switchgrass, sand lovegrass, and giant dropseed make up about 75 percent of the climax vegetation. Other important grasses, making up some 25 percent of the climax vegetation, are side-oats grama, silver bluestem, hairy grama, sand dropseed, and perennial three-awn. Along with these are found woody plants such as sand plum, shin oak, and skunkbush.

If the range is in excellent condition, the total production per acre of air-dry herbage ranges from 1,700 pounds in years of unfavorable rainfall to 3,400 pounds in years of favorable rainfall. About two-thirds of this

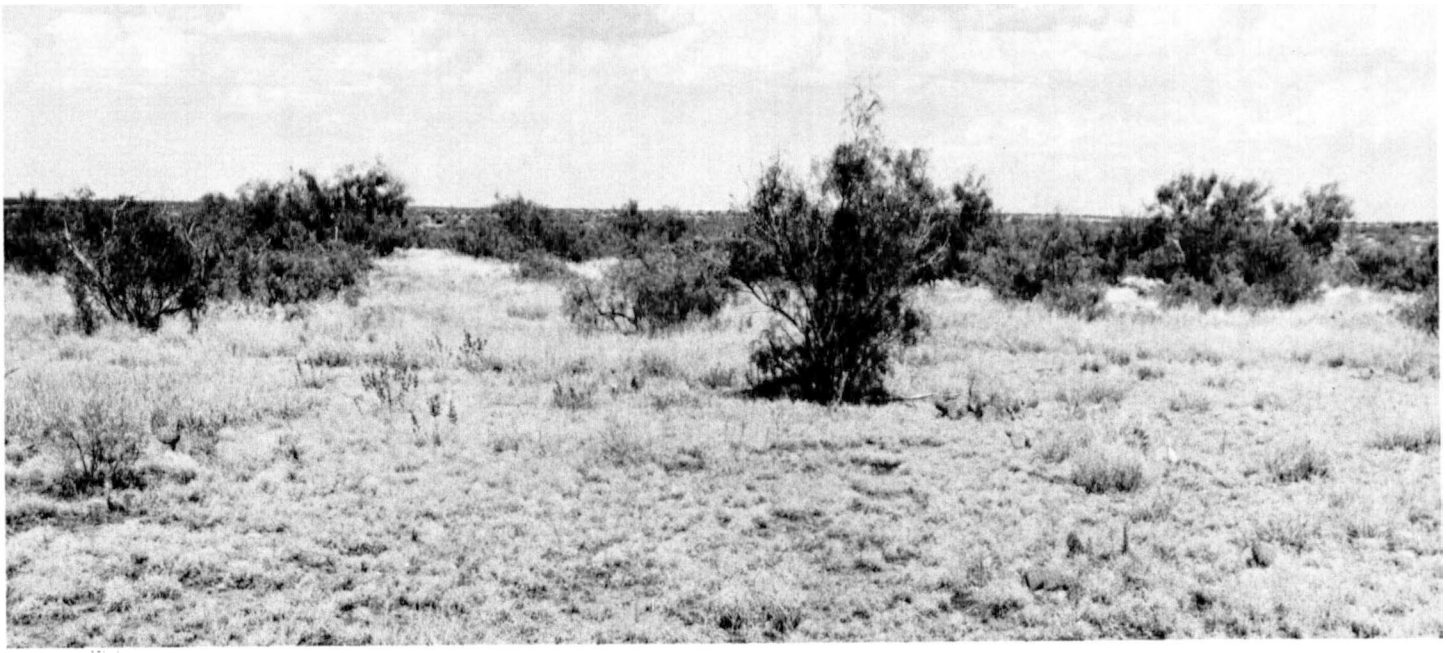

Figure 20.—An area of Deep Hardland range site on a Tillman silty clay loam. The grasses are mainly buffalograss and tobosagrass.

production can be considered suitable forage for livestock and wildlife.

GRAVELLY RANGE SITE

Hilgrave very gravelly sandy loam is the only soil in this site. This is a gently sloping to very steep soil on dissected hills. It is sometimes "paved" with gravel. The gravel is interspersed throughout the profile.

As a result of the gravel, the soil of this site has a good relationship between the plants and the soil, moisture, and air. Even though there is a good variety of vegetation, it is sparse. As the site deteriorates and erosion takes away the topsoil, the ability of the site to produce is greatly reduced.

Grasses such as side-oats grama, blue grama, little bluestem, and Arizona cottontop make up 70 percent of the potential plant community. Smaller amounts of sand bluestem, indiangrass, and switchgrass are also found on some of the more favored spots. Other grasses include hairy grama, buffalograss, silver bluestem, Texas wintergrass, and small amounts of shin oak. Invaders are Texas grama, sand muhly, hairy tridens, fall witchgrass, agrito, redberry juniper, catclaw, pricklypear, and numerous annuals. Mesquite invades the deeper soils that may be associated with this site (fig. 21).

If the range is in excellent condition, the total production per acre of air-dry herbage ranges from 1,100 pounds in years of unfavorable rainfall to 1,800 pounds in years of favorable rainfall. About 60 percent of this production can be considered suitable forage for livestock and wildlife.

GYPLAND RANGE SITE

The nearly level soils of this site are high in gypsum. The distinctive characteristic of the site is the effect the varying amount of gypsum has on the vegetation of the site.

The climax vegetation is directly affected by the gypsum. Except in areas of almost pure gypsum, this site has a mid- and tall-grass appearance. Characteristic grasses are side-oats grama, little bluestem, and sand bluestem. In places where the gypsum content is 75 percent and higher, vegetation is sparse and side-oats grama and hairy grama are dominant.

Approximately 60 percent of the climax vegetation is made up of blue grama, indiangrass, switchgrass, vine mesquite, plains bristlegrass, and Arizona cottontop. Other important grasses on this range site are hairy grama, buffalograss, slim or rough tridens, reverchon panic, black grama, silver bluestem, sand dropseed, and perennial three-awn. Also characteristic of the site are dotted gayfeather, black feather dalea, and false broomweed. The principal invaders are mesquite, redberry juniper, yucca, catclaw, Texas grama, hairy tridens, and various annuals.

If the range is in excellent condition, the total production per acre of air-dry herbage ranges from 500 pounds in years of unfavorable rainfall to 1,100 pounds in years of favorable rainfall. Production depends on the amount of gypsum in the soil. About 65 percent of this production is suitable forage for livestock and wildlife.

MIXEDLAND RANGE SITE

The soils of this site are nearly level to moderately steep and are in areas that have defined drainage patterns.

About 70 percent of the climax vegetation consists of blue grama. Other grasses are little bluestem, Arizona cottontop, plains bristlegrass, side-oats grama, and, along the larger drains, Canada wildrye, switchgrass, and western wheatgrass. For the most part, little bluestem is confined to isolated areas that have more than usual moisture. Approximately 30 percent of the grasses consists of increasers—buffalograss, hairy grama, sand drop-

Figure 21.—**An area of Gravelly range site in which woody plants have invaded. The woody plants are mesquite, juniper, and associated brush.**

seed, silver bluestem, and, along drains, meadow dropseed.

Any deterioration in the vegetation results in an immediate thinning of side-oats grama, Arizona cottontop, and plains bristlegrass. Blue grama is the next prominent grass to thin out. If continuously overgrazed, the range vegetation soon consists almost entirely of buffalograss and numerous invading forbs; blue grama is confined to protected areas. The chief invader grasses are red grama, Texas grama, six-weeks grama, tumble windmillgrass, hooded windmillgrass, gummy lovegrass, little barley, tumblegrass, and hairy tridens. Woody invaders are mesquite, pricklypear, tasajillo, small soapweed, and juniper.

If this site has deteriorated, recovery is slow because viable seeds of climax plants are lacking and because of surface crusting of the soil. In these instances, the site responds well to reseeding of primary grasses.

If the range is in excellent condition, the total production per acre of air-dry herbage ranges from 1,600 pounds in years of unfavorable rainfall to 2,400 pounds in years of favorable rainfall. About 70 percent of this production can be considered suitable forage for livestock and wildlife.

ROUGH BREAKS RANGE SITE

This site consists of moderately steep to very steep soils. Most areas are inaccessible to livestock.

About 70 percent of the climax vegetation consists of side-oats grama, little bluestem, and blue grama. Switchgrass, sand bluestem, indiangrass, and Canada wildrye are found in places where moisture conditions are more favorable. The other 30 percent of the original grass cover consists of hairy grama, perennial three-awn, slim tridens, and sand dropseed. Woody species on the slopes are redberry juniper, feather dalea, skunkbush, and catclaw acacia. Invaders on the site are Texas grama, hairy tridens, sand muhly, and various annuals.

Even if the range is in excellent condition, vegetation usually is sparse. Under prolonged heavy use, the steep slopes lose their protective vegetative cover, erosion is accelerated, and soil loss is severe. Intensive management and protective measures must be applied before stabilization is accomplished.

If the range is in excellent condition, the total production per acre of air-dry herbage ranges from 500 pounds in years of unfavorable rainfall to 900 pounds in years of favorable rainfall. No more than 50 percent of this production can be considered suitable forage for livestock, because the rest is inaccessible. Wildlife makes better use of the vegetation on the steeper slopes.

SANDY BOTTOMLAND RANGE SITE

This site consists of nearly level to gently undulating soils along stream beds. Some areas are subject to frequent flooding and deposition. If unprotected by plant cover, the site is subject to scouring and gullying.

The climax vegetation of this site is made up of mid and tall grasses. Indiangrass, switchgrass, and sand bluestem dominate. Other grasses are side-oats grama, little bluestem, Canada wildrye, Texas bluegrass, and big bandreed. These species make up about 70 percent of the climax community. A few woody plants, such as sand plum, cottonwood, willow, sand sagebrush, and skunkbush, are present under climax conditions.

Any vegetative deterioration created by overgrazing results in a rapid increase of such grasses as vine-mesquite, three-awn, sand dropseed, blue grama, inland saltgrass, and alkali sacaton. Further degeneration in the plant stand results in invasion by gummy lovegrass, annual three-awn, tumble lovegrass, low-growing paspa-

lums, and various annuals. Woody invaders are yucca, groundsels, and salt cedar.

If the range is in excellent condition, the total production per acre of air-dry herbage ranges from 2,200 pounds in years of unfavorable rainfall to 3,500 pounds in years of favorable rainfall. About 75 percent of this production can be considered adequate forage for livestock and wildlife.

SANDYLAND RANGE SITE

The soils of this site are smooth and nearly level to sloping and are undulating to hummocky.

About 75 percent of the climax plant community on this site consists of sand bluestem, switchgrass, indiangrass, little bluestem, Canada wildrye, sand lovegrass, side-oats grama, and Texas bluegrass. Approximately 25 percent of the plants are silver bluestem, dropseed, hairy grama, blue grama, and perennial three-awn. On some of the soils in this site, a few woody plants such as sand plum and sand sagebrush are present in the climax vegetation.

Any deterioration in this site results in a rapid increase of small soapweed (yucca), shin oak, and annuals. Invading grasses include annual three-awn, fringed signalgrass, tumble windmillgrass, gummy lovegrass, red lovegrass, tumble lovegrass, and low growing paspalums. The chief invading weeds are common ragweed, wax goldenweed, tumble ringwing, annual wildbuckwheat, rose-ring gaillardia, prairie sunflower, woollywhite, beebalm, pricklepoppy, curlycup gumweed, Riddell grounsel, and stillingia.

In many areas shin oak that has invaded the site must be controlled before grasses can make any recovery. Mechanical methods of control are not feasible because of the soil blowing that could result. The site responds favorably to chemical control of shin oak. The site has ability, under good care, to regain good to excellent condition in a few years provided a seed source is available. When response is slow, overseeding by the best known methods speeds up recovery.

This is a good-producing site, but it varies widely in production from year to year. If the range is in excellent condition, the total production per acre of air-dry herbage ranges from 1,700 pounds in years of unfavorable rainfall to 3,200 pounds in years of favorable rainfall. About two-thirds of this production can be considered suitable forage for livestock and wildlife.

SANDY LOAM RANGE SITE

This site consists of nearly level to strongly sloping soils on upland plains. It is capable of supporting a wide variety of vegetation.

Side-oats grama, little bluestem, Arizona cottontop, and bristlegrass normally occur in areas of more favorable moisture. These grasses make up about 70 percent of the climax plant community.

Buffalograss, blue grama, sand dropseed, perennial three-awn, hairy grama, and silver bluestem make up the other 30 percent of the vegetation. Woody increasers that make up a maximum of 5 percent of the potential plant community are sand sagebrush, agarito, skunkbush, and mimosa.

Following deterioration of the climax plant cover, sand dropseed, three-awn, mesquite, lotebush, pricklypear, and numerous annuals invade. When response of the grass to management is slow, overseeding has proven successful in speeding recovery. Seeding in conjunction with mechanical brush control not only increases production but provides a greater variety of grass on which livestock can graze.

If the range is in excellent condition, the total production per acre of air-dry herbage ranges from 1,800 pounds in years of unfavorable rainfall to 3,000 pounds in years of favorable rainfall. About two-thirds of this production can be considered forage for livestock and wildlife.

SHALLOW REDLAND RANGE SITE

This site consists of gently sloping to strongly sloping soils.

The climax plant community consists of mostly mid and short grasses. The better plants, of which side-oats grama is the dominant species, constitute about 65 percent of the plant community. Other important grasses are blue grama, vine-mesquite, and little bluestem. Sand bluestem and indiangrass occur on some areas that have northern and eastern exposures. In these areas the moisture conditions are more favorable.

Forbs in the climax plant community are groundplum milkvetch, dalea, prairie-clover, scurf-pea, heath aster, Engelmanndaisy, dotted gayfeather, penstemon, sagewort, and gaura. These forbes are important indicators of trends in the condition of the range. Desert shrubs such as acacia, mimosa, vine ephedra, agarita, and skunkbush are present to a limited extent.

About 35 percent of the climax vegetation is composed of hairy grama, silver bluestem, buffalograss, perennial three-awn, and tobosagrass.

The chief woody invaders are mesquite, grassland croton, pricklypear, and lotebush. Common invading perennial grasses are hairy tridens, sand dropseed, Texas grama, red grama, and tumblegrass. The chief invading forbs are broom snakeweed, wavyleaf thistle, plains actinea, gray goldaster, rock daisy, threadleaf groundsel, and Texas stillingia. Other common invading forbs are common broomweed, bitterweed actinea, oneseed croton, Texas filaree, evax, plaintain, plains greenthread, and bladderpod.

If the range is in excellent condition, the total production per acre of air-dry herbage ranges from 1,200 pounds in years of unfavorable rainfall to 1,800 pounds in years of favorable rainfall. About 80 percent of this production can be considered suitable forage for livestock and wildlife.

VALLEY RANGE SITE

Most of this site consists of nearly level soils. It is on the higher parts of the flood plains or is in wide, shallow, concave drainageways. It narrows in many places where adjacent sites steepen, but it widens out lower down the drainage pattern.

About 65 percent of the climax plant community consists of side-oats grama, vine-mesquite, western wheatgrass, blue grama, and Canada wildrye. The remaining 35 percent is made up of buffalograss, Texas wintergrass, silver bluestem, tobosagrass, meadow dropseed, white tridens, Texas bluegrass, hackberry, and elm. Common invaders are mesquite, condalia, pricklypear, tasajillo, redberry juniper, hairy tridens, and various annuals.

If the range is in excellent condition, the total production per acre of air-dry herbage ranges from 1,800 pounds in year of unfavorable rainfall to 2,900 pounds in years of favorable rainfall. About 75 percent of this production is considered suitable forage for livestock and wildlife.

VERY SHALLOW RANGE SITE

This site consists mainly of gently sloping to steep soils. There are some knolls and relatively steep escarpments. The soils in this site are characterized by limestone rocks on the surface and in the soil profile.

The site is generally found in a higher condition class than adjacent sites. Grass is normally sparce. Rarely are all the better grasses grazed out. Generally there are enough of these grasses on which to base a management program that will improve the vegetation on the site.

The site has the appearance of a mid-grass site where side-oats grama is dominant. Other grasses on this site are blue grama, Arizona cottontop, and little bluestem. On the northern slopes and in places where moisture is more favorable, sand bluestem, indiangrass, vine-mesquite, plains bristlegrass and other grasses grow. These grasses make up about 70 percent of the potential plant community.

The wide variety of grasses constituting the other 30 percent of the climax vegetation include hairy grama, black grama, buffalograss, silver bluestem, sand dropseed, perennial three-awn, and slim or rough tridens.

Invaders include hairy tridens, Texas grama, red grama, tumblegrass, mesquite, pricklypear, lotebush, yucca, and various annuals.

If the range is in excellent condition, the total production per acre of air-dry herbage ranges from 700 pounds in years of unfavorable rainfall to 1,300 pounds in years of favorable rainfall. About 60 percent of this production can be considered suitable forage for livestock.

Engineering Uses of the Soils [3]

This section provides information of special interest to engineers, contractors, farmers, and others who use soil as structural material or as foundation material upon which structures are built. In this section are discussed those properties of the soils that affect construction and maintenance of roads and airports, pipelines, building foundations, water storage facilities, erosion control structures, drainage systems, and sewage disposal systems. Among the soil properties most important in engineering are permeability, compressibility, shear strength, density, shrink-swell potential, water-holding capacity, grain-size distribution, plasticity, and reaction.

Information concerning these and related soil properties are furnished in tables 3, 4, and 5. The estimates and interpretations of soil properties in these tables can be used in:

1. Planning and designing agricultural drainage systems, farm ponds, irrigation systems, diversion terraces, and other structures for controlling water and conserving soils.
2. Selecting potential locations for highways, airports, pipelines, and underground cables.
3. Locating probable sources of sand, gravel, or rock suitable for use as construction material.
4. Selecting potential industrial, commercial, residential, and recreational areas.
5. Supplementing the information obtained from other published maps, reports, and aerial photographs for the purpose of making maps and reports that can be used readily by engineers.

The engineering interpretations reported here do not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads and where the excavations are deeper than the depths of layers here described. The estimated values for bearing capacity and traffic-supporting capacity expressed in words should not be assigned specific values. There are small areas of other soils and contrasting situations included in the mapping units that may have different engineering properties than those listed. Even in these situations, though, the soil map is useful in planning more detailed field investigations and for indicating the kinds of problems that may be expected.

Cottonwood soils are undermined in many places by pockets and channels caused by dissolving of gypsum. These pockets and channels are hazardous to engineering and construction, and extensive testing should be done to avoid them.

Hilgrave very gravelly sandy loam and the deep substrata of some soils bordering rivers and creeks are possible sources of gravel in Cottle County.

Some terms used by soil scientists may be unfamiliar to engineers, and some words have different meanings in soil science than they have in engineering. Among the terms that have special meaning in soil science are sand, silt, clay, surface soil, subsoil, and horizon. These and other terms are defined in the Glossary at the back of the survey.

Engineering classification systems

The two systems most commonly used in classifying samples of soil horizons for engineering are the AASHO system (*1*), adopted by the American Association of State Highway Officials, and the Unified soil classification system (*10*), used by Soil Conservation Service engineers, the Department of Defense, and others.

The AASHO system is used to classify soils according to those properties that affect their use in highway construction. 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 (*3*). In group A–1 are gravelly soils of high shear strength, or the best soils for subgrade (foundation); and at the other extreme, A–7, are clay soils that have low strength when wet. The best soils for subgrade are therefore classified as A–1, the next best A–2, and so on to class A–7, 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. If soil material is near a classification boundary it is given a symbol showing both classes; for example, A–2 or A–4. Within each group, the relative engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for

[3] By JOHN ADAMS, civil engineer, Soil Conservation Service.

TABLE 3.—*Estimated soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. These soils column. The symbol > means greater than;

Soil series and map symbols	Hydrologic group	Depth to bedrock	Depth from surface (typical profile)	Classification		
				USDA texture	Unified	AASHO
		Inches	*Inches*			
Abilene: AbA	C	>60	0–26	Clay loam	CL	A–6
			26–38	Clay	CL	A–7
			38–48	Clay loam	CL	A–6, A–7
			48–72	Clay loam	CL	A–6
*Badland: Bo. For Owens part, see Owens series. No estimates made, because soil material is too variable. Onsite investigation required.						
Bukreek: BuA, BuB, BuC	B	>60	0–9	Loam	ML–CL	A–4
			9–48	Sandy clay loam	CL	A–6
			48–66	Sandy clay loam	CL	A–4, A–6
			66–102	Loam	CL	A–4
Carey: CaA, CaB	B	>60	0–13	Loam	ML, ML–CL	A–4
			13–28	Sandy clay loam	CL, ML–CL	A–4, A–6
			28–42	Loam	ML–CL	A–4
			42–72	Very fine sandy loam	ML–CL	A–4
			72–100	Soft calcareous sandstone.		
*Colorado: Cd, Ce, Cf For Yahola part of Cf, see Yahola series.	B	>60	0–6	Clay loam	ML–CL	A–4
			6–60	Clay loam	CL, ML–CL	A–6
Cottonwood:						
Co For shallow part, see unit Ct.	B	21–36	0–26	Loam	CL	A–6
			26–36	Gypsiferous earth or gypsum beds.		
Ct	C	3–10	0–8	Loam	ML, CL	A–6
			8–36	Loam, soft white gypsiferous material.		
Delwin: De	A	>60	0–18	Fine sand	SM, SM–SC	A–2–4, A–3
			18–66	Sandy clay loam	SC, SM	A–2–4, A–4, A–6
			66–72	Loamy fine sand	SM, SP–SM	A–2, A–3
Enterprise: EnA, EnB, EnC, EnD	B	>60	0–60	Very fine sandy loam	ML, ML–CL	A–4
Hardeman: HaA, HaB, HaC, HaD	B	>60	0–60	Fine sandy loam	ML–CL, SM–SC	A–4
Heatly: He	A	>60	0–28	Fine sand	SM, SC	A–2, A–3
			28–34	Sandy loam	SM, SC	A–2, A–4
			34–80	Sandy clay loam	SC, SM	A–2, A–6
Hilgrave: Hg	B	>60	0–7	Very gravelly sandy loam	SM, SM–SC	A–2–4
			7–26	Very gravelly loam and sandy clay loam.	GM–GC	A–1
			26–40	Gravelly loamy sand	GW–GM	A–3
			40–60	Coarse sand	SM, SP–SM	A–1
Lincoln: Lc, Lf	A	>60	0–13	Fine sandy loam	SM	A–4
			13–60	Fine sand (stratified)	SM	A–2
Lipan: Ln	D	>60	0–18	Clay	CH	A–7
			18–70	Clay	CH	A–7
Lofton: Lo	D	>60	0–8	Clay loam	CL	A–6
			8–18	Silty clay	CL	A–7
			18–45	Clay	CH, CL	A–7
			45–85	Silty clay	CL	A–7

significant in engineering

may have different properties, and it is necessary to follow carefully the instructions for referring to other series that appear in the first
the symbol < means less than]

Percentage passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)				
				Inches per hour	*Inches per inch of soil*	*pH value*	
100	100	90–99	75–80	0. 20–0. 63	0. 15–0. 19	6. 6–7. 8	Moderate.
100	100	90–99	90–95	0. 20–0. 63	0. 14–0. 18	7. 9–8. 4	High.
100	90–100	90–99	70–80	0. 20–0. 63	0. 14–0. 18	7. 9–8. 4	Moderate.
100	90–100	90–99	70–80	0. 20–0. 63	0. 12–0. 16	7. 9–8. 4	Low.
100	100	95–100	65–75	0. 63–2. 00	0. 12–0. 16	6. 6–7. 8	Low.
100	100	90–100	75–85	0. 63–2. 00	0. 13–0. 17	7. 4–8. 4	Low.
90–100	85–90	80–90	55–65	0. 63–2. 00	0. 12–0. 16	7. 9–8. 4	Low.
100	95–100	80–90	65–75	0. 63–2. 00	0. 12–0. 14	7. 9–8. 4	Low.
100	100	95–100	60–75	0. 63–2. 00	0. 16–0. 20	6. 6–7. 8	Low.
100	100	95–100	70–80	0. 63–2. 00	0. 14–0. 18	6. 6–8. 4	Low.
100	100	95–100	60–75	0. 63–2. 00	0. 14–0. 16	7. 9–8. 4	Low.
100	95–100	90–100	50–65	0. 63–2. 00	0. 14–0. 15	7. 9–8. 4	Low.
100	100	95–100	75–90	0. 63–2. 00	0. 14–0. 17	7. 9–8. 4	Low.
100	100	85–95	70–80	0. 63–2. 00	0. 14–0. 17	7. 9–8. 4	Low.
100	100	85–95	60–75	0. 63–2. 00	0. 12–0. 16	7. 9–8. 4	Low.
100	100	90–100	60–75	0. 63–2. 00	0. 11–0. 14	7. 9–8. 4	Low.
100	100	85–100	10–20	6. 30–20. 00	0. 05–0. 09	6. 1–7. 3	Low.
100	100	90–100	15–45	0. 63–2. 00	0. 14–0. 16	6. 1–7. 3	Low.
100	100	60–75	8–25	6. 30–20. 00	0. 06–0. 10	7. 4–7. 8	Low.
100	100	95–99	80–90	2. 00–6. 30	0. 18–0. 20	7. 4–8. 4	Low.
95–100	90–95	85–95	40–60	2. 00–6. 30	0. 10–0. 13	7. 4–8. 4	Low.
100	100	70–100	10–20	6. 30–20. 00	0. 05–0. 09	6. 1–7. 3	Low.
100	100	90–100	25–35	2. 00–6. 30	0. 12–0. 14	6. 6–7. 3	Low.
100	100	85–100	15–45	0. 63–2. 00	0. 14–0. 16	6. 6–7. 3	Low.
75–90	65–85	35–45	5–10	6. 30–20. 00	0. 07–0. 10	6. 1–8. 4	Low.
25–40	15–30	10–25	8–20	2. 00–6. 30	0. 10–0. 12	6. 1–8. 4	Low.
65–80	35–45	10–25	5–10	6. 30–20. 00	0. 04–0. 08	7. 9–8. 4	Low.
95–100	90–100	10–20	5–15	6. 30–20. 00	0. 04–0. 08	7. 9–8. 4	Low.
100	100	50–90	36–45	6. 30–20. 00	0. 06–0. 09	7. 9–8. 4	Low.
100	90–100	50–90	20–35	6. 30–20. 00	0. 04–0. 06	7. 9–8. 4	Low.
100	100	95–100	85–95	<. 06	0. 15–0. 18	7. 4–8. 4	High.
100	95–100	90–100	80–95	<. 06	0. 15–0. 18	7. 9–8. 4	High.
100	100	98–100	75–85	0. 20–0. 63	0. 16–0. 19	7. 4–7. 8	Moderate.
100	100	98–100	70–90	0. 06–0. 20	0. 16–0. 18	7. 4–7. 8	Moderate.
100	100	95–100	80–90	<. 06	0. 16–0. 18	7. 4–8. 4	High.
100	95–100	90–100	60–80	0. 06–0. 20	0. 12–0. 14	7. 9–8. 4	Moderate.

TABLE 3.—*Estimated soil properties*

Soil series and map symbols	Hydrologic group	Depth to bedrock	Depth from surface (typical profile)	Classification		
				USDA texture	Unified	AASHO
		Inches	*Inches*			
Miles:						
MeB, MeC	B	>60	0–17	Loamy fine sand	SM	A–2–4, A–4
			17–69	Sandy clay loam	SC, CL	A–6
			69–85	Loam	SM	A–4
MfA, MfB, MfC, MfD	B	>60	0–9	Fine sandy loam	SM	A–4, A–2–4
			9–32	Sandy clay loam	SC, CL	A–6
			32–72	Sandy clay loam	SC, SM–SC	A–2–4, A–6
Nobscot: No	A	>60	0–22	Fine sand	SP–SM, SM	A–3, A–2
			22–52	Sandy loam	SM, ML	A–2, A–4
			52–76	Loamy fine sand	SM, SP–SM	A–2, A–3
*Owens: Ob, Ot	D	12–20	0–13	Clay	CL, CH	A–7
			13–30	Clayey shale	CL, CH	A–6, A–7
No estimates made for Badland. Soil material too variable. For Talpa and Vernon parts of Ot, see the respective series.						
Paducah: PaC	B	36–72	0–16	Loam	ML, ML–CL	A–4
			16–27	Clay loam	ML–CL	A–4
			27–44	Loam	ML–CL	A–4
			44–72	Very fine sandy loam	ML–CL	A–4
			72–90	Soft Permian red beds.		
*Quanah: Qt	B	>60	0–30	Silty clay loam	CL, ML–CL	A–6
			30–48	Silty clay loam	CL, ML–CL	A–6, A–4
			48–60	Clay loam	CL	A–6
For Talpa part, see Talpa series.						
Quinlan	C	10–20	0–13	Loam	ML, CL	A–4
			13–60	Weakly cemented, fine-grained sandstone.		
Mapped only in an undifferentiated unit with Woodward soils.						
Rough broken land: Ro.						
No estimate made because soil material is too variable. Onsite investigation required.						
Sagerton: SaA, SaB, ScA, ScB	C	>60	0–7	Clay loam	CL	A–6
			7–25	Clay	CL	A–6, A–7
			25–84	Clay loam	CL	A–6
St. Paul: Sp	B	>60	0–10	Silt loam	ML, CL	A–4
			10–44	Clay loam	CL	A–6
			44–84	Clay loam	CL, ML	A–6
*Springer: SrB, SrD, StD	B	>60	0–16	Loamy fine sand	SM, SM–SP	A–2–4, A–3
			16–75	Fine sandy loam	SM, SM–SC	A–2–4, A–4
			75–92	Loamy fine sand	SM, SM–SP	A–2–4, A–3
For Tivoli part of StD, see Tivoli series.						
Talpa: Ta	D	5–10	0–6	Stony loam	CL	A–6
			6	Hard fractured dolomitic limestone.		
Tillman: TmA, TmB, TmB2	C	>60	0–6	Silty clay loam	CL	A–6, A–7
			6–49	Clay	CL, CH	A–6, A–7
			49–90	Clay	CL, CH	A–6, A–7
Tivoli: Tv	A	>60	0–60	Fine sand	SP–SM	A–2, A–3
Veal: VeB, VeC, VeD	B	>60	0–8	Fine sandy loam	SM, SC	A–4, A–2–4
			8–60	Loam	ML, ML–CL	A–4
			60–72	Fine sandy loam	SM, SC	A–4, A–2–4
Vernon: VnB, VnC	D	28–36	0–6	Clay loam	CL	A–6
			6–28	Clay	CL, CH	A–7–6, A–6
			28–60	Clayey shale	CL, CH	A–7–6, A–6

significant in engineering—Continued

Percentage passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)				
				Inches per hour	*Inches per inch of soil*	*pH value*	
95–100	90–100	80–95	15–25	2. 00–6. 30	0. 06–0. 10	6. 1–7. 3	Low.
98–100	95–100	90–97	40–55	0. 63–2. 00	0. 13–0. 17	6. 1–8. 4	Low.
95–100	95–100	80–95	35–50	0. 63–2. 00	0. 12–0. 14	7. 9–8. 4	Low.
95–100	95–100	80–90	30–50	2. 00–6. 30	0. 11–0. 14	6. 1–7. 3	Low.
98–100	95–100	90–97	40–55	0. 63–2. 00	0. 13–0. 17	6. 1–8. 4	Low.
90–100	90–95	82–92	30–50	0. 63–2. 00	0. 12–0. 16	7. 9–8. 4	Low.
100	100	50–90	5–15	6. 30–20. 00	0. 05–0. 06	5. 6–6. 5	Low.
100	100	85–100	20–60	2. 00–6. 30	0. 09–0. 13	5. 6–6. 5	Low.
100	100	60–90	8–20	6. 30–20. 00	0. 04–0. 06	6. 1–6. 5	Low.
95–100	95–100	90–100	80–95	<. 06	0. 13–0. 19	7. 9–8. 4	High.
90–100	85–100	70–90	55–80	<. 06	0. 13–0. 15	7. 9–8. 4	High.
100	100	95–100	50–90	0. 63–2. 00	0. 16–0. 20	6. 6–7. 8	Low.
100	96–99	95–99	55–65	0. 63–2. 00	0. 15–0. 18	6. 6–8. 4	Low.
100	96–99	95–99	60–65	0. 63–2. 00	0. 15–0. 18	7. 9–8. 4	Low.
100	100	95–100	55–65	0. 63–2. 00	0. 14–0. 18	7. 9–8. 4	Low.
100	100	95–98	85–95	0. 63–2. 00	0. 15–0. 18	7. 9–8. 4	Low.
90–100	90–95	85–90	75–85	0. 63–2. 00	0. 14–0. 16	7. 9–8. 4	Low.
100	100	95–98	85–90	0. 63–2. 00	0. 15–0. 18	7. 9–8. 4	Low.
100	100	90–100	55–70	2. 00–6. 30	0. 12–0. 16	7. 9–8. 4	Low.
95–100	90–100	90–100	70–85	0. 20–0. 63	0. 15–0. 20	7. 4–7. 8	Low.
95–100	90–100	90–100	75–90	0. 20–0. 63	0. 15–0. 20	7. 4–8. 4	Moderate.
90–100	90–100	80–100	70–85	0. 20–0. 63	0. 10–0. 15	7. 9–8. 4	Low.
100	100	100	75–90	0. 63–2. 00	0. 16–0. 20	6. 6–7. 8	Low.
100	100	100	80–95	0. 20–0. 63	0. 14–0. 18	7. 4–8. 4	Moderate.
100	100	100	80–95	0. 20–0. 63	0. 14–0. 17	7. 9–8. 4	Low.
100	95–100	70–85	8–25	6. 30–20. 00	0. 06–0. 10	6. 6–7. 3	Low.
100	95–100	80–95	15–35	2. 00–6. 30	0. 09–0. 14	6. 6–8. 4	Low.
100	95–100	70–85	8–25	2. 00–6. 30	0. 06–0. 10	7. 4–7. 8	Low.
75–90	70–90	70–85	60–80	0. 63–2. 00	0. 14–0. 16	7. 9–8. 4	Low.
100	95–100	90–98	70–95	0. 20–0. 63	0. 16–0. 20	6. 6–7. 8	Moderate.
95–100	95–100	90–98	70–95	0. 06–0. 20	0. 15–0. 18	7. 4–8. 4	High.
90–100	90–100	80–90	60–90	0. 06–0. 20	0. 13–0. 17	7. 4–8. 4	Moderate.
100	100	50–80	5–10	6. 30–20. 00	0. 05–0. 07	6. 6–8. 4	Low.
95–100	95–100	85–95	30–50	2. 00–6. 30	0. 10–0. 14	7. 9–8. 4	Low.
95–100	95–100	85–90	55–70	0. 63–2. 00	0. 13–0. 16	7. 9–8. 4	Low.
100	100	85–95	30–50	2. 00–6. 30	0. 10–0. 14	7. 9–8. 4	Low.
95–100	95–100	90–100	80–85	0. 63–2. 00	0. 13–0. 17	7. 9–8. 4	Moderate.
95–100	90–100	90–100	80–95	<0. 06	0. 13–0. 17	7. 9–8. 4	High.
90–95	85–90	70–90	70–80	<0. 06	0. 08–0. 12	7. 9–8. 4	High.

TABLE 3.—*Estimated soil properties*

Soil series and map symbols	Hydrologic group	Depth to bedrock	Depth from surface (typical profile)	Classification		
				USDA texture	Unified	AASHO
		Inches	*Inches*			
Weymouth: WeB, WeC, WeD	B	>60	0–19 19–60	Clay loam Clay loam	CL CL	A–6 A–6
*Woodward: WoB, WoC, Wr, Wu. No estimates made for Rough broken land. Soil material too variable. For Quinlan part of Wu, see Quinlan series.	B	20–45	0–30 30–60	Loam Weakly consolidated very fine sandy loam.	CL	A–4
Yahola: Ya	B	>60	0–60	Very fine sandy loam	ML	A–4

TABLE 4.—*Engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. These soils may have different

Soil series and map symbols	Suitability as source of—		Degree and kind of limitation for—				
	Topsoil	Road subgrade	Highway location	Foundations for low buildings	Septic tank filter fields	Sewage lagoons	Farm ponds: Reservoir areas
Abilene: AbA	Fair: clay loam texture.	Poor: high shrink-swell potential.	Severe: high shrink-swell potential.	Severe: high shrink-swell potential.	Severe: moderately slow permeability.	Slight	Moderate: moderately slow permeability.
*Badland: Bo. No estimate made, because soil material is too variable. Onsite investigation required. For Owens part, see Owens series.							
Bukreek: BuA, BuB, BuC	Fair: 6 to 12 inches of loam.	Fair: fair traffic-supporting capacity.	Moderate: fair traffic-supporting capacity.	Slight	Moderate: moderate permeability.	Moderate: moderate permeability.	Moderate: moderate permeability.
Carey: CaA, CaB	Fair: 5 to 19 inches of loam.	Fair: fair traffic-supporting capacity.	Moderate: fair traffic-supporting capacity.	Slight	Moderate: moderate permeability.	Moderate: moderate permeability.	Moderate: moderate permeability.
*Colorado: Cd, Ce, Cf. For Yahola part of Cf, see Yahola series.	Fair: clay loam texture.	Fair: fair traffic-supporting capacity.	Severe: flooding	Severe: flooding	Severe: flooding	Moderate: moderate permeability.	Moderate: moderate permeability.
Cottonwood: Co. For shallow part, see unit Ct.	Good	Fair: fair traffic-supporting capacity.	Moderate: fair traffic-supporting capacity.	Slight	Slight	Severe: permeability of underlying material.	Severe: permeability of underlying material.
Ct	Poor where there is 3 to 6 inches of loam. Fair where there is 6 to 10 inches of loam.	Poor: 3 to 10 inches of material.	Moderate: fair traffic-supporting capacity.	Slight	Severe: depth to bedrock is 3 to 10 inches.	Severe: depth to bedrock is 3 to 10 inches.	Severe: depth to bedrock is 3 to 10 inches.

significant in engineering—Continued

Percentage passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)				
				Inches per hour	*Inches per inch of soil*	*pH value*	
100	95–100	90–100	70–80	0. 63–2. 00	0. 16–0. 20	7. 9–8. 4	Low.
100	95–100	85–95	70–75	0. 63–2. 00	0. 13–0. 17	7. 9–8. 4	Low.
100	100	90–100	60–85	0. 63–2. 00	0. 12–0. 16	7. 9–8. 4	Low.
100	100	90–95	50–60	2. 00–6. 30	0. 12–0. 15	7. 9–8. 4	Low.

interpretations of the soils

properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring to other series that appear in the first column]

Degree and kind of limitation for—Continued	Soil features affecting—							Corrosivity to uncoated steel
Farm ponds—Continued	Camp areas	Picnic areas	Playgrounds	Paths and trails	Irrigation	Terraces and diversions	Waterways	
Embankments								
Moderate: fair resistance to piping and erosion.	Moderate: clay loam texture; moderately slow permeability.	Moderate: clay loam texture.	Moderate: clay loam texture; moderately slow permeability.	Moderate: clay loam texture.	Low intake rate...	All features favorable.	All features favorable.	High: clay texture in subsoil.
Moderate: poor resistance to piping and erosion.	Slight.....	Slight.....	Slight where slope is 0 to 2 percent. Moderate where slope is 2 to 5 percent.	Slight.....	All features favorable.	All features favorable.	All features favorable.	Moderate: sandy clay loam texture.
Moderate: poor resistance to piping and erosion.	Slight.....	Slight.....	Slight where slope is 0 to 2 percent. Moderate where slope is 2 to 3 percent.	Slight.....	All features favorable.	All features favorable.	All features favorable.	Low.
Moderate: poor resistance to piping and erosion.	Severe: flooding..	Moderate: flooding; clay loam texture.	Severe: flooding..	Moderate: flooding; clay loam texture.	Occasional flooding.	Occasional flooding.	Occasional flooding.	Moderate: clay loam texture.
Moderate: fair resistance to piping and erosion.	Slight.....	Slight.....	Slight.....	Slight.....	All features favorable.	All features favorable.	All features favorable.	High: conductivity.
Severe: depth to bedrock is 3 to 10 inches.	Slight where slope is 0 to 8 percent. Moderate where slope is 8 to 15 percent. Severe where slope is 15 to 20 percent.	Slight where slope is 0 to 8 percent. Moderate where slope is 8 to 15 percent. Severe where slope is 15 to 20 percent.	Severe: depth to bedrock is 3 to 10 inches.	Slight where slope is 8 to 15 percent. Moderate where slope is 15 to 20 percent.	Depth to bedrock is 3 to 10 inches.	Depth to bedrock is 3 to 10 inches.	Difficult to establish vegetation.	High: conductivity.

TABLE 4.—*Engineering interpretations*

Soil series and map symbols	Suitability as source of—		Degree and kind of limitation for—				
	Topsoil	Road subgrade	Highway location	Foundations for low buildings	Septic tank filter fields	Sewage lagoons	Farm ponds: Reservoir areas
Delwin: De	Poor: fine sand texture.	Good	Slight	Slight	Slight	Moderate: moderate permeability.	Moderate: moderate permeability.
Enterprise: EnA, EnB, EnC, EnD.	Good	Fair: fair traffic-supporting capacity.	Moderate: fair traffic-supporting capacity.	Slight	Slight where slope is 0 to 5 percent. Moderate where slope is 5 to 10 percent. Severe where slope is 10 to 12 percent.	Severe: moderately rapid permeability.	Severe: moderately rapid permeability.
Hardeman: HaA, HaB, HaC, HaD.	Good	Fair: fair traffic-supporting capacity.	Moderate: fair traffic-supporting capacity.	Slight	Slight where slope is 0 to 5 percent. Moderate where slope is 5 to 10 percent. Severe where slope is 10 to 12 percent.	Severe: moderately rapid permeability.	Severe: moderately rapid permeability.
Heatly: He	Poor: fine sand texture.	Fair: fair traffic-supporting capacity.	Moderate: fair traffic-supporting capacity.	Slight	Moderate: moderate permeability.	Moderate: moderate permeability.	Moderate: moderate permeability.
Hilgrave: Hg	Poor: 60 percent gravel.	Good	Slight where slope is 3 to 6 percent. Moderate where slope is 6 to 15 percent Severe where slope is 15 to 50 percent.	Slight where slope is 3 to 6 percent. Moderate where slope is 6 to 15 percent. Severe where slope is 15 to 50 percent.	Slight where slope is 3 to 5 percent. Moderate where slope is 5 to 10 percent. Severe where slope is 10 to 50 percent.	Severe: 7 to 50 percent slopes; moderately rapid permeability.	Severe: moderately rapid permeability.
Lincoln: Lc, Lf	Fair: 6 to 15 inches of fine sandy loam.	Good	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: rapid permeability.	Severe: rapid permeability.
Lipan: Ln	Poor: clay texture.	Poor: poor traffic-supporting capacity; high shrink-swell potential.	Severe: poor traffic-supporting capacity; high shrink-swell potential.	Severe: high shrink-swell potential.	Severe: very slow permeability.	Slight	Slight
Lofton: Lo	Fair: clay loam texture.	Poor: poor traffic supporting capacity; high shrink-swell potential.	Severe: poor traffic-supporting capacity; high shrink-swell potential.	Severe: high shrink-swell potential.	Severe: very slow permeability.	Slight	Slight
Miles:							
MeB, MeC	Poor: loamy fine sand texture.	Fair: fair traffic-supporting capacity.	Moderate: fair traffic supporting capacity.	Slight	Slight	Moderate: moderate permeability.	Moderate: moderate permeability.
MfA, MfB, MfC, MfD	Fair: 7 to 20 inches of fine sandy loam.	Fair: fair traffic-supporting capacity.	Moderate: fair traffic-supporting capacity.	Slight	Slight where slope is 0 to 5 percent. Moderate where slope is 5 to 10 percent. Severe where slope is 10 to 12 percent.	Moderate where slope is 0 to 7 percent. Severe where slope is 7 to 12 percent.	Moderate: moderate permeability.

of the soils—Continued

Degree and kind of limitation for—Continued	Soil features affecting—							Corrosivity to uncoated steel
Farm ponds—Continued Embankments	Camp areas	Picnic areas	Playgrounds	Paths and trails	Irrigation	Terraces and diversions	Waterways	
Moderate: poor resistance to piping and erosion.	Severe: fine sand texture.	Severe: fine sand texture.	Severe: fine sand texture.	Severe: fine sand texture.	High intake rate	Erodibility	Erodibility	Low.
Moderate: poor resistance to piping and erosion.	Slight where slope is 0 to 8 percent. Moderate where slope is 8 to 12 percent.	Slight where slope is 0 to 8 percent. Moderate where slope is 8 to 12 percent.	Slight where slope is 0 to 2 percent. Moderate where slope is 2 to 6 percent. Severe where slope is 6 to 12 percent.	Slight	Slope	Slope	Erodibility	Low.
Moderate: poor resistance to piping and erosion.	Slight where slope is 0 to 8 percent. Moderate where slope is 8 to 12 percent.	Slight where slope is 0 to 8 percent. Moderate where slope is 8 to 12 percent.	Slight where slope is 0 to 2 percent. Moderate where slope is 2 to 6 percent. Severe where slope is 6 to 12 percent.	Slight	Slope	Slope	Erodibility	Low.
Moderate: poor resistance to piping and erosion.	Severe: fine sand texture.	Severe: fine sand texture.	Severe: fine sand texture.	Severe: fine sand texture.	High intake rate	Sandy texture; erodibility.	Sandy texture; erodibility.	Low.
Severe: high permeability.	Severe: 60 percent gravel.	Severe: 60 percent gravel.	Severe: 60 percent gravel.	Severe: 60 percent gravel.	Very gravelly	Very gravelly	Very gravelly	Low.
Moderate: poor resistance to piping and erosion.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding.	Flood hazard; intake rate; low available water capacity.	Flooding	Flooding	Low.
Moderate: fair slope stability.	Severe: clay texture; very slow permeability.	Severe: clay texture.	Severe: clay texture; very slow permeability.	Severe: clay texture.	Depressional area; very slow permeability.	Clayey soil	Clayey soil	High: clay texture.
Moderate: fair slope stability; high compressibility.	Moderate: clay loam texture; very slow permeability.	Moderate: clay loam texture.	Moderate: clay loam texture.	Moderate: clay loam texture.	Low intake rate	All features favorable.	All features favorable.	High: silty clay texture in subsoil.
Moderate: fair to poor resistance to piping and erosion.	Moderate: loamy fine sand texture.	Moderate: loamy fine sand texture.	Moderate: loamy fine sand texture.	Moderate: loamy fine sand texture.	High intake rate.	Erodibility	Erodibility	Moderate: sandy clay loam texture in subsoil.
Moderate: fair to poor resistance to piping and erosion.	Slight where slope is 0 to 8 percent. Moderate where slope is 8 to 12 percent.	Slight where slope is 0 to 8 percent. Moderate where slope is 8 to 12 percent.	Slight where slope is 0 to 2 percent. Moderate where slope is 2 to 6 percent. Severe where slope is 6 to 12 percent.	Slight	Complex slopes	All features favorable.	Erodibility	Moderate: sandy clay loam texture in subsoil.

TABLE 4.—*Engineering interpretations*

Soil series and map symbols	Suitability as source of—		Degree and kind of limitation for—				
	Topsoil	Road subgrade	Highway location	Foundations for low buildings	Septic tank filter fields	Sewage lagoons	Farm ponds: Reservoir areas
Nobscot: No	Poor fine sand texture.	Good	Slight	Slight	Slight	Severe: moderately rapid permeability.	Severe: moderately rapid permeability.
*Owens: Ob, Ot. No estimates made for Badland. Soil material too variable. For Talpa and Vernon parts of Ot, see Talpa and Vernon series.	Poor: clay texture.	Poor: poor traffic-supporting capacity, high shrink-swell potential.	Severe: poor traffic-supporting capacity; high shrink-swell potential; 15 to 30 percent slopes.	Severe: high shrink-swell potential; 15 to 30 percent slopes.	Severe: very slow permeability.	Slight where slope is 1 to 2 percent. Moderate where slope is 2 to 7 percent. Severe where slope is 7 to 30 percent.	Slight
Paducah: PaC	Fair: 6 to 10 inches of loam.	Fair: fair traffic-supporting capacity.	Moderate: fair traffic-supporting capacity.	Slight	Moderate: moderate permeability.	Moderate: moderate permeability.	Moderate: moderate permeability.
*Quanah: Qt. For Talpa part, see Talpa series.	Fair: silty clay loam texture.	Fair: fair traffic-supporting capacity.	Moderate: fair traffic-supporting capacity.	Slight	Moderate: moderate permeability.	Moderate: moderate permeability.	Moderate: moderate permeability.
Quinlan. Mapped only in an undifferentiated unit with Woodward soils.	Fair: 10 to 20 inches of loam.	Poor: 10 to 20 inches of material.	Moderate: fair traffic-supporting capacity.	Slight	Severe: depth to bedrock is 10 to 20 inches.	Severe: depth to bedrock is 10 to 20 inches.	Severe: depth to bebrock is 10 to 20 inches; moderately rapid permeability.
Rough broken land: Ro. No estimates made because soil material is too variable. Onsite investigation required.							
Sagerton: SaA, SaB	Poor where there is 5 to 6 inches of loam. Fair where there is 6 to 12 inches of loam.	Fair: fair traffic-supporting capacity; moderate shrink-swell potential.	Moderate: fair traffic-supporting capacity; moderate shrink-swell potential.	Moderate: moderate shrink-swell potential.	Severe: moderately slow permeability.	Slight where slope is 0 to 2 percent. Moderate where slope is 2 to 3 percent.	Moderate: moderately slow permeability.
ScA, ScB	Fair: clay loam texture.	Fair: fair traffic-supporting capacity; moderate shrink-swell potential.	Moderate: fair traffic-supporting capacity; moderate shrink-swell potential.	Moderate: moderate shrink-swell potential.	Severe: moderately slow permeability.	Slight where slope is 0 to 2 percent. Moderate where slope is 2 to 3 percent.	Moderate: moderately slow permeability.
St. Paul: Sp	Fair: 7 to 10 inches of loam.	Fair: fair traffic-supporting capacity; moderate shrink-swell potential.	Moderate: fair traffic-supporting capacity; moderate shrink-swell potential.	Moderate: moderate shrink-swell potential.	Moderate: moderately slow permeability.	Slight	Moderate: moderately slow permeability.

of the soils—Continued

Degree and kind of limitation for—Continued	Soil features affecting—							Corrosivity to uncoated steel
Farm ponds—Continued Embankments	Camp areas	Picnic areas	Playgrounds	Paths and trails	Irrigation	Terraces and diversions	Waterways	
Severe: high permeability; poor slope stability; poor resistance to piping and erosion.	Severe: fine sand texture.	Severe: fine sand texture.	Severe: fine sand texture.	Severe: fine sand texture.	High intake rate.	Erodibility	Erodibility	Low.
Moderate: fair slope stability.	Severe: clay texture; 15 to 30 percent slopes.	Severe: clay texture; 15 to 30 percent slopes.	Severe: clay texture; 6 to 30 percent slopes.	Severe: clay texture.	Very slow permeability.	All features favorable.	Difficult to establish vegetation.	Moderate: corrosivity.
Moderate: poor resistance to piping and erosion.	Slight	Slight	Slight where slope is 0 to 2 percent. Moderate where slope is 2 to 5 percent.	Slight	All features favorable.	All features favorable.	All features favorable.	Moderate: very fine sandy loam texture in substratum.
Moderate: medium compressibility; poor resistance to piping and erosion.	Moderate: clay loam texture.	Moderate: clay loam texture.	Moderate: clay loam texture.	Moderate: clay loam texture.	All features favorable.	All features favorable.	All features favorable.	Moderate: clay loam texture in substratum.
Severe: 10 to 20 inches of material.	Slight where slope is 0 to 8 percent. Moderate where slope is 8 to 12 percent.	Slight where slope is 0 to 8 percent. Moderate where slope is 8 to 12 percent.	Slight where slope is 0 to 2 percent. Moderate where slope is 2 to 6 percent. Severe where slope is 6 to 12 percent.	Slight	Depth to bedrock is 10 to 20 inches.	Depth to bedrock is 10 to 20 inches.	Depth to bedrock is 10 to 20 inches.	Low.
Moderate: fair resistance to piping and erosion.	Moderate: moderately slow permeability.	Slight	Moderate: moderately slow permeability.	Slight	All features favorable.	All features favorable.	All features favorable.	Moderate: clay loam texture.
Moderate: fair resistance to piping and erosion.	Moderate: clay loam texture; moderately slow permeability.	Moderate: clay loam texture.	Moderate: clay loam texture; moderately slow permeability.	Moderate: clay loam texture.	All features favorable.	All features favorable.	All features favorable.	Moderate: clay loam texture.
Moderate: fair slope stability; medium compressibility.	Moderate: moderately slow permeability.	Slight	Moderate: moderately slow permeability.	Slight	All features favorable.	All features favorable.	All features favorable.	Moderate: clay loam texture.

TABLE 4.—*Engineering interpretations*

Soil series and map symbols	Suitability as source of—		Degree and kind of limitation for—				
	Topsoil	Road subgrade	Highway location	Foundations for low buildings	Septic tank filter fields	Sewage lagoons	Farm ponds: Reservoir areas
*Springer: SrB, SrD, StD. For Tivoli part of unit StD, see Tivoli series.	Poor loamy fine sand texture.	Good	Slight where slope is 0 to 6 percent. Moderate where slope is 6 to 8 percent.	Slight	Slight where slope is 0 to 5 percent. Moderate where slope is 5 to 8 percent.	Severe: moderately rapid permeability.	Severe: moderately rapid permeability.
Taipa Ta	Poor: 10 to 30 percent stones.	Poor: 5 to 10 inches of material.	Severe depth to bedrock is 5 to 10 inches.	Severe: depth to bedrock is 5 to 10 inches.	Severe: depth to bedrock is 5 to 10 inches.	Severe depth to bedrock is 5 to 10 inches.	Severe: depth to bedrock is 5 to 10 inches.
Tillman: TmA, TmB TmB2	Fair silty clay loam texture.	Poor. poor traffic-supporting capacity; high shrink-swell potential.	Severe: poor traffic-supporting capacity, high shrink-swell potential.	Severe high shrink-swell potential.	Severe slow permeability.	Slight where slope is 0 to 2 percent. Moderate where slope is 2 to 3 percent.	Slight
Tivoli: Tv	Poor fine sand texture.	Good	Slight	Slight	Slight	Severe rapid permeability.	Severe: rapid permeability.
Veal: VeB, VeC, VeD	Poor: 30 to 35 percent calcium carbonate equivalent.	Fair: fair traffic-supporting capacity.	Moderate: fair traffic-supporting capacity.	Slight	Slight where slope is 1 to 5 percent. Moderate where slope is 5 to 10 percent. Severe where slope is 10 to 12 percent.	Severe: moderate permeability; calcareous substrata.	Severe: moderate permeability; calcareous substrata.
Vernon: VnB, VnC	Fair: clay loam texture.	Poor: poor traffic-supporting capacity; high shrink-swell potential.	Severe: poor traffic-supporting capacity; high shrink-swell potential.	Severe: high shrink-swell potential.	Severe: very slow permeability.	Slight where slope is 1 to 3 percent. Moderate where slope is 3 to 5 percent.	Slight
Weymouth: WeB, WeC, WeD	Fair: clay loam texture.	Fair: fair traffic-supporting capacity.	Moderate: fair traffic-supporting capacity.	Slight	Moderate: moderate permeability.	Moderate where slope is 2 to 7 percent: moderate permeability. Severe where slope is 7 to 12 percent.	Moderate: moderate permeability.
*Woodward: WoB, WoC, Wr, Wu. For Rough broken land part of Wr, see Rough broken land. For Quinlan part of Wu, see the Quinlan series.	Good	Fair: fair traffic-supporting capacity.	Moderate: fair traffic-supporting capacity.	Slight	Severe: 20 to 45 inches to bedrock.	Severe: 20 to 45 inches to bedrock.	Moderate: moderate permeability.
Yahola: Ya	Good	Fair: fair traffic-supporting capacity.	Severe: flooding	Severe: flooding	Severe: flooding	Severe: moderately rapid permeability.	Severe: moderately rapid permeability.

of the soils—Continued

Degree and kind of limitation for—Continued	Soil features affecting—							Corrosivity to uncoated steel
Farm ponds—Continued Embankments	Camp areas	Picnic areas	Playgrounds	Paths and trails	Irrigation	Terraces and diversions	Waterways	
Severe: poor resistance to piping and erosion.	Moderate: loamy fine sand texture.	Moderate: loamy fine sand texture.	Moderate: loamy fine sand texture; 2 to 5 percent slopes.	Moderate: loamy fine sand texture.	High intake rate	Erodibility	Erodibility	Low.
Severe: 5 to 10 inches of material.	Slight where slope is 3 to 8 percent. Moderate where slope is 8 to 15 percent. Severe where slope is 15 to 30 percent.	Slight where slope is 3 to 8 percent. Moderate where slope is 8 to 15 percent. Severe where slope is 15 to 30 percent.	Severe: depth to bedrock is 5 to 10 inches.	Slight where slope is 3 to 15 percent. Moderate where slope is 15 to 25 percent. Severe where slope is 25 to 30 percent.	Depth to bedrock is 5 to 10 inches.	Depth to bedrock is 5 to 10 inches.	Depth to bedrock is 5 to 10 inches.	High: resistivity.
Moderate: fair slope stability; high compressibility.	Moderate: silty clay loam texture; slow permeability.	Moderate: silty clay loam texture.	Moderate: silty clay loam texture; slow permeability.	Moderate: silty clay loam texture.	Low intake rate	All features favorable.	All features favorable.	High: clay texture.
Severe: high permeability; poor resistance to piping and erosion.	Severe: fine sand texture.	Severe: fine sand texture.	Severe: fine sand texture.	Severe: fine sand texture.	Erodibility; rapid permeability.	Erodibility	Erodibility; difficult to establish plants.	Low.
Moderate: poor resistance to piping and erosion.	Slight where slope is 1 to 8 percent. Moderate where slope is 8 to 12 percent.	Slight where slope is 1 to 8 percent. Moderate where slope is 8 to 12 percent.	Slight where slope is 1 to 2 percent. Moderate where slope is 2 to 6 percent. Severe where slope is 6 to 12 percent.	Slight	Slope	Slope	Slope	Moderate: conductivity.
Moderate: fair slope stability.	Severe: very slow permeability.	Moderate: clay loam texture.	Severe: very slow permeability.	Moderate: clay loam texture.	Low intake rate	All features favorable.	All features favorable.	High: clay texture.
Moderate: medium compressibility; fair resistance to piping and erosion.	Moderate: clay loam texture; 8 to 12 percent slopes.	Moderate: clay loam texture; 8 to 12 percent slopes.	Moderate where slope is 2 to 6 percent and severe where slope is 6 to 12 percent; clay loam texture.	Moderate: clay loam texture.	Slope	Slope	Slope	Moderate: clay loam texture.
Moderate: fair resistance to piping and erosion.	Slight where slope is 1 to 8 percent. Moderate where slope is 8 to 15 percent.	Slight where slope is 1 to 8 percent. Moderate where slope is 8 to 15 percent.	Slight where slope is 1 to 2 percent. Moderate where slope is 2 to 6 percent. Severe where slope is 6 to 15 percent.	Slight	Slope	Slope	Slope	Low.
Moderate: poor resistance to piping and erosion.	Severe: flooding	Moderate: flooding.	Severe: flooding	Slight	Flooding	Flooding	Flooding	Low.

TABLE 5.—*Engineering*

[Tests performed by Texas State Highway Department in accordance with standard

Soil name and location	Parent material	Texas report number	Depth	Soil shrinkage [1]		
				Shrinkage limit	Shrinkage ratio	Linear shrinkage
			Inches	*Percent*		*Percent*
Bukreek loam:	Loamy outwash.	65-507-R	0-7	16	1.79	3.6
0.3 mile N. of the SW. corner of sec. 12, D&W RR Co. Survey. (Modal)		65-508-R	16-34	15	1.84	9.3
		65-509-R	48-66	15	1.83	5.5
Heatly fine sand:	Eolian sand.	65-520-R	0-22	17	1.74	1.3
0.25 mile W. of the NW. corner of sec. 2, Blk. E, Matador Cottle Co. Survey. (Modal)		65-521-R	22-36	18	1.79	4.4
		65-522-R	48-76	16	1.77	2.2
Nobscot fine sand:	Eolian sand.	65-517-R	6-22	14	1.84	.8
0.4 mile S. of NE. corner of sec. 7, John H. Stephens Survey. (Modal)		65-518-R	22-36	15	1.82	2.3
		65-519-R	48-76	16	1.75	2.1
Sagerton clay loam:	Loamy outwash.	65-510-R	7-20	12	1.92	14.0
0.4 mile E. of the NW. corner of sec. 3, I.R.R. Co. Survey. (Modal)		65-511-R	44-66	13	2.06	11.8
		65-512-R	66-76	11	1.97	10.6
Sagerton loam:	Loamy outwash.	65-513-R	10-32	13	1.91	11.8
0.7 mile SW. of junction of Farm Roads 1038 and 1168 on Farm Road 1168, then 0.15 mile N. and 0.7 mile W. on county road and 200 feet S. in field. (Modal)		65-514-R	44-76	15	1.88	9.8
Tillman silty clay loam:	Clayey Permian red beds.	65-523-R	0-8	13	1.90	11.7
300 feet N. of SW. corner of sec. 22, Blk. M, R.M. Thompson Survey. (Modal)		65-524-R	18-32	11	1.95	16.4
		65-525-R	44-76	15	1.88	16.0

[1] Based on AASHO Designation T 99, Method A (*1*).

[2] Mechanical analyses according to the AASHO Designation T 88 (*1*). Results by this procedure may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the

the best material to 20 for the poorest. The AASHO classification for tested soils, with index numbers in parentheses, is shown in table 5. The estimated classification for all soils mapped in the survey area is given in table 3.

In the Unified soil classification system, soils are classified according to particle-size distribution, plasticity index, liquid limit, and organic-matter content (*10*). Soils are grouped in 15 classes. There are 8 classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; 6 classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and 1 class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example CH–MH.

Soil scientists use the USDA textural classification system (*8*). In this, the texture of the soil is determined according to the proportion of soil particles smaller than 2 millimeters in diameter, that is, the proportions of sand, silt, and clay.

Estimated engineering properties

Table 3 provides estimates of soil properties important in engineering. These estimates are based on field classification and descriptions, physical and chemical tests of selected representative samples, test data from comparable soils in adjacent areas, and detailed experience in working with the individual kinds of soil in the survey area.

In the column headed "Hydrologic group," the soils are placed in one of four groups according to their ability to restrict runoff from a heavy storm after they have been thoroughly wetted. The groups range from open sands (lowest runoff potential—Group A) to tight clays (highest runoff potential—Group D).

Soils in group A have a high infiltration rate, even when thoroughly wetted. They have a high rate of water transmission and low runoff potential. The soils of this group are deep, are well drained or excessively drained, and consist chiefly of sand or gravel, or both.

Soils in group B have a moderate infiltration rate when thoroughly wetted. Their rate of water transmission and their runoff potential are moderate. These soils are moderately deep or deep, moderately well drained or well drained, and fine-textured to moderately coarse textured.

Soils in group C have a slow infiltration rate when thoroughly wetted. Their rate of water transmission is slow, and their potential runoff is high. These soils have a layer that impedes the downward movement of water, or they are moderately fine textured to fine textured and have a slow infiltration rate.

test data

procedures of the American Association of State Highway Officials (AASHO)]

Mechanical analysis [2]								Liquid limit	Plasticity index	Classification [3]	
Percentage passing sieve—					Percentage smaller than—					AASHO	Unified
⅜ inch	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm	0. 005 mm.	0. 002 mm.				
								Percent			
			99	71	55	15	13	22	4	A-4 (7)	CL-ML
			99	79	65	30	28	34	19	A-6 (12)	CL
95	91	89	87	60	45	22	18	25	8	A-4 (5)	CL
			71	13	10	2	7	19	2	A-2-4 (0)	SM
			93	29	27	9	20	26	9	A-2-4 (0)	SC
			88	18	15	12	9	20	3	A-2-4 (0)	SM
			82	12	7	2	1	19	3	A-2-4 (0)	SP-SM
			85	22	9	9	8	19	3	A-2-4 (0)	SM
			64	17	15	12	11	20	3	A-2-4 (0)	SM
			97	86	79	46	40	42	25	A-7-6 (14)	CL
	99	97	94	83	78	41	34	36	22	A-6 (13)	CL
99	98	98	95	79	68	39	32	31	19	A-6 (12)	CL
				84	79	42	37	37	22	A-6 (13)	CL
			99	83	68	31	28	34	20	A-6 (12)	CL
		99	98	94	85	38	29	37	20	A-6 (12)	CL
		98	95	92	89	49	45	48	29	A-7-6 (17)	CL
97	94	91	83	79	77	59	47	52	31	A-7-6 (18)	CH

material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soil.

[3] Unified and AASHO classification made by SCS personnel. The AASHO classification is based on AASHO Designation M 145-49(*1*). The Unified classification is based on U.S. Department of Defense MIL-STD-619B (*10*).

Soils in group D have a very slow infiltration rate when thoroughly wetted. Their rate of water transmission is very slow, and their runoff potential is very high. In this group are (1) clay soils that have high shrink-swell potential; (2) soils that have a permanent high water table; (3) soils that have a claypan or a clay layer at or near the surface; and (4) soils that are shallow over nearly impervious material.

Depth to bedrock is the depth in inches from the surface to consolidated material.

USDA texture is determined by the relative proportions of sand, silt, and clay in soil material that is less than 2.0 millimeters in diameter. "Sand," "silt," "clay," and some of the other terms used in the USDA textural classification are defined in the glossary of this survey.

Permeability, as used in table 3, relates only to movement of water downward through undisturbed and uncompacted soil. It does not include lateral seepage. The estimates are based on structure and porosity of the soil. Plowpans, surface crusts, and other properties resulting from use of the soils are not considered.

Available water capacity is the amount of water a soil can hold and make available to plants. It is the numerical difference between the percentage of water in the soil at field capacity and the percentage in the soil at the point at which plants wilt. The rate is expressed as inches of water per inch of soil depth.

Reaction is the degree of acidity or alkalinity of a soil, expressed as a pH value. The pH value and relative terms used to describe soil reaction are explained in the glossary.

Shrink-swell potential is an indication of the volume change to be expected of the soil material with changes in moisture content. Shrinking and swelling of soils causes much damage to building foundations, roads, and other structures. A high shrink-swell potential indicates hazards to the maintenance of structures constructed in, on, or with such materials.

A column for seasonal high water table was not included since this is not a problem in soils in Cottle County. Lincoln soils have a temporary water table at a depth of 2 to 6 feet following intensive rains.

Salinity was left out of table 3 because it is too low to be significant to the engineering practices in the county.

Engineering interpretations

Table 4 contains selected information useful to engineers and others who plan to use soil material in construction of highways, farm facilities, buildings, and

sewage disposal systems. Deterimental or undesirable features are emphasized. Very important desirable features may also be listed. The ratings and other interpretations in this table are based on estimated engineering properties of the soils in table 3, on available test data, including those in table 5, and on field experience. While the information applies strictly only to soil depths indicated in table 3, it is reasonably reliable to depth of about 6 feet for most soils, and to a depth of several more feet for some.

Topsoil is a term used to designate a fertile soil or soil material, ordinarily rich in organic matter, used as a topdressing for lawns, gardens, roadbanks, and the like. The ratings indicate suitability for such use.

Road subgrade is material used to build embankments. The ratings indicate the performance of soil material moved from borrow areas for these purposes.

Highway location is influenced by features of the undisturbed soil that affect construction and maintenance of highways. Soil features, favorable as well as unfavorable, are the principal ones that affect geographic location of highways.

Foundations for low buildings are affected chiefly by features of the undisturbed soil that determine its capacity to support low buildings that have normal foundation loads. Specific values of bearing strength are not assigned.

Spectic tank filter fields are affected mainly by permeability, location of water table, and susceptibility to flooding. The degree of limitations and principal reasons for assigning moderate or severe limitations are given.

Sewage lagoons are influenced chiefly by soil features such as permeability, location of water table, and slope. The degree of limitation and principal reasons for assigning moderate or severe limitations are given.

Farm pond reservoir areas are affected mainly by seepage loss of water, and the soil features are those that influence such seepage.

Farm pond embankments serve as dams. The soil features of both subsoil and substratum are important to the use of soil for constructing embankments.

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

Picnic areas are subject to heavy foot traffic, but most vehicular traffic is confined to access roads. Preparation of an area consists of leveling sites for tables and fireplaces and building access roads. The assumption is made that good vegetative cover can be established and maintained. Soil limitations for waste disposal and for playgrounds are treated as separate items. Important properties affecting this use are wetness, flooding, slope, surface texture, and rockiness. Prime requirements for this use are freedom from muddiness and dustiness. Strong slopes and rockiness greatly increase the cost of site leveling and of building access roads.

Playgrounds are those areas that are used intensively for play, such as basball, football, badminton, and other organized games. These areas are subject to intensive foot traffic. The assumption is made that good vegetative cover can be established and maintained. Properties that affect the use of the soil for playgrounds are those that determine suitability for intensive foot traffic and that affect design, construction, and maintenance. The best soils for playgrounds have a nearly level surface that is free of coarse fragments and rock outcrops, have good drainage, are free from flooding during periods of heavy use, and have a surface layer that is firm even after rains and is not dusty when dry. Depth to rock is an important consideration on uneven slopes that require grading and leveling.

Paths and trails apply to soils to be used for local and cross-country footpaths and trails for bridle paths. It is assumed that the soils will be used in their natural state and that little or no cutting and filling will be done in design and layout of the trails. Properties that affect paths and trails are those that affect foot traffic, such as wetness, surface texture, and coarse fragments, and those that affect design, construction, and maintenance, such as slope, rockiness, or stoniness. Safety hazards such as sheer cliffs, slippery rocks, and the like were not considered in developing this guide but may be important factors to consider in final evaluation of a site.

Irrigation suitability is based on such features of the soil as depth, slope, available water capacity, permeability, water intake rate, topography, and the hazards of soil blowing and water erosion.

Terraces and diversions are low structures designed to impound or divert water. The relevant soil features are those that affect use of the soil as material for constructing terraces and diversions.

Grassed waterways suitability is determined by the hazard of erosion and the amount of shaping that can be done, which in turn depends on slope, stoniness, depth to bedrock, and the relative ease of establishing vegetation.

Corrosivity indicates the potential danger to uncoated metal through chemical action that dissolves or weakens the structural material. Structural materials may corrode when buried in soil, and a given material corrodes in some kinds of soil more rapidly than in others. Ratings are based on soil conditions at a depth of 4 feet. Ratings were not given for concrete since concrete corrosion is low in all soils.

Engineering test data

Engineering test data for samples of six soil series taken in Cottle County are given in table 5. This data was furnished by the Texas State Highway Department. Some terms used in table 5 are discussed in the paragraphs that follow.

As moisture is removed, the volume of a soil decreases in direct proportion to the loss of moisture until a condition of equilibrium, called the shrinkage limit, is reached. Beyond the shrinkage limit, more moisture may be removed, but the volume of the soil will not change. Generally, the lower the shrinkage limit, the higher the content of clay.

Shrinkage ratio is the volume change resulting from the drying of a soil material, divided by the loss of moisture caused by drying. The ratio is expressed numerically.

Lineal shrinkage is the decrease in one dimension of the soil when the moisture content is reduced from a given percentage to the shrinkage limit (*3*). Lineal shrinkage is expressed as a percentage of the original dimension.

The plastic limit is the moisture content at which the soil material passes from a semisolid to a plastic state. Liquid limit is the moisture content at which a soil passes from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil is in a plastic condition.

Wildlife

In Cottle County, the principal kinds of wildlife are white-tailed deer, turkey, bobwhite quail, scaled (blue) quail, dove, cottontail rabbits, jackrabbits, and numerous kinds of nongame birds. Also present are raccoons, fox, ring-tailed cats, skunks, oppossum, and other furbearers. The predators commonly found are bobcats and coyotes. Intermittent lakes, streams, ponds, and grain fields attract ducks and geese during migration. Most farm and ranch ponds are stocked with channel catfish, black bass, and sunfish. Several farmers and ranchers in Cottle County are finding wildlife and fish resources to be a profitable crop when properly managed.

Successful management of wildlife on any tract of land requires, among other thing, that food, cover, and water be available in a suitable combination. Lack of any one of these necessities, unfavorable balance between them, or inadequate distribution of them may severely limit or account for the absence of desired wildlife species. Information on soils provides a valuable tool in creating, improving, or maintaining suitable food, cover, and water for wildlife.

Most wildlife habitats are managed by planting suitable vegetation, by manipulating existing vegetation so as to bring about natural establishment, increase, or improvement of desired plants. or by combinations of such measures. The influence of a soil on the growth of most plants is known, and it can be inferred for others from a knowledge of the characteristics and behavior of the soil. In addition, water areas can be created or natural ones improved for wildlife habitat.

Soil interpretations for wildlife habitat serve a number of purposes. They aid in selecting the more suitable sites for various kinds of management. They indicate the level of management needed to achieve satisfactory results. They also show why it may not be feasible generally to manage a particular area for a given kind of wildlife. These interpretations may also serve in broad-scale planning of wildlife management areas, parks, and nature areas, or planning for acquiring wildlife lands.

Soil properties that affect the growth of wildlife habitat are the thickness of soil useful to crops, texture of the surface layer, available water capacity to a depth of 40 inches, wetness, surface stoniness, hazard of flooding, and slope.

The soil areas shown on the soil map are rated without regard to positional relationships with adjoining mapped areas. The size, shape, and location of an outlined area do not affect the rating. Certain influences on habitats such as elevation and aspect must be appraised on the site.

In table 6 the soils of Cottle County are rated for suitability for six elements of wildlife habitat and for three kinds of wildlife. These ratings are based upon limitations imposed by the characteristics or behavior of the soils. The meaning of the suitability ratings used in table 6 are as follows:

Well suited indicates that habitats generally are easily created, improved, or maintained; that the soil has few or no limitations that affect management; and that satisfactory results can be expected.

Suited indicates that habitats can be created, improved or maintained in most places; that the soil has moderate limitations that affect management; and that moderate intensity of management and fairly frequent attention may be required for satisfactory results.

Poorly suited indicates that habitats can be created, improved, or maintained in most places; that the soil has rather severe limitations; that habitat management is difficult and expensive and requires intensive effort; and that results are not always satisfactory. For short-term use, soils rated as poorly suited may provide easy establishment and temporary values.

Unsuited indicates that the soil limitation is so extreme that it is impractical, if not impossible, to manage the designated habitat element. Unsatisfactory results are probable.

The six elements of wildlife habitat stated in table 6 are briefly defined in the following paragraphs.

Grain and seed crops are agricultural grains or seed-producing annuals planted to produce food for wildlife. Examples are corn, sorghum, millet, soybeans, wheat, oats, and sunflower.

Grasses and legumes are domestic perennial grasses and legumes planted to furnish food and cover for wildlife. Grasses are bahia, ryegrass, fescue, and panicgrass. Legumes include clover, annual lespedeza, and bush lespedeza.

Wild herbaceous upland plants are perennial grasses, forbs, and weeds that provide food and cover for wildlife. Examples of these are beggarweed, perennial lespedeza, wildbean indiangrass, wild ryegrass, and bluestem.

Hardwood trees and shrubs are nonconiferous trees, shrubs, and woody vines that produce fruits, nuts, buds, catkins, or foliage (browse) used extensively as food by wildlife. These plants commonly become established through natural processes, but may be planted. Examples are oak, mesquite, whitebrush, granjeno, catclaw, cherry-grape, honeysuckle, greenbrier, autumn-olive, and multiflora rose.

Wetland food and cover plants are annual and perennial wild herbaceous plants in moist to wet sites, exclusive of submerged or floating aquatics, that produce food or cover that is extensively and dominantly used by wetland forms of wildlife. Examples are smartweed, wild millet, bulrush, spike sedge, rushes, sedges, burreeds, wild-rice cutgrass, sourdock, and cattails.

Shallow water developments are low dikes and water control structures established to create habitat princi-

TABLE 6.—*Suitability of the soils for elements of*

Soil series and map symbols	Elements of wildlife habitat		
	Grain and seed crops	Grasses and legumes	Wild herbaceous upland plants
Abilene: AbA	Well suited	Well suited	Well suited
Badland: Bo For Owens part, see Owens series.	Unsuited	Unsuited	Unsuited
Bukreek: BuA, BuB, BuC	Well suited	Well suited	Well suited
Carey: CaA, CaB	Well suited	Well suited	Well suited
Colorado:			
Cd, Ce	Suited	Well suited	Well suited
Cf For Yahola part of unit Cf, see Yahola series.	Poorly suited	Suited	Suited
Cottonwood:			
Co	Well suited	Well suited	Well suited
Ct	Unsuited	Unsuited	Poorly suited
Delwin: De	Suited	Suited	Poorly suited
Enterprise: EnA, EnB, EnC, EnD	Well suited	Well suited	Well suited
Hardeman:			
HaA, HaB, HaC	Well suited	Well suited	Well suited
HaD	Suited	Well suited	Well suited
Heatly: He	Suited	Suited	Poorly suited
Hilgrave: Hg	Unsuited	Unsuited	Suited
Lincoln:			
Lc	Suited	Suited	Suited
Lf	Poorly suited	Suited	Suited
Lipan: Ln	Suited	Suited	Suited
Lofton: Lo	Well suited	Well suited	Well suited
Miles:			
MeB, MeC	Well suited	Well suited	Well suited
MfA, MfB, MfC, MfD	Well suited	Well suited	Well suited
Nobscot: No	Suited	Suited	Poorly suited
*Owens: Ob, Ot For Badland part of Ob, see Badland. For Talpa and Vernon parts of Ot, see the respective series.	Poorly suited	Poorly suited	Suited
Paducah: PaC	Well suited	Well suited	Well suited
Quanah: Qt For Talpa part, see Talpa series.	Well suited	Well suited	Well suited
Quinlan Mapped only in an undifferentiated unit with Woodward soils.	Poorly suited	Poorly suited	Suited
Rough broken land: Ro	Unsuited	Unsuited	Poorly suited
Sagerton: SaA, SaB, ScA, ScB	Well suited	Well suited	Well suited
St. Paul: Sp	Well suited	Well suited	Well suited
Springer:			
SrB	Well suited	Well suited	Well suited
SrD, StD For Tivoli part of StD, see Tivoli series.	Suited	Well suited	Well suited

wildlife habitat and for kinds of wildlife

Elements of wildlife habitat—Continued			Kinds of wildlife		
Hardwood trees and shrubs	Wetland food and cover plants	Shallow water developments	Open-land wildlife	Brushland wildlife	Wetland wildlife
Unsuited	Unsuited	Unsuited	Well suited	Poorly suited	Unsuited.
Unsuited	Unsuited	Unsuited	Poorly suited	Poorly suited	Unsuited.
Unsuited	Unsuited	Unsuited	Well suited	Poorly suited	Unsuited.
Unsuited	Unsuited	Unsuited	Well suited	Poorly suited	Unsuited.
Unsuited	Poorly suited	Unsuited	Well suited	Poorly suited	Poorly suited.
Unsuited	Suited	Unsuited	Suited	Poorly suited	Poorly suited.
Unsuited	Unsuited	Unsulted	Well suited	Poorly suited	Unsuited.
Unsuited	Unsuited	Unsuited	Poorly suited	Poorly suited	Unsuited.
Poorly suited	Unsuited	Unsuited	Suited	Suited	Unsuited.
Unsuited	Unsuited	Unsuited	Well suited	Poorly suited	Unsuited.
Unsuited	Unsuited	Unsuited	Well suited	Poorly suited	Unsuited.
Unsuited	Unsuited	Unsuited	Well suited	Poorly suited	Unsuited.
Poorly suited	Unsuited	Unsuited	Suited	Suited	Unsuited.
Unsuited	Unsuited	Unsuited	Poorly suited	Poorly suited	Unsuited.
Unsuited	Poorly suited	Poorly suited	Suited	Poorly suited	Poorly suited.
Unsuited	Suited	Poorly suited	Suited	Poorly suited	Poorly suited.
Unsuited	Poorly suited	Poorly suited	Suited	Poorly suited	Poorly suited.
Unsuited	Poorly suited	Poorly suited	Well suited	Poorly suited	Poorly suited.
Poorly suited	Unsuited	Unsuited	Well suited	Suited	Unsuited.
Unsuited	Unsuited	Unsuited	Well suited	Poorly suited	Unsuited.
Poorly suited	Unsuited	Unsuited	Suited	Suited	Unsuited.
Unsuited	Unsuited	Unsuited	Poorly suited	Poorly suited	Unsuited.
Unsuited	Unsuited	Unsuited	Well suited	Poorly suited	Unsuited.
Unsuited	Unsuited	Unsuited	Well suited	Poorly suited	Unsuited.
Unsuited	Unsuited	Unsuited	Poorly suited	Poorly suited	Unsuited.
Unsuited	Unsuited	Unsuited	Poorly suited	Poorly suited	Unsuited.
Unsuited	Unsuited	Unsuited	Well suited	Poorly suited	Unsuited.
Unsuited	Unsuited	Unsuited	Well suited	Poorly suited	Unsuited.
Poorly suited	Unsuited	Unsuited	Well suited	Suited	Unsuited.
Poorly suited	Unsuited	Unsuited	Well suited	Suited	Unsuited.

TABLE 6.—*Suitability of the soils for elements of*

Soil series and map symbols	Elements of wildlife habitat		
	Grain and seed crops	Grasses and legumes	Wild herbaceous upland plants
Talpa: Ta	Unsuited	Unsuited	Poorly suited
Tillman: TmA, TmB, TmB2	Well suited	Well suited	Well suited
Tivoli: Tv	Poorly suited	Poorly suited	Poorly suited
Veal: VeB, VeC, VeD	Well suited	Well suited	Well suited
Vernon: VnB, VnC	Well suited	Well suited	Well suited
Weymouth:			
WeB, WeC	Well suited	Well suited	Well suited
WeD	Suited	Well suited	Well suited
Woodward:			
WoB, WoC	Well suited	Well suited	Well suited
Wr, Wu	Suited	Well suited	Well suited
For Rough broken land part of Wr, see Rough broken land. For Quinlan part of Wu, see Quinlan series.			
Yahola: Ya	Suited	Well suited	Well suited

pally for waterfowl. They may be designed so that they can be drained, planted, and flooded, or they may be used as permanent impoundments to grow submerged aquatics. Both freshwater and brackish-water situations are included.

The three general kinds of wildlife rated in table 6 are defined in the following paragraphs.

Open-land wildlife consists of birds and mammals that normally frequent cropland, pastures, and areas overgrown with grasses, herbs, and shrubs. Examples of this kind of wildlife are quail, cottontail rabbits, jackrabbits, meadowlarks, and lark sparrows.

Brushland wildlife consists of birds and mammals that normally frequent areas of hardwood trees and shrubs. Examples of brushland wildlife are deer, turkey, squirrel, raccoon, and javelina.

Wetland wildlife consists of birds and mammals that normally frequent such areas as ponds, streams, ditches, marshes, and swamps. Examples of this kind of wildlife are ducks, geese, rails, shorebirds, and snipe.

Formation and Classification of the Soils

This section explains how soils form and the factors that are involved in their formation. It describes briefly the system of soil classification used in the United States. Table 7 shows the classification of soils in Cottle County by higher categories.

Factors of Soil Formation

There are five major factors of soil formation. They are climate, living organisms, parent material, topography, and time. If a factor is varied, a different soil forms.

Several processes were involved in the formation of horizons in the soils of Cottle County. Three of the main processes are accumulation of organic matter, leaching of calcium carbonate and bases, and formation and translocation of silicate clay minerals. In most soils more than one of these processes have been active in the development of horizons.

Accumulation of organic matter in the upper part of the profile to form an A1 horizon has been important. The soils of Cottle County range from medium to low in organic-matter content.

Leaching of carbonates and bases has occurred in nearly all of the soils. Leaching of bases in soils usually precedes translocation of silicate clay minerals. Most of the soils of the county are moderately leached, and this has contributed to the development of horizons. Calcium carbonate has been leached from the upper horizons of most of the soils. The amount of rainfall, however, has not been great enough to leach the carbonates entirely from the soil, and many of the soils have a layer in which calcium carbonate has accumulated.

In several soils of Cottle County, the downward translocation of clay minerals has contributed to horizon development. The Bt horizon of such soils contains appreciably more silicate clay than the A horizon. These soils were probably leached of carbonates and soluble salts to a considerable extent before translocation of silicate clays took place. Abilene, Bukreek, Sagerton, and Miles soils are examples of soils that have translocated silicate clays accumulated in the Bt horizon.

Climate

Cottle County has a subtropical climate with dry winters and hot, humid summers. Because of high winds, evaporation is high and seldom does rainwater move below the normal rooting zone. Calcium carbonate has been leached from the upper horizons of about half of the

wildlife habitat and for kinds of wildlife—Continued

Elements of wildlife habitat—Continued			Kinds of wildlife		
Hardwood trees and shrubs	Wetland food and cover plants	Shallow water developments	Open-land wildlife	Brushland wildlife	Wetland wildlife
Suited	Unsuited	Unsuited	Poorly suited	Poorly suited	Unsuited.
Unsuited	Unsuited	Unsuited	Well suited	Poorly suited	Unsuited.
Poorly suited	Unsuited	Unsuited	Poorly suited	Poorly suited	Unsuited.
Unsuited	Unsuited	Unsuited	Well suited	Poorly suited	Unsuited.
Unsuited	Unsuited	Unsuited	Well suited	Poorly suited	Unsuited.
Unsuited	Unsuited	Unsuited	Well suited	Poorly suited	Unsuited.
Unsuited	Unsuited	Unsuited	Well suited	Poorly suited	Unsuited.
Unsuited	Unsuited	Unsuited	Well suited	Poorly suited	Unsuited.
Unsuited	Unsuited	Unsuited	Well suited	Poorly suited	Unsuited.
Unsuited	Poorly suited	Unsuited	Well suited	Poorly suited	Poorly suited.

soils in the county. Sagerton, Miles, Nobscot, Heatly, and Springer are examples of soils that have been leached. Calcium carbonate has accumulated in layers in many of the soils. As the carbonates were being leached, clay particles were also moved down to accumulate and form a more slowly permeable horizon. Sagerton and Abilene are examples of soils affected by this process. The wide variation in temperature has favored the weathering of parent materials to form soil.

Wind has a marked affect on the formation of soils in the county. It aids in breaking down parent material, in reworking many deposits, and in shifting materials from place to place.

Living organisms

Plants, animals, insects, bacteria, and fungi are important in the formation of soils. Gains in organic matter and nitrogen in the soil, gains or losses in plant nutrients, and changes in structure and porosity are among the changes caused by living organisms.

Vegetation, especially grass, has affected soil formation in Cottle County more than living organisms. The grass vegetation produced soils that generally are moderate in organic matter. Some of the young, sandy, and shallow soils are low in organic matter.

Parent material

Parent material is the unconsolidated mass from which a soil is formed. It determines the limits of the chemical and mineralogical composition of the soils.

The soils in Cottle County formed in four kinds of parent material. They are soils that formed in Permian clays and shales, Permian sands and silts, or limestone and gypsum; soils that formed in sandy to clayey outwash, or old alluvium; soils that formed in recent alluvium; and soils that formed in recent eolian material.

Cottle County is underlain by red-bed geologic formations that are part of the Double Mountain Group (4). The formations were laid down as sediments on the eastern side of the Permian sea with the dip to the west and northwest. These Permian formations are the Blaine Formation (shale, siltstone, sandstone, gypsum, and dolomite) and the undivided Cloud Chief Gypsum and Whitehorse Sandstone (shale, sandstone, sand, gypsum, and dolomite). Pleistocene terrace deposits are found along the Pease River. Pleistocene deposits also surround most of the surface-washed and windblown sand deposits of Recent age. These sandy deposits cover about 20 to 25 percent of the county and are in the western, central, and southern parts.

The Permian materials are exposed over a large part of the northern, eastern, and northwestern parts of the county. The terrain ranges from nearly level to rolling and steep.

Soils that formed in the clayey red beds of the Permian, where slopes are nearly level to gentle, are the deep, well-developed Lofton, Tillman, and Quanah soils. Those that formed where slopes are steeper, such as the Owens soils, are less deeply developed. St. Paul, Carey, and Paducah soils formed in sandy or silty Permian material. Quinlan soils are steeper and less deeply developed.

Soils that formed over Permian dolomitic limestone are the Talpa soils. They are very shallow and stony.

Soils that formed in Permian gypsum are the very shallow Cottonwood soils.

A mantle of outwash materials was deposited over the Permian red beds during the Pliocene to Pleistocene period (7). These outwash deposits range from a few feet up to about 15 feet in thickness. The materials are variable in texture and range from clayey to silty and sandy.

The finer textured outwash materials were deposited by slowly moving water. Topography is smooth. The Sagerton and Abilene soils formed in these materials.

The sandier outwash materials were deposited by faster moving waters. Some of these sandier materials were later reworked by wind into an undulating to hummocky terrain. Soils such as Bukreek and Miles formed in sandy outwash materials. Springer soils formed in such materials that were reworked by wind.

The eolian materials are confined to narrow bands that parallel some of the larger streams and rivers. These materials were blown from the river channels and deposited on the south and east sides of the stream channels. The coarser textured sands were deposited nearest the river and have a hummocky to duny topography. Tivoli and Nobscot soils formed in coarse-textured material. The finer sands were carried farther from the river channels and have a smooth topography. Hardeman and Enterprise soils formed in these finer sands. All of these eolian soils are deep, but they are not well developed and lack distinct horizons.

The Colorado, Yahola, and Lincoln soils formed in recent alluvium. They are on the flood plains of streams. A characteristic of most recent alluvial soils is that stratified layers of different textures occur throughout the profile. Alluvial soils on some of the lower flood plains are subject to occasional to frequent overflows and deposition of fresh alluvial sediment.

Topography

Topography, or relief, affects soil formation through its influence on drainage, erosion, plant cover, and soil temperature. The topography of Cottle County ranges from nearly level to very steep.

Soils that formed on nearly level to gently sloping positions are deeper and have more distinct horizon development than soils that formed on gently sloping to sloping hilltops and ridges. This is because the soils in lower positions receive extra water, have less runoff, and are subject to less erosion.

On steep slopes, geologic erosion occurs almost as fast as the soils form.

Time

Time, usually a long time, is required for soils to form distinct horizons. The differences in length of time that parent material has been in place are commonly reflected in the degree of development of the soil profile.

The soils in Cottle County range from recent to well developed. The recent soils have very little profile development and the well-developed soils have well-expressed soil horizons. Tivoli soils are an example of recent soils lacking development. Miles soils are an example of well-developed soils with developed horizons. Miles soils have been in place for a long enough time to approach equilibrium with their environment, and they have a mature, well-developed profile.

Classification of the Soils

Classification consists of an orderly grouping of soils according to a system designed to make it easier to remember soil characteristics and interrelationships. Classification is useful in organizing and applying the results of experience and research. Soils are placed in narrow classes for discussion in detailed soil surveys and for application of knowledge to farms and fields. The many thousands of narrow classes are then grouped into progressively fewer and broader classes in successively higher categories so that information can be applied to large geographic areas.

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (*2*) and revised later (*6*). The system currently used by the National Cooperative Soil Survey was developed in the early sixties (*9*) and was adopted in 1965 (*5*). It is under continual study.

The current system of classification has six categories. Beginning with the most inclusive, these categories are the order, the suborder, the great group, the subgroup, the family, and the series. The criteria for classification are soil properties that are observable or measurable, but the properties are selected so that soils of similar genesis are grouped together. The placement of some soil series in the current system of classification, particularly in families, may change as more precise information becomes available.

Table 7 shows the classification of each soil series in Cottle County by family, subgroup, and order according to the current system.

ORDER.—Soils are grouped into orders according to properties that seem to have resulted from the same processes acting to about the same degree on the parent material. Ten soil orders are recognized in the current system. Entisols, Vertisols, Inceptisols, Aridosols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate the soil orders are those that tend to give broad climatic groupings of soils. Two exceptions, Entisols and Histosols, occur in many different climates.

Five of the ten soil orders occur in Cottle County: Entisols, Inceptisols, Mollisols, Vertisols, and Alfisols. Entisols are recent soils in which there has been little, if any, horizon development. Inceptisols occur on young land surfaces. Mollisols have a thick dark-colored surface layer, moderate to strong structure, and base saturation of more than 50 percent. Vertisols are soils in which natural churning or inversion of soil material takes place, mainly through the swelling and shrinking of clays. Alfisols have a clay-enriched B horizon and a base saturation of more than 35 percent.

SUBORDER.—Each order is divided into suborders, primarily on the basis of soil characteristics that seem to produce classes having the greatest similarity. The soil properties used are mainly those that reflect either the presence or absence of waterlogging or differences in climate or vegetation. The climatic range of the suborders is narrower than that of the orders.

GREAT GROUP.—Each suborder is divided into great groups on the basis of uniformity in the kinds and sequence of major horizons and soil features. The horizons considered are those in which clay, iron, or humus has accumulated and those that have pans that interfere with the growth of roots or the movement of water. The features considered are the self-mulching properties of clays, soil temperature, chemical composition (mainly calcium, magnesium, sodium, and potassium content), and the like.

SUBGROUP.—Each great group is divided into subgroups, one representing the central (typic) segment of the group, and other groups, called intergrades, that

TABLE 7.—*Classification of soil series*

Series	Family	Subgroup	Order
Abilene [1]	Fine, mixed, thermic	Pachic Argiustolls	Mollisols.
Bukreek	Fine-loamy, mixed, thermic	Typic Paleustolls	Mollisols.
Carey [1]	Fine-silty, mixed, thermic	Typic Argiustolls	Mollisols.
Colorado	Fine-loamy, mixed (calcareous), thermic	Typic Ustifluvents	Entisols.
Cottonwood	Loamy, carbonatic, thermic, shallow	Ustic Torriorthents	Entisols.
Delwin	Fine-loamy, mixed, thermic	Udic Paleustalfs	Alfisols.
Enterprise	Coarse-silty, mixed, thermic	Typic Ustochrepts	Inceptisols.
Hardeman	Coarse-loamy, mixed, thermic	Typic Ustochrepts	Inceptisols.
Heatly	Loamy, mixed, thermic	Arenic Paleustalfs	Alfisols.
Hilgrave	Loamy-skeletal, mixed, thermic	Aridic Haplustalfs	Alfisols.
Lincoln	Sandy, mixed, thermic	Typic Ustifluvents	Entisols.
Lipan	Fine, montmorillonitic, thermic	Entic Pellusterts	Vertisols.
Lofton [1]	Fine, mixed, thermic	Torrentic Argiustolls	Mollisols.
Miles	Fine-loamy, mixed, thermic	Udic Paleustalfs	Alfisols.
Nobscot	Loamy, mixed, thermic	Arenic Haplustalfs	Alfisols.
Owens	Clayey, mixed, thermic, shallow	Typic Ustochrepts	Inceptisols.
Paducah	Fine-silty, mixed, thermic	Typic Haplustalfs	Alfisols.
Quanah	Fine-silty, mixed, thermic	Typic Calciustolls	Mollisols.
Quinlan	Loamy, mixed, thermic, shallow	Typic Ustochrepts	Inceptisols.
Sagerton	Fine, mixed, thermic	Typic Paleustolls	Mollisols.
St. Paul	Fine-silty, mixed, thermic	Pachic Argiustolls	Mollisols.
Springer	Coarse-loamy, mixed, thermic	Udic Paleustalfs	Alfisols.
Talpa	Loamy, mixed, thermic	Lithic Calciustolls	Mollisols.
Tillman	Fine, mixed, thermic	Typic Paleustolls	Mollisols.
Tivoli [1]	Mixed, thermic	Typic Ustipsamments	Entisols.
Veal [1]	Fine-loamy, carbonatic, thermic	Aridic Ustochrepts	Inceptisols.
Vernon	Fine, mixed, thermic	Typic Ustochrepts	Inceptisols.
Weymouth	Fine-loamy, mixed, thermic	Typic Ustochrepts	Inceptisols.
Woodward	Coarse-silty, mixed, thermic	Typic Ustochrepts	Inceptisols.
Yahola	Coarse-loamy, mixed (calcareous), thermic	Typic Ustifluvents	Entisols.

[1] In this county, these soils are taxadjuncts to the series for which they are named:
Some of the Abilene soils are outside the range defined for the series because layers within the Bt horizon have a chroma of more than 4.
Some of the Carey soils are outside the range defined for the series because they have secondary carbonates beginning at a depth of 36 to 40 inches.
Some of the Lofton soils are outside the range defined for the series because they have a color hue of 7.5YR and are too red.
Some of the Tivoli soils are outside the range defined for the series because they are calcareous at a depth of less than 40 inches.
Some of the Veal soils are outside the range defined for the series because they have a color hue of 5YR and are too red.
These differences do not affect the use or behavior of these soils.

have properties of one great 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 the range of any other great group, suborder, or order.

FAMILY.—Families are established within a subgroup primarily on the basis of properties that affect the growth of plants or the behavior of soils when used for engineering purposes. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

SERIES.—The series is a group of soils that have major horizons that, except for texture of the surface layer, are similar in important characteristics and in arrangement in the profile.

Climate [4]

Cottle County has a subtropical climate with dry winters and hot, humid summers. Average annual precipitation is 22.14 inches.

Rainfall occurs most frequently as a result of thunderstorms, monthly and annual amounts are extremely variable. Rainfall has varied from 7.72 inches in 1956 to 41.92 inches in 1941. Maximum precipitation usually occurs in May and June, when warm, moist, tropical, maritime air is carried far inland from the Gulf of Mexico. This airmass produces moderate to heavy thunderstorms, sometimes with hail, in the afternoon and evening. A lesser rainfall peak occurs in October as cold fronts, which are absent in summer, increase in frequency and clash with the warm, moist, tropical Gulf air. Four-fifths of the average annual precipitation falls during April through October.

Periods of drought are rather common. One year out of every 10, on an average, total rainfall is less than 15 inches. On the other hand, 1 year out of every 10 annual rainfall exceeds 30 inches. During exceptionally wet years, little benefit is derived from much of the precipitation, because it results from heavy downpours that produce excessive runoff.

Cottle County is cut off from the Gulf of Mexico moisture source rather effectively during the colder months by frequent surges of drier polar and arctic air masses invading the area from the north. Consequently, precipitation is relatively light in winter. Snow falls occasionally in winter, but it is generally light and melts rapidly. Data on the average monthly snowfall are biased by rare, exceptionally heavy snows such as occurred in

[4] By ROBERT B. ORTON, climatologist for Texas, National Weather Service, U.S. Department of Commerce.

February 1938, December 1942, February 1945, and January 1966. The average is therefore a poor estimate of expected snowfall.

Temperature, like rainfall, is extremely variable, especially during the colder 6 months of the year. From November through March, cold fronts are frequent, bringing rapid and pronounced changes. However, cold spells are short, rarely lasting more than 48 hours before westerly and southwesterly winds bring higher temperatures. Strong, fast-moving cold fronts late in spring may follow several weeks of mild weather.

The average daily minimum temperature in January, the coldest month, is 27.5° F. The maximum temperature exceeds 32° about 9 days out of 10 in January; the average maximum is 54.8°. Daytime temperatures are hot in summer, particularly in July and August. Evaporative-type home air conditioners are effective about 90 percent of the time in Cottle County. Table 8 summarizes the average temperature and precipitation.

Prevailing winds are southerly to southwesterly throughout the year, although northerly winds are frequent in winter. The strongest sustained winds are late in winter and in spring. These winds occasionally produce dust storms.

The average length of the growing season (freeze-free period) is 219 days. The average date of the last temperature of 32° in spring is April 2, and the average date of the first temperature of 32° in fall is November 7. Low temperatures depend on differences in topography, wind, plant cover, and soil condition, so that significant departures in these values are likely to be found in the rural areas. The average annual relative humidity is 76 percent at 6 a.m., 47 percent at noon, and 44 percent at 6 p.m. Average annual sunshine is 72 percent of the total possible. Average lake evaporation is 67 inches annually.

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Glossary

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

Alkali soil. Generally, a highly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (pH 8.5 or higher) or so

TABLE 8.—*Temperature and*

[All data based on records kept at Paducah, Texas,

Month	Temperature [1]				Precipitation			
	Average daily maximum	Average highest maximum	Average daily minimum	Average lowest minimum	Average total [2]	Probability of receiving—		
						0 or Trace	0.50 inch or more	1.00 inch or more
	°F.	°F.	°F.	°F.	Inches	Percent	Percent	Percent
January	54. 8	77. 3	27. 5	9. 6	. 77	5	55	32
February	58. 2	80. 4	31. 3	15. 3	. 85	10	59	35
March	66. 8	87. 7	37. 8	19. 9	. 95	8	65	40
April	79. 1	95. 5	50. 2	34. 6	1. 86	1	85	65
May	86. 6	100. 5	59. 1	47. 9	3. 54	<1	97	93
June	92. 8	104. 1	66. 7	56. 9	3. 46	<1	89	79
July	97. 5	104. 8	71. 2	64. 5	2. 10	1	78	68
August	96. 9	106. 0	69. 6	61. 3	2. 06	8	75	60
September	88. 3	99. 7	62. 0	49. 0	2. 28	4	78	62
October	78. 9	94. 1	51. 4	37. 9	2. 44	5	80	80
November	65. 9	84. 3	38. 8	23. 1	. 88	15	49	30
December	56. 6	77. 8	31. 0	16. 2	. 95	10	55	35
Year	76. 9		49. 7		22. 14			

[1] Length of record, 15 years; period of record, 1955–69.
[2] Length of record, 33 years.

high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is poor from this cause.

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.

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

Caliche. A more or less cemented deposit of calcium carbonate in many soils of warm-temperate areas, as in the Southwestern States. The material may consist of soft, thin layers in the soil or of hard, thick beds just beneath the solum, or it may be exposed at the surface by erosion.

Catena. A sequence, or "chain," of soils on a landscape, developed from one kind of parent material but having different characteristics because of differences in relief and drainage.

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. Synonym: clay coating.

Claypan. A compact, slowly permeable soil horizon that contains more clay than the horizon above and below it. A claypan is commonly hard when dry and plastic or stiff when wet.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

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 in 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.

Diversion, or diversion terrace. A ridge of earth, generally a terrace, that is built to divert runoff from its natural course and, thus, to protect areas downslope from the effects of such runoff.

Drainage class (natural). Drainage 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 water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A horizon and upper part of the B horizon and have mottling in the lower part of the B horizon and in the C horizon.

Somewhat poorly drained soils are wet for significant periods but not all the time. Some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods; they are light gray and generally mottled from the surface downward, but some have few or no mottles.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light

precipitation data

elevation, 1,890 feet; <means less than]

Precipitation—Continued										
Probability of receiving—continued					Average number of days with [3]—			Snow or sleet		
2.00 inches or more	3.00 inches or more	4.00 inches or more	5.00 inches or more	6.00 inches or more	0.10 inch or more	0.50 inch or more	1.00 inch or more	Average total [2]	Maximum monthly [2]	Greatest depth [3]
Percent	*Percent*	*Percent*	*Percent*	*Percent*				*Inches*	*Inches*	*Inches*
9	4	<1	<1	<1	2	(4)	(4)	2.2	9.2	8
11	4	1	<1	<1	2	(4)	(4)	2.4	16.0	7
13	4	3	<1	<1	2	1	(4)	1.4	9.0	5
40	21	10	5	5	3	1	(4)	.4	6.0	0
75	55	41	30	20	5	3	1	0	0	0
59	39	24	15	12	5	3	1	0	0	0
40	20	11	8	4	4	2	1	0	0	0
39	20	11	7	5	3	1	(4)	0	0	0
39	25	18	10	4	4	2	1	0	0	0
40	28	18	10	6	3	2	1	(4)	.5	1
10	5	3	<1	<1	2	1	(4)	.4	5.0	3
18	8	4	2	1	2	1	(4)	1.6	12.0	5
					37	17	5	8.4	16.0	8

[3] Length of record, 16 years.
[4] Less than one-half.

gray, with or without mottling, in the deeper parts of the profile.

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Fallow. Cropland left idle in order to restore productivity, mainly through accumulation of water, nutrients, or both. Summer fallow is a common stage before cereal grain in regions of limited rainfall. The soil is tilled for at least one growing season to control weeds, to aid decomposition of plant residue, and to encourage the storage of moisture for the succeeding grain crop.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the oven-dry weight, after the gravitational, or free, water has been allowed to drain away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Gilgai. Typically, the microrelief of Vertisols—clayey soils that have a high coefficient of expansion and contraction with changes in moisture; usually a succession of microbasins and microknolls, in nearly level areas, or of microvalleys and microridges that run with the slope.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused by (1) accumulation of clay, sesquioxides, humus, or some combination of these; (2) prismatic or blocky structure; (3) redder or stronger colors than the A horizon; or (4) some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

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

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.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Plowpan. A compacted layer formed in the soil immediately below the plowed layer.

Poorly graded. A soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles in poorly graded soil material, density can be increased only slightly by compaction.

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

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. In words, the degrees 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 alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline	9.1 and higher
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

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

Saline soil. A soil that contains soluble salts in amounts that impair growth of plants but that does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments that range from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz, but the sand may be of any mineral composition. As a textural class soil that is 85 percent or more sand and not more than 10 percent clay.

Silica. Silica is a combination of silicon and oxygen. The mineral form is called quartz.

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

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on relatively steep slopes and in swelling clays, where there is marked change in moisture content.

Slick spots. Small areas in a field that are slick when wet because they contain excess exchangeable sodium or alkali.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles, less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *Very coarse sand* (2.0 to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter). The separates recognized by the International Society of Soil Science are as follows: I (2.0 to 0.2 millimeter); II (0.2 to 0.02 millimeter); III (0.02 to 0.002 millimeter); IV (less than 0.002 millimeter).

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically, the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

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

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil. A presumed fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

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.

Well-graded soil. A soil or soil material consisting of particles that are well distributed over a wide range in size or diameter. Such a soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an oven-dry basis, at which plants (specifically sunflower) wilt so much that they do not recover when placed in a dark, humid atmosphere.

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