Issued December 1968

SOIL SURVEY

Hughes County, Oklahoma

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
OKLAHOMA AGRICULTURAL EXPERIMENT STATION

Major fieldwork for this soil survey was done in the period 1956–64. Soil names and descriptions were approved in 1965. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1964. This survey was made cooperatively by the Soil Conservation Service and the Oklahoma Agricultural Experiment Station; it is part of the technical assistance furnished to the Hughes County Soil and Water Conservation District.

HOW TO USE THIS SOIL SURVEY

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

Locating Soils

All of the soils of Hughes County are shown on the detailed map at the back of this survey. This map consists of many sheets that are made from aerial photographs. Each sheet is numbered to correspond with numbers shown on the Index to Map Sheets.

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

Finding and Using Information

The "Guide to Mapping Units" can be used to find information in the survey. This guide lists all of the soils of the county in alphabetic order by map symbol and gives the capability classification, the range site classification, and the windbreak and post-lot classification of each soil. It also shows the page where each range site and each windbreak and post-lot group is described.

Interpretations not included in the text can be developed by grouping the soils according to their suitability or limitations for a particular use. 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 ranchers and those who work with them can learn about use and management of the soils from the soil descriptions and from the discussions of the range sites.

Foresters and others can refer to the section "Use of the Soils for Woodland, Windbreaks, and Post Lots," where the soils are grouped according to their suitability for trees.

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

Ranchers and others interested in range can find, under "Use of the Soils for Range," groupings of the soils according to their suitability for range and a description of the vegetation on each range site.

Engineers and builders can find, under "Use of the Soils in Engineering," tables that give test data, estimates of soil properties, and information about soil features that affect engineering practices and structures.

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

Newcomers in Hughes County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "General Nature of the County."

Cover picture

Bermudagrass pasture on Verdigris soils in foreground. Bates and Collinsville soils in background.

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SOIL SURVEY OF HUGHES COUNTY, OKLAHOMA

BY ROSCOE M. LONG, SOIL CONSERVATION SERVICE

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

HUGHES COUNTY is in the southeastern part of Oklahoma (fig. 1). The total area is 518,400 acres, or 810 square miles. Holdenville is the county seat.

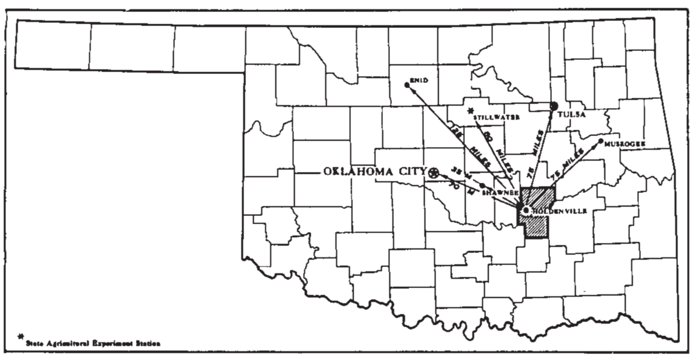

Figure 1.—**Location of Hughes County in Oklahoma.**

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Hughes County, where they are located, and how they can be used. They went into the county knowing they likely would find many soils they had already seen, and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; 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 rock material that has not been changed much by leaching or by roots of plants.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. To use this survey efficiently, it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, the major horizons of all the soils of one series 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. Konawa and Bates, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the natural, undisturbed landscape. Soils of one series can differ somewhat in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man.

Many soil series contain soils that differ in the texture of their surface layer. According to such differences in texture, separations called soil types are made. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Konawa fine sandy loam and Konawa loamy fine sand are two soil types in the Konawa series. The difference in the texture of their surface layers is apparent from their names.

Some types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into phases. The name of a soil phase indicates a feature that affects management. For example, Konawa fine sandy loam, 1 to 3 percent slopes, is one of three phases of Konawa fine sandy loam, a soil type that has a slope range of 1 to 5 percent.

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 the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil type or a phase of a soil type. 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 type or phase.

In preparing some detailed maps, the soil scientists have a problem of delineating areas where different kinds of soils are so intricately mixed or occur in individual areas of such small size that it is not practical to show them separately on the map. They show such a mixture of soils as one mapping unit and call it a soil complex. Ordinarily, a soil complex is named for the major kinds of soils in it, for example, Talihina-Collinsville complex, 5 to 20 percent slopes. Most surveys include areas where the soil material is so rocky, so shallow, or so frequently worked by wind and water that it cannot be classified by soil series. These areas are shown on the map like other mapping units, but they are given descriptive names, such as Alluvial land, and are called land types.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soils 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 soils. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way that it is readily useful to different groups of readers, among them farmers, managers of rangeland, engineers, and homeowners. Grouping soils that are similar in suitability for each specified use is the method of organization commonly used in the soil survey. On the basis of yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others, then adjust them according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

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

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of farming or other land use. Such a map is not suitable for planning the management of a farm or field, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect management.

Described in the following pages are the five soil associations in Hughes County. More detailed information about the individual soils in each association can be obtained by studying the detailed soil map and by reading the section "Descriptions of the Soils."

1. Dennis-Bates-Talihina association

Deep to shallow, very gently sloping to moderately steep, loamy soils on prairie uplands

This association occurs throughout the county but is most extensive in the northwestern and northeastern parts. Dennis soils make up about 30 percent of the acreage, Bates soils 23 percent, and Talihina soils 9 percent. The remaining 38 percent consists of Breaks-Alluvial land complex,

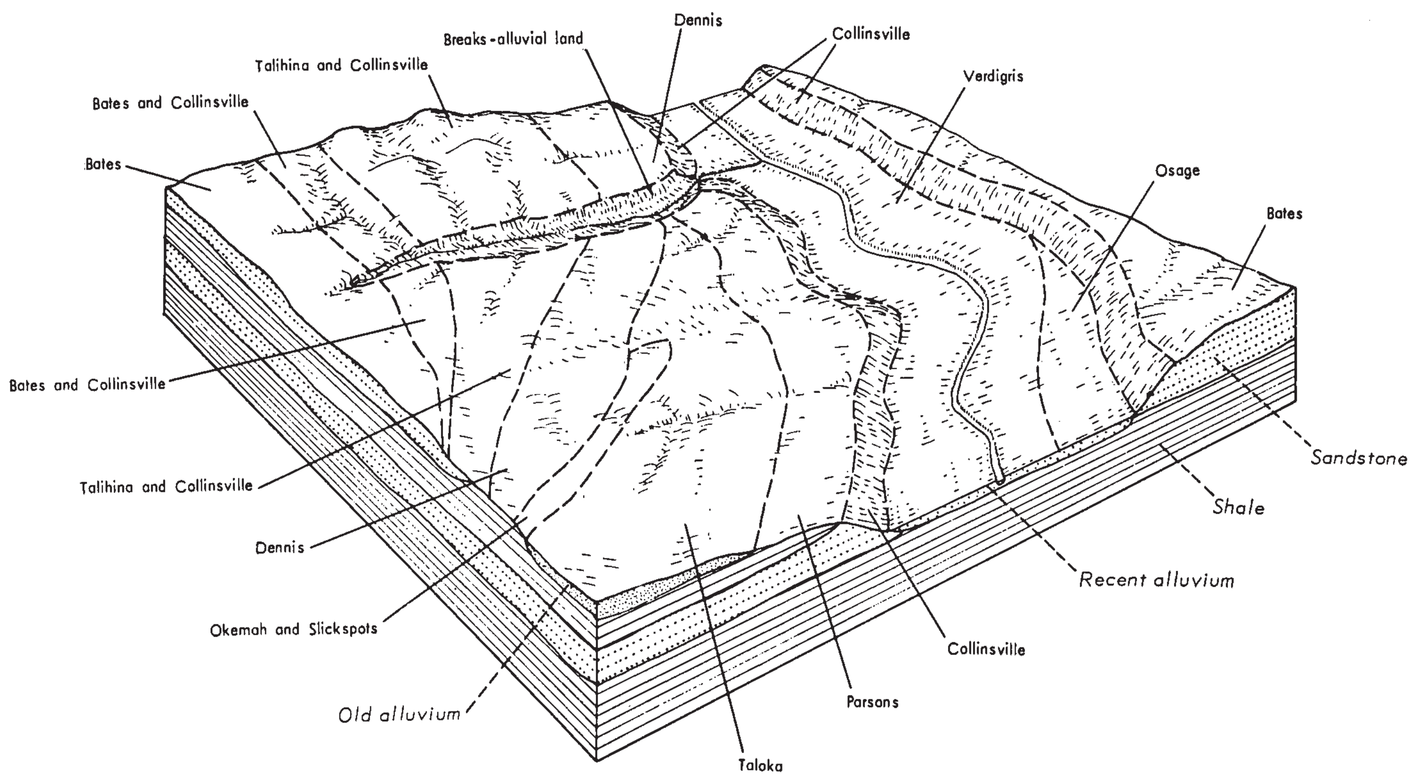

***Figure 2.*—Typical pattern of soils in associations 1 and 2.**

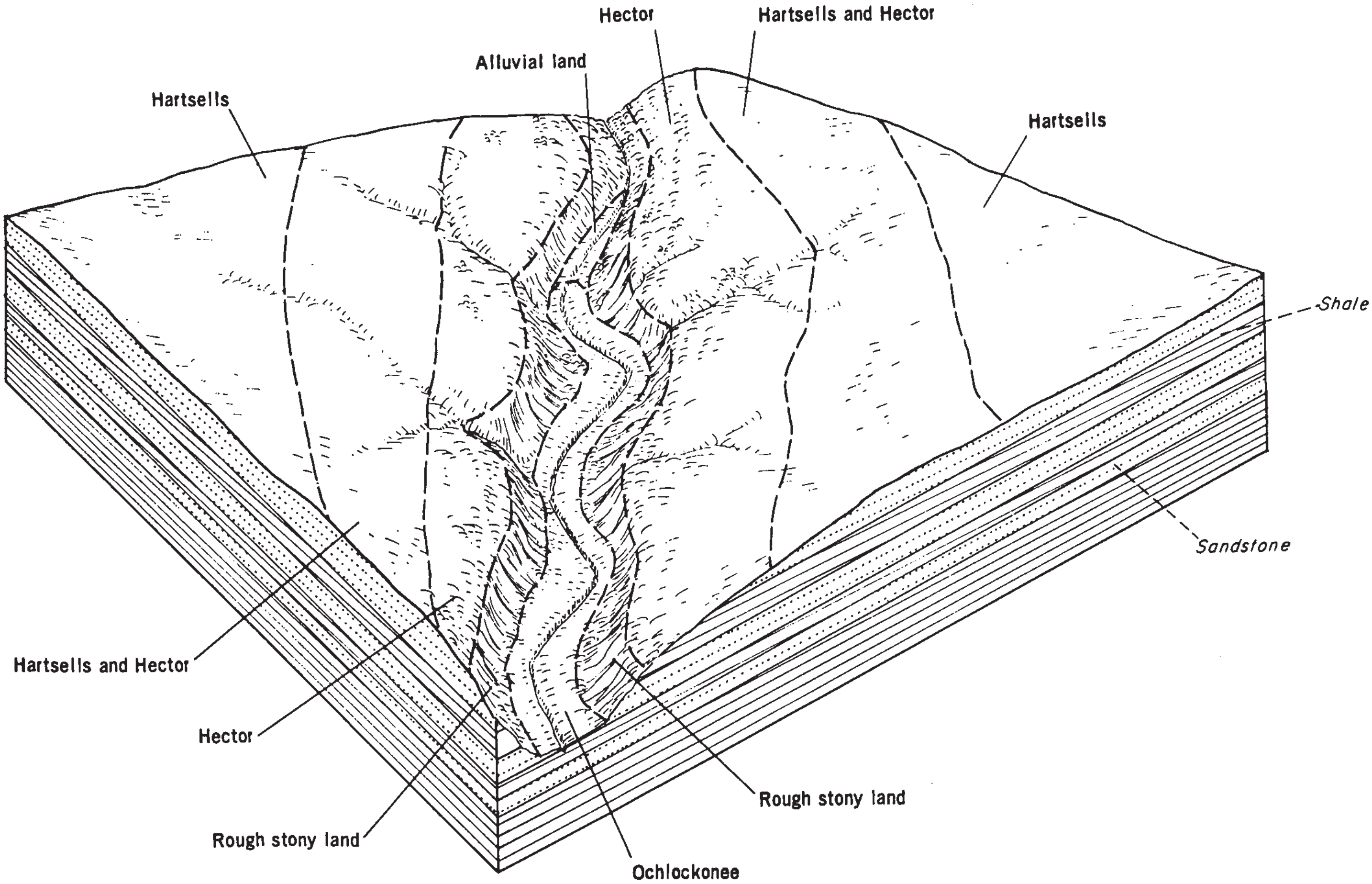

Figure 3.—Typical pattern of soils in association 3.

Collinsville soils, Okemah-Slickspots complex, Parsons soils, Taloka soils, Oil-waste land, and other soils. The association occupies about 33 percent of the county. Figure 2 shows a typical pattern of the soils.

Dennis soils are deep and very gently sloping to gently sloping. They have a surface layer of medium acid, brownish loam, 10 to 15 inches thick, and a subsoil of brownish light clay to heavy clay loam. Bates soils are moderately deep and very gently sloping to gently sloping. The surface layer is medium acid, brownish fine sandy loam in the upper 12 inches and brown light loam in the lower 6 inches. The subsoil is brown to yellowish-brown heavy loam to light sandy clay loam or light clay loam. Talihina soils are shallow, stony, and sloping to moderately steep. They have a surface layer of medium acid, brownish clay loam. The underlying material is clay.

Dennis and Bates soils are used for crops, for native meadow, and for native pasture. The commonly grown crops are corn, cotton, peanuts, grain sorghum, oats, alfalfa, and bermudagrass. Talihina soils are used for range, meadow, and pasture.

2. *Verdigris-Osage association*

Deep, level and nearly level, loamy and clayey soils on prairie bottom lands

This association is largely along Wewoka and Little Wewoka Creeks and the Little River. Verdigris soils make up about 85 percent of the acreage, and Osage soils 8 percent. The remaining 7 percent consists of Ochlockonee and other soils and of Alluvial land. This association occupies about 6 percent of the county. Figure 2 shows a typical pattern of the soils.

Verdigris soils and Osage soils are deep and level or nearly level. The surface layer of Verdigris soils has a brownish color, has a loamy texture, and is medium acid to slightly acid. It ranges from 16 to 26 inches in thickness. Beneath the surface layer is about 40 inches of brownish clay loam to heavy silty clay loam. The surface layer of Osage soils is slightly acid, grayish light clay 10 to 20 inches thick. This layer is underlain by about 50 inches of gray clay.

Verdigris and Osage soils are used for crops, for range, and for pasture. The commonly grown crops are corn, alfalfa, grain sorghum, oats, cotton, peanuts, and bermudagrass.

3. *Hector-Hartsells association*

Very shallow to moderately deep, very gently sloping to steep, loamy soils on timbered uplands

This association is mostly in the eastern and southern parts of the county. Hector soils make up about 66 percent of the acreage, and Hartsells soils 21 percent. The remaining 13 percent consists of Alluvial land, Rough stony land, Ochlockonee soils, and other soils. This association occupies about 42 percent of the county. Figure 3 shows a typical pattern of the soils.

Hector soils are shallow and very shallow. They have a surface layer of strongly acid to very strongly acid, grayish and brownish gravelly fine sandy loam 4 to 20 inches thick. The underlying material is brownish fractured sandstone. Hartsells soils are moderately deep. They have a surface layer of brownish fine sandy loam 5 to 18 inches thick. The subsoil is mainly sandy clay loam.

Hector soils are used for range. Hartsells soils are used for crops, for range, and for pasture. The commonly grown crops are corn, oats, grain sorghum, alfalfa, cotton, and bermudagrass. Blackjack oak, post oak, and hickory grow in areas that have not been cleared for cultivation.

4. Konawa-Stidham association

Deep, nearly level to sloping, sandy and loamy soils on timbered uplands

This association is adjacent to the bottom lands of the North Canadian and the South Canadian Rivers and in areas west of Gerty and around Non. Konawa soils make up about 62 percent of the acreage, and Stidham soils 5 percent. The remaining 33 percent consists of Alluvial land, Vanoss soils, and Eufaula soils. The association occupies about 17 percent of the county. Figure 4 shows a typical pattern of the soils.

Konawa soils are deep and nearly level to sloping. They have a surface layer of medium acid, brownish loamy fine sand or fine sandy loam 4 to 20 inches thick. The upper part of the subsoil is yellowish-red sandy clay loam, and the lower part is reddish-yellow loamy sand. Stidham soils are deep and nearly level. They have a surface layer of slightly acid or medium acid loamy fine sand and a subsoil of light sandy clay loam.

Konawa and Stidham soils are used for crops, for range, and for pasture. The commonly grown crops are corn, oats, peanuts, grain sorghum, cotton, alfalfa, and bermudagrass.

5. Reinach-Brazos association

Deep, level and nearly level, loamy and sandy soils chiefly on prairie bottom lands

This association occurs on bottom lands of the North Canadian and the South Canadian Rivers. Reinach soils make up about 53 percent of the acreage, and Brazos soils 33 percent. The remaining 14 percent consists mainly of Brewer soils. The association occupies about 2 percent of the county. Figure 4 shows a typical pattern of the soils.

Reinach soils and Brazos soils are deep and level or nearly level. The surface layer of Reinach soils is brownish very fine sandy loam 10 to 16 inches thick. Beneath this layer is calcareous very fine sandy loam that becomes sandier as depth increases. Brazos soils have a surface layer of brownish loamy fine sand 6 to 12 inches thick. The underlying material is brownish fine sand.

Reinach and Brazos soils are used for crops, for range, and for pasture. The commonly grown crops are peanuts, corn, oats, grain sorghum, alfalfa, cotton, and bermudagrass.

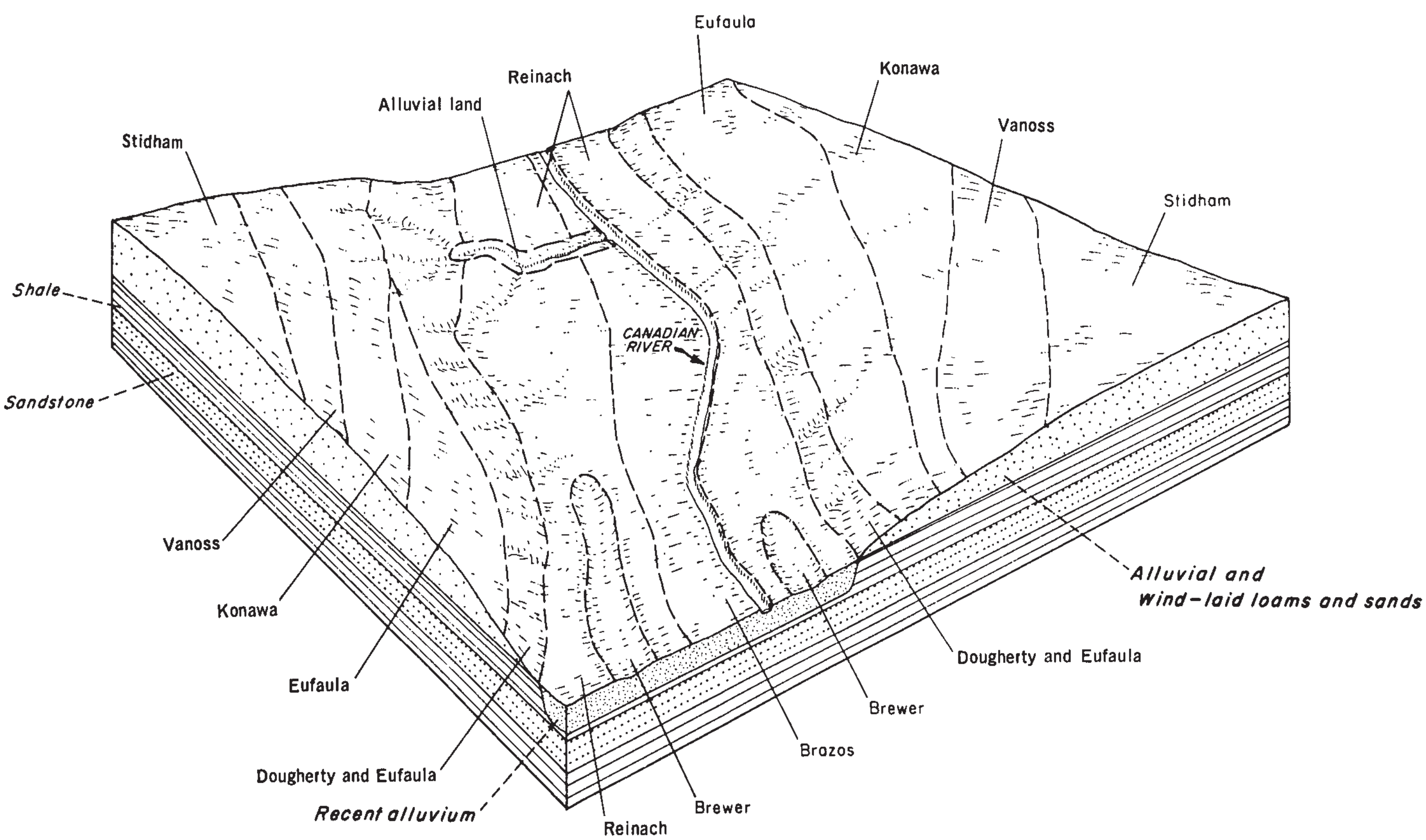

Figure 4.—**Typical pattern of soils in associations 4 and 5.**

Descriptions of the Soils

In this section the soils of Hughes County are described in detail. The procedure is to describe first a soil series and then the mapping units in that series. The description of each soil series includes a description of a profile that is considered representative of all the soils of the series. If the profile of a given mapping unit differs from this typical profile, the differences are stated in the description of the mapping unit, unless they are apparent from the name of the mapping unit. To get full information on any one mapping unit, it is necessary to read both the description of that unit and the description of the soil series to which the unit belongs.

As explained in the section "How This Survey Was Made," a few of the mapping units, Eroded loamy land and Oil-waste land, for example, are not part of any soil series, but they are listed in alphabetic order along with the soil series.

The approximate acreage and proportionate extent of each mapping unit are shown in table 1. Many terms used in describing soil series and mapping units are defined in the Glossary, and some are defined in the section "How This Survey Was Made." At the back of this survey is the "Guide to Mapping Units," which lists all the mapping units in the county and shows the capability unit, range site, and windbreak and post-lot group in which each has been placed.

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

Mapping unit	Acres	Percent
Alluvial land	22, 200	4. 3
Bates fine sandy loam, 1 to 3 percent slopes	14, 600	2. 8
Bates fine sandy loam, 3 to 5 percent slopes	7, 740	1. 5
Bates fine sandy loam, 3 to 5 percent slopes, eroded	7, 535	1. 5
Bates-Collinsville fine sandy loams, 1 to 3 percent slopes	1, 580	. 3
Bates-Collinsville fine sandy loams, 3 to 5 percent slopes	9, 950	1. 9
Brazos loamy fine sand	3, 840	. 8
Breaks-Alluvial land complex	13, 100	2. 5
Brewer clay loam, ponded	1, 620	. 3
Collinsville soils, 5 to 8 percent slopes	2, 395	. 5
Dennis loam, 1 to 3 percent slopes	26, 500	4. 9
Dennis loam, 3 to 5 percent slopes	8, 430	1. 6
Dennis loam, 2 to 5 percent slopes, eroded	17, 750	3. 4
Dougherty-Eufaula complex, 8 to 20 percent slopes	4, 820	. 9
Eroded loamy land	15, 075	2. 9
Eufaula fine sand, undulating	2, 380	. 5
Hartsells fine sandy loam, 1 to 3 percent slopes	9, 975	2. 0
Hartsells fine sandy loam, 3 to 5 percent slopes	9, 530	1. 9
Hartsells fine sandy loam, 3 to 5 percent slopes, eroded	12, 184	2. 4
Hartsells-Hector fine sandy loams, 2 to 5 percent slopes	12, 550	2. 4
Hartsells-Hector complex, 2 to 5 percent slopes, eroded	7, 870	1. 5
Hector complex, 5 to 30 percent slopes	148, 000	28. 5
Konawa fine sandy loam, 1 to 3 percent slopes	6, 010	1. 2
Konawa fine sandy loam, 3 to 5 percent slopes	995	. 2
Konawa fine sandy loam, 2 to 5 percent slopes, eroded	5, 355	1. 0
Konawa loamy fine sand, 3 to 8 percent slopes	28, 200	5. 4
Konawa loamy fine sand, 3 to 8 percent slopes, severely eroded	14, 600	2. 8
Ochlockonee fine sandy loam	4, 420	. 9
Oil-waste land	675	. 1
Okemah-Slickspots complex, 1 to 3 percent slopes	8, 650	1. 7
Okemah-Slickspots complex, 1 to 3 percent slopes, eroded	1, 680	. 3
Osage clay	2, 610	. 5
Parsons silt loam, 0 to 1 percent slopes	6, 610	1. 3
Reinach very fine sandy loam	6, 100	1. 2
Rough stony land	7, 420	1. 4
Stidham loamy fine sand, 0 to 2 percent slopes	5, 100	1. 0
Talihina-Collinsville complex, 5 to 20 percent slopes	25, 800	5. 0
Taloka silt loam, 0 to 1 percent slopes	1, 428	. 3
Taloka silt loam, 1 to 3 percent slopes	2, 625	. 5
Vanoss loam, 0 to 1 percent slopes	2, 606	. 5
Vanoss loam, 1 to 3 percent slopes	1, 602	. 3
Verdigris clay loam	7, 790	1. 5
Verdigris silt loam	18, 500	3. 6
Total	518, 400	100. 0

Alluvial Land

Alluvial land (Al) occurs on narrow flood plains and is flooded frequently. The slope range is 0 to 2 percent. This mapping unit is deep and is made up of light-colored and dark-colored, brownish, slightly acid to strongly acid material. The texture ranges chiefly from fine sandy loam to clay loam but is loamy fine sand in minor areas. Most areas are somewhat excessively drained, but some are somewhat poorly drained.

This mapping unit is flooded too frequently to be used for cultivated crops. Most of the acreage is in pasture, a use to which it is well suited. Bermudagrass, native grass, and a mixture of tall fescue and legumes are suitable crops. Pecans also are suitable.

Alluvial land is susceptible to deposition and scouring and is difficult to protect and drain. Fertilization and good pasture management are needed. (Capability unit Vw–1; Loamy Bottomland range site)

Bates Series

The Bates series consists of moderately deep, loamy, well-drained soils. These soils formed under tall grass in material weathered from interbedded acid sandstone and sandy shale. The slope range is 1 to 5 percent. The native vegetation is a mixture of big bluestem, little bluestem, indiangrass, and switchgrass, and a few persimmon trees and sumac bushes.

In a typical profile, the upper part of the surface layer is medium acid, dark-brown fine sandy loam about 12 inches thick. It has granular structure and is very friable when moist. The lower 6 inches of the surface layer is similar, but is light loam in texture. The subsoil is medium acid, brown to yellowish-brown heavy loam to light clay loam. It has subangular blocky structure and is friable when moist and hard when dry. The underlying material is strong-brown loam and contains many small sandstone fragments. Acid sandstone is at a depth of about 38 inches.

Bates soils absorb water well, are moderately permeable, and have moderate water-holding capacity. Water erosion generally is a hazard, and soil blowing is likely late in fall and early in spring. Less than half the acreage of these soils is cultivated.

Following is a description of a typical profile of Bates fine sandy loam, 1 to 3 percent slopes. This profile is in a native pasture about 825 feet east and 300 feet south of the northwest corner of the NE¼ sec. 15, T. 7 N., R. 9 E.

A1—0 to 12 inches, brown (10YR 4/3) fine sandy loam; dark brown (10YR 3/3) when moist; weak, fine, granular structure; slightly hard when dry, very friable when moist; pH 6.0; gradual boundary.

A3—12 to 18 inches, brown (7.5YR 4/3) light loam; dark brown (7.5YR 3/3) when moist; moderate, medium, granular structure; hard when dry, very friable when moist; pH 6.0; gradual boundary.

B2t—18 to 28 inches, brown (7.5YR 5/4) heavy loam; brown (7.5YR 4/4) when moist; prismatic structure breaking to moderate, medium, subangular blocky; hard when dry, friable when moist; pH 5.6; gradual boundary.

C—28 to 38 inches, strong-brown (7.5YR 5/6) loam; about 20 percent small sandstone fragments; pH 6.0; gradual boundary.

R—38 inches +, acid sandstone.

The A horizon ranges from 10 to 20 inches in thickness. When moist, this horizon is dark brown to very dark grayish brown. The texture generally is fine sandy loam but is light loam in small areas. The B horizon ranges from heavy loam to light sandy clay loam or light clay loam in texture and from yellowish brown to brown in color. The depth to the R horizon ranges from 20 to 40 inches.

Bates soils have a less clayey B horizon than Dennis soils and are deeper to bedrock than Collinsville soils, which lack a textural B horizon.

Bates fine sandy loam, 1 to 3 percent slopes (BaB).—This soil is largely in the northern half of the county. It has the profile described as typical for the Bates series. The slopes generally are convex.

A large part of this soil is in cultivation. Peanuts, cotton, small grain, corn, grain sorghum, forage sorghum, and bermudagrass are suitable crops. Both native grasses and tame grasses are suitable for pasture.

This soil is easy to cultivate, but it is susceptible to moderate erosion. Runoff from adjacent uplands is a hazard in some places.

Effective conservation measures include returning crop residue, using a good cropping system, and planting a cover crop after harvest. Peanuts should be followed by a fall-sown crop such as rye or vetch, for protection against soil blowing. (Capability unit IIe-2; Loamy Prairie range site)

Bates fine sandy loam, 3 to 5 percent slopes (BaC).—This soil is largely in the northern half of the county. It has a profile similar to the one described for the Bates series, except that the depth to rock ranges from 24 to 40 inches. The slopes generally are convex.

A fairly large part of this soil is in cultivation. Corn, peanuts, grain sorghum, cotton, small grain, and bermudagrass are suitable crops. Both native grasses and tame grasses are suitable for pasture.

This soil is moderately easy to cultivate, but it is susceptible to severe erosion. Crop residue or green-manure crops are needed for protection during periods of excessive wind or heavy rain. If row crops are grown, this soil needs to be fertilized, terraced, and protected by crop residue and grassed waterways. Terraces are not needed if soil-maintaining crops are grown every year. (Capability unit IIIe-2; Loamy Prairie range site)

Bates fine sandy loam, 3 to 5 percent slopes, eroded (BaC2).—This soil is largely in the northern half of the county. The profile is similar to the one described for the Bates series, but erosion has thinned the surface layer. The slopes generally are convex. In more than half the acreage, the plow layer is made up of a mixture of surface soil and subsoil material. There are shallow gullies 150 to 300 feet apart in some places. Between the gullies the surface layer is less than 8 inches thick.

All of this soil has been cultivated, and part of it is still under cultivation. Grain sorghum, bermudagrass, corn, and small grain are suitable crops that help to protect the soil. Peanuts, cotton, and forage sorghum are also suitable, but they must be followed by a cover crop for erosion control.

This soil is moderately easy to cultivate, but it is susceptible to severe erosion. Fertilizer generally is needed to insure enough crop residue for soil protection. Terraces and good management of crop residue are needed if corn and other row crops are grown. (Capability unit IIIe-6; Loamy Prairie range site)

Bates-Collinsville fine sandy loams, 1 to 3 percent slopes (BcB).—This complex is in the northern half of the county. It is 77 percent Bates fine sandy loam, 20 percent Collinsville fine sandy loam, and 3 percent Talihina soils. The Bates soil has a profile similar to the one described for the series, except that the depth to rock ranges from 20 to 30 inches. The Collinsville soil has a profile similar to the one described for the Collinsville series, but it is not stony and is more than 10 inches deep to rock. A profile of the Talihina soil is described under the Talihina series. The slopes generally are convex.

A small part of this complex is in cultivation. Grain sorghum, wheat, oats, and bermudagrass, which leave enough residue to protect the soils, are the crops best suited. Cotton and peanuts can be grown successfully if followed by a cover crop. Both native grasses and tame grasses are suitable for pasture.

These soils are moderately difficult to cultivate and are susceptible to severe erosion. Management problems include preserving structure, maintaining fertility, checking erosion, and improving the water-holding capacity. Contour farming, terraces, and grassed waterways are effective means of controlling erosion. (Capability unit IIIe-5; Bates soil, Loamy Prairie range site; Collinsville soil, Shallow Prairie range site)

Bates-Collinsville fine sandy loams, 3 to 5 percent slopes (BcC).—This complex is in the northern half of the county. It is 77 percent Bates fine sandy loam, 20 percent Collinsville fine sandy loam, and 3 percent Talihina soils. The Bates soil has a profile similar to the one described for the Bates series, but the depth to rock ranges from 20 to 30 inches. The Collinsville and Talihina soils have profiles similar to the ones described for the respective series. The slopes generally are convex.

Only a small part of this complex is in cultivation. Wheat, oats, bermudagrass, and sericea lespedeza are suitable crops. Both native grasses and tame grasses are suitable for pasture.

These soils are moderately difficult to cultivate and are susceptible to severe erosion. Management problems include preserving structure, maintaining fertility, and checking erosion. Close-growing sown crops generally prevent excessive erosion. Crop residue should be utilized to maintain and protect the soils. Fertilizer generally is needed to insure enough crop residue for soil protection. (Capability unit IVe-3; Bates soil, Loamy Prairie range site; Collinsville soil, Shallow Prairie range site)

Brazos Series

The Brazos series consists of deep, sandy, somewhat excessively drained soils on low terraces along the North Canadian and the South Canadian Rivers. These soils formed under tall grass in sandy alluvium. The slope range is 0 to 1 percent. The native vegetation is a mixture of big bluestem, little bluestem, indiangrass, and switchgrass, and a few cottonwood, sycamore, and cedar trees.

The surface layer in a typical profile is weakly calcareous, dark-brown loamy fine sand that is single grain and very friable when moist. It ranges from 6 to 12 inches in thickness. Beneath the surface layer, in most places, is brown fine sand that is single grain and is loose both when moist and when dry. The average thickness is about 20 inches. The underlying material consists of calcareous sandy sediments.

Brazos soils absorb water very rapidly, are rapidly permeable, and have low water-holding capacity. They are susceptible to soil blowing. Only a small acreage is cultivated.

Following is a description of a typical profile of Brazos loamy fine sand (0 to 1 percent slopes). This profile is in an abandoned field 700 feet east and 650 feet north of the southwest corner of sec. 10, T. 6 N., R. 9 E.

A1—0 to 8 inches, brown (7.5YR 5/3) loamy fine sand; dark brown (7.5YR 3/3) when moist; single grain; loose when dry, very friable when moist; pH 8.4; calcareous; gradual boundary.

AC—8 to 28 inches, light-brown (7.5YR 6/4) fine sand; brown (7.5YR 5/4) when moist; single grain; loose when dry, loose when moist; noncalcareous; pH 8.0; gradual boundary.

C—28 to 67 inches, pink (7.5YR 7/4) stratified fine sand; light brown (7.5YR 6/4) when moist; single grain; loose when dry, loose when moist; calcareous; pH 8.4.

The A horizon ranges from 6 to 12 inches in thickness and, when dry, from brown to grayish brown in color. This horizon is weakly calcareous in most places but is noncalcareous or mildly alkaline in some. The AC horizon is stratified loamy fine sand and fine sand. If the strata are mixed, the texture is fine sand. This horizon ranges from mildly alkaline to moderately alkaline and from noncalcareous to weakly calcareous. The C horizon is somewhat variable in texture but is fine sand in most places.

Brazos soils are sandier in the uppermost 24 inches than Reinach soils and are sandier throughout than Brewer soils.

Brazos loamy fine sand (0 to 1 percent slopes) (Bf).—This soil is along the North Canadian and the South Canadian Rivers. Its profile is the one described as typical for the series. Most areas are nearly level, but a few are undulating.

A small part of this soil is cultivated. Grain sorghum, forage sorghum, peanuts, cotton, and bermudagrass are suitable crops. Both native tall grasses and tame grasses are suitable for pasture.

This soil is moderately easy to cultivate, and it is moderately susceptible to soil blowing. Poor tilth and low water-holding capacity severely limit use. If little residue remains after crops are harvested, cover crops, such as rye or vetch and rye, are needed for protection late in winter and in spring. Fertilization also is needed. (Capability unit IIIs-1; Sandy Bottomland range site)

Breaks-Alluvial Land Complex

Breaks-Alluvial land complex (Bk) occurs on the sides and floors of drainageways on the prairies. The slope range is 0 to 20 percent. The areas range from 75 to 400 feet in width but ordinarily are between 150 feet and 300 feet wide.

This land type is made up of shallow to deep soils that generally have a loamy surface layer and a loamy or clayey subsoil. Some areas are stony.

All of this land type is suitable for native pasture, and the areas of deeper soils are suitable for tame bermudagrass pasture. Bermudagrass withstands flooding and provides protection against erosion.

The erosion hazard is a severe limitation on the Breaks, and frequent flooding is a severe limitation on Alluvial land. A protective cover of vegetation should be maintained. Fertilization and good general pasture management are needed. (Capability unit VIe-4; Breaks, Loamy Prairie range site; Alluvial land, Loamy Bottomland range site)

Brewer Series

The Brewer series consists of deep, loamy, moderately well drained soils on terraces along the North Canadian and South Canadian Rivers. The slope range is 0 to 1 percent. These soils formed in loamy alluvium under tall grass. The native vegetation is made up of big bluestem, little bluestem, indiangrass, and switchgrass; cottonwood, sycamore, and pecan trees; and a few hawthorn bushes.

In a typical profile, the surface layer is slightly acid, very dark brown clay loam that has granular structure and is friable when moist. It is about 14 inches thick. The subsoil, to a depth of about 40 inches, is medium acid or slightly acid, very dark brown to black clay loam. It has subangular blocky structure and is firm when moist and very hard when dry. This layer grades to mottled sandy clay loam. The underlying material consists of calcareous sediments.

Brewer soils are slowly permeable and have high water-holding capacity. Water erosion is not a hazard, but runoff from adjacent hills causes ponding in some areas. Most of the acreage of these soils is cultivated.

Following is a description of a typical profile of Brewer clay loam, ponded (0 to 1 percent slopes). This profile is in a cultivated field 620 feet south and 240 feet east of the northwest corner of the NE¼ sec. 6, T. 6 N., R. 9 E.

A1—0 to 14 inches, dark grayish-brown (10YR 4/2) light clay loam; very dark brown (10YR 2/2) when moist;

moderate, medium, granular structure; hard when dry, friable when moist; pH 6.5; gradual boundary.

B21t—14 to 24 inches, very dark gray (10YR 3/1) heavy clay loam; black (10YR 2/1) when moist; moderate, medium, subangular blocky structure; very hard when dry, firm when moist; pH 6.5; gradual boundary.

B22t—24 to 40 inches, very dark grayish-brown (10YR 3/2) heavy clay loam; very dark brown (10YR 2/2) when moist; common, fine, distinct, strong-brown mottles; moderate, coarse, subangular blocky structure; very hard when dry, firm when moist; pH 6.0; diffuse boundary.

B3—40 to 56 inches +, mottled yellowish-red (5YR 5/6) and dark grayish-brown (10YR 4/2) sandy clay loam; weak, medium, subangular blocky structure; hard when dry, firm when moist; pH 6.0.

The A horizon ranges from 8 to 20 inches in thickness. When dry, this horizon is grayish brown to brown or dark brown and very dark grayish brown, in hues of 10YR and 7.5YR. The B horizon ranges from heavy clay loam to light clay in texture. When dry, this layer ranges from very dark gray to brown and dark brown, in hues of 10YR and 7.5YR. The depth to material redder than 7.5YR ranges from 20 to 75 inches, and the depth to material coarser than fine sandy loam is greater than 40 inches. Distinct mottles occur between depths of 20 to 30 inches.

Brewer soils are more clayey than Reinach and Brazos soils.

Brewer clay loam, ponded (0 to 1 percent slopes) (Bp).—This soil is on bottom lands of the North Canadian and the South Canadian Rivers. Its profile is the one described as typical for the Brewer series.

A large part of this soil is in cultivation. Corn, forage sorghum, grain sorghum, cotton, oats, pecans, alfalfa, fescue, and bermudagrass are suitable crops. Both native grasses and tame grasses are suitable for pasture.

This soil is moderately difficult to cultivate. It is flooded occasionally. In some areas diversion terraces or dikes are needed to intercept runoff from adjacent uplands. Surface drainage is needed in fields used for row crops. (Capability unit IIw–1; Heavy Bottomland range site)

Collinsville Series

The Collinsville series consists of very shallow and shallow, stony, loamy, well-drained soils on prairie uplands. These soils formed under tall grass in material weathered from acid sandstone. The slope range is 1 to 8 percent. The native vegetation is a mixture of big bluestem, little bluestem, indiangrass, and switchgrass, and a few sumac bushes.

The surface layer in a typical profile is medium acid, dark-brown fine sandy loam that has granular structure and is very friable when moist. It ranges from 4 to 20 inches in thickness. The underlying material is soft, fractured sandstone.

Collinsville soils have moderately rapid permeability and limited capacity for absorbing and holding water. Only a small acreage of these soils is cultivated.

Following is a description of a typical profile of a Collinsville fine sandy loam that has a slope range of 5 to 8 percent. This profile is in a native pasture 850 feet west and 75 feet north of the southeast corner of sec. 10, T. 7 N., R. 9 E.

A1—0 to 9 inches, grayish-brown (10YR 5/2) fine sandy loam; dark brown (10YR 3/3) when moist; weak, fine, granular structure; a few sandstone fragments less than 1 inch in diameter; soft when dry, very friable when moist; pH 6.0; gradual, wavy boundary.

R—9 inches +, yellowish-brown (10YR 5/6), soft, fractured sandstone; yellowish brown (10YR 5/6) when moist; few, distinct, brown mottles; pH 6.5.

The texture of the A horizon ranges from stony sandy loam to fine sandy loam and light loam. When moist, this horizon ranges from dark brown to very dark brown in color. The depth to sandstone ranges from 4 to 20 inches.

Collinsville soils lack a B horizon and are less deep to sandstone than Bates soils. They are sandier throughout than Talihina soils.

Collinsville soils, 5 to 8 percent slopes (CoD).—These soils generally are in the northern half of the county. They have a profile similar to the one described for the Collinsville series. The texture of the surface layer ranges from stony sandy loam to fine sandy loam and light loam.

These soils are not suitable for cultivation, because of stones, limited water-holding capacity, and other adverse features. All of the acreage is in native range and pasture. (Capability unit VIIs–4; Shallow Prairie range site)

Dennis Series

The Dennis series consists of deep, loamy, moderately well drained soils. These soils developed under tall grass in material weathered from shale and clay. The slope range is 1 to 5 percent. The native vegetation is a mixture of big bluestem, little bluestem, indiangrass, and switchgrass.

In a typical profile, the surface layer is medium acid, very dark grayish-brown loam that has granular structure and is friable when moist (fig. 5). It is about 12 inches thick. The upper 16 inches of the subsoil is medium acid to neutral, dark grayish-brown to dark yellowish-brown clay loam that has blocky structure and is firm or very firm when moist and hard or very hard when dry. The lower part of the subsoil is yellowish-brown light clay that is moderately alkaline or mildly alkaline and has blocky structure. Below a depth of 60 inches is yellowish-brown, massive, moderately alkaline clay.

Dennis soils absorb water fairly well, are slowly permeable, and have high water-holding capacity. They are slightly susceptible to water erosion. Nearly all of the acreage is cultivated.

Following is a description of a typical profile of Dennis loam, 1 to 3 percent slopes. This profile is in a cultivated field 1,000 feet south and 900 feet east of the northwest corner of sec. 30, T. 8 N., R. 9 E.

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) loam; very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; hard when dry, friable when moist; pH 6.0; clear boundary.

A1—8 to 12 inches, dark grayish-brown (10YR 4/2) heavy loam; very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; pH 6.0; gradual boundary.

B1—12 to 19 inches, grayish-brown (10YR 5/2) clay loam; dark grayish brown (10YR 4/2) when moist; weak, coarse, subangular blocky structure breaking to moderate, medium, granular; common, distinct, yellowish-red and reddish-brown mottles; about 1 percent iron concretions; hard when dry, firm when moist; pH 6.3; clear boundary.

B21t—19 to 28 inches, light yellowish-brown (10YR 6/4) heavy clay loam; dark yellowish brown (10YR 4/4) when moist; moderate, coarse, blocky structure; common, medium, distinct, yellowish-red mottles; about 1 percent iron concretions; very hard when dry, firm when moist; pH 6.7; gradual boundary.

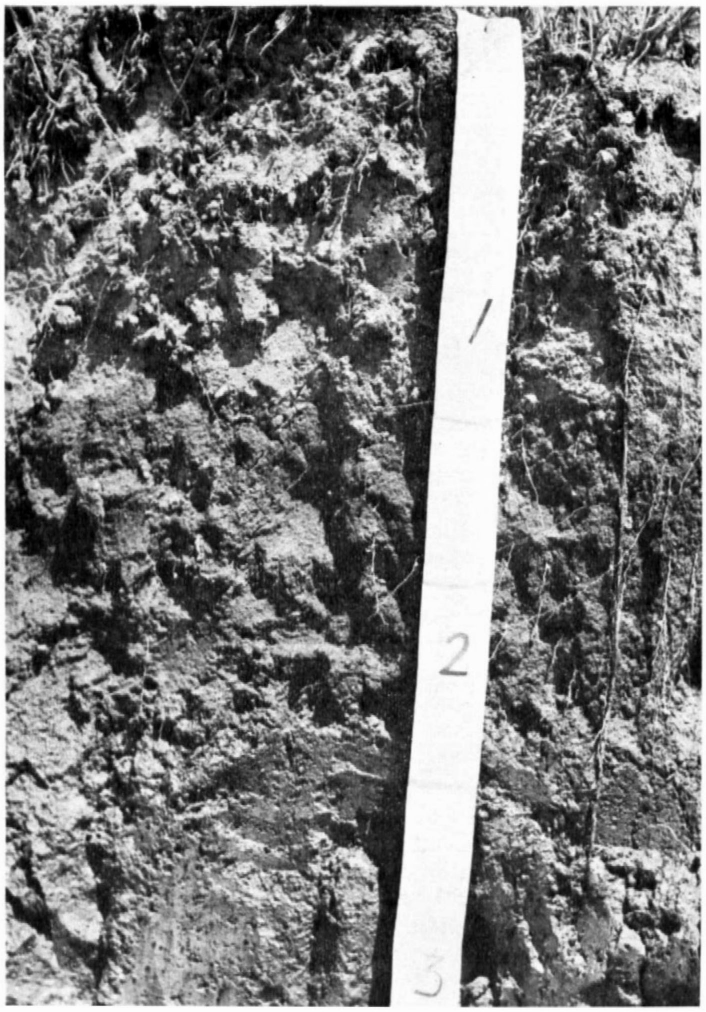

Figure 5.—Profile of Dennis loam.

B22t—28 to 42 inches, pale-brown (10YR 6/3) light clay; yellowish brown (10YR 5/4) when moist; moderate, coarse, blocky structure; common, coarse, faint, yellowish-brown mottles; less than 1 percent iron concretions; very hard when dry, very firm when moist; pH 7.5; gradual boundary.

B23t—42 to 60 inches, light yellowish-brown (10YR 6/4) light clay; yellowish brown (10YR 5/4) when moist; weak, coarse, blocky structure; common, coarse, faint, brown mottles; vertical faces of peds somewhat discolored by silt from the A horizon; very hard when dry, very firm when moist; pH 8.0; gradual boundary.

C—60 to 63 inches +, brownish-yellow (10YR 6/6) light clay; yellowish brown (10YR 5/6) when moist; massive; common, coarse, faint, yellowish-brown mottles; very hard when dry, very firm when moist; pH 8.0.

The A horizon is loam in most places but is silt loam in small areas. The thickness ranges from 10 to 15 inches and ordinarily is about 12 inches. When dry, this horizon ranges from grayish brown to dark grayish brown and brown. The clay content of the B horizon increases with increasing depth. Generally, the layer in which the clay content is greatest has a light clay texture, but in some minor places it has a heavy clay loam texture. The mottles vary in size, color, and amount. The reaction ranges from medium acid to moderately alkaline. Weathered shale and clay occur below a depth of 60 inches.

Dennis soils have a less dense and less clayey B horizon than Parsons soils and a more clayey B horizon than Bates soils.

Dennis loam, 1 to 3 percent slopes (DnB).—This soil is on prairies throughout the county. It has the profile described as typical for the Dennis series.

A large part of this soil is cultivated. Wheat, oats, and barley are the most suitable crops, and corn, peanuts, grain sorghum, sweet sorghum, alfalfa, cotton, and bermudagrass can be grown successfully. Both native grasses and tame grasses are suitable for pasture.

This soil is easy to cultivate, but it is susceptible to moderate erosion (fig. 6). Adequate crop residue should be left for soil improvement. Wheat can be grown each year if the residue is well managed. Diversion terraces and waterways are needed in some places. (Capability unit IIe-3; Loamy Prairie range site)

Figure 6.—Terracing and contour farming on Dennis loam, 1 to 3 percent slopes.

Dennis loam, 3 to 5 percent slopes (DnC).—This soil occurs throughout the county. It has a profile similar to the one described for the Dennis series, but the surface layer ranges from 8 to 13 inches in thickness.

A large part of this soil is cultivated. Corn, peanuts, grain sorghum, cotton, small grain, and bermudagrass are suitable crops. Alfalfa is less well suited. Both native grasses and tame grasses are suitable for pasture.

This soil is moderately easy to cultivate, but it is susceptible to severe erosion. If used for crops, it needs to be protected by terraces, grassed waterways, and crop residue or green-manure crops. Terraces are not needed if high-residue crops are grown every year. (Capability unit IIIe-2; Loamy Prairie range site)

Dennis loam, 2 to 5 percent slopes, eroded (DnC2).—This soil occurs on prairies throughout the county. The profile is similar to the one described for the Dennis series, but erosion has thinned the surface layer. In more than half the acreage, the plow layer is made up of a mixture of surface soil and subsoil material. There are shallow gullies 50 to 300 feet apart in some places. Between the gullies the surface layer is less than 8 inches thick.

A large part of this soil is cultivated. Grain sorghum, small grain, corn, and bermudagrass are suitable crops that help to protect the soil. Peanuts, cotton, and forage sorghum also are suitable, but they must be followed by a cover crop for erosion control.

This soil is moderately easy to cultivate, but it is susceptible to severe erosion. Fertilizer generally is needed to insure enough crop residue for soil protection. Terracing and good management of crop residue are needed if corn or other row crops are grown. Terracing is not necessary in areas used for bermudagrass pasture. (Capability unit IIIe-6; Loamy Prairie range site)

Dougherty Series

The Dougherty series consists of deep, sandy, well-drained soils along the North Canadian and the South Canadian Rivers. These soils formed in old alluvium. The slope range is 8 to 20 percent. The native vegetation is made up of blackjack oak, post oak, and hickory trees and an understory of tall grasses, including big bluestem, little bluestem, indiangrass, and switchgrass.

In a typical profile the surface layer is very pale brown loamy fine sand that is very friable when moist and loose when dry. It ranges from 20 to 36 inches in thickness. The subsoil is red or yellowish-red, medium acid to strongly acid sandy clay loam to heavy sandy loam of subangular blocky structure. The underlying material is old alluvium.

Dougherty soils absorb water well, are moderately permeable, and have moderately high water-holding capacity. If used as range, they are not likely to erode. None of the acreage is cultivated.

Dougherty soils in this county are mapped only in a complex with Eufaula soils.

Following is a description of a typical profile of a Dougherty loamy fine sand that has a slope range of 8 to 20 percent. This profile is 1,300 feet west and 150 feet north of the southeast corner of sec. 8, T. 6 N., R. 11 E.

A1—0 to 5 inches, very pale brown (10YR 7/3) loamy fine sand; brown (10YR 5/3) when moist; single grain; loose when dry, very friable when moist; pH 6.5; gradual boundary.

A2—5 to 24 inches, very pale brown (10YR 8/4) loamy fine sand; light yellowish brown (10YR 6/4) when moist; single grain; loose when dry, very friable when moist; pH 6.0; abrupt, wavy boundary.

B2t—24 to 37 inches, red (2.5YR 5/6) sandy clay loam; red (2.5YR 4/6) when moist; weak, medium and coarse, subangular blocky structure; hard when dry, friable when moist; pH 5.5; gradual, wavy boundary.

B3—37 to 50 inches, yellowish-red (5YR 5/8) light sandy clay loam; yellowish red (5YR 4/8) when moist; weak, medium, subangular blocky structure; slightly hard when dry, friable when moist; pH 6.0; gradual boundary.

C—50 to 65 inches, yellowish-red (5YR 5/8) loamy fine sand; massive; soft when dry, very friable when moist; pH 6.0.

The texture of the A horizon ranges from loamy fine sand to fine sand, and the thickness ranges from 20 to 36 inches. When these soils are dry, the color of the A1 horizon ranges from very pale brown to grayish brown, and that of the A2 horizon from very pale brown to pale brown and light yellowish brown. The B2t horizon, when dry, ranges from red to reddish brown, yellowish red, and reddish yellow in color. It is medium acid to strongly acid in reaction. The clay content of the B2t horizon ranges from 18 to 30 percent.

The B2t horizon of Dougherty soils contains more clay than that of Eufaula soils and is more red than that of Stidham soils.

Dougherty-Eufaula complex, 8 to 20 percent slopes (DtE).—This complex is from 50 to 75 percent Dougherty loamy fine sand and from 15 to 25 percent Eufaula fine sand. The Dougherty soil has the profile just described. The Eufaula soil has a profile similar to the one described for the Eufaula series.

The soils are not suited to cultivation. If cleared of their native vegetation, they would be subject to severe erosion. They are better suited to native pasture, tame pasture, wildlife habitat, and recreation uses than to crops. Tame pastures need to be fertilized and protected from overgrazing. (Capability unit VIe-5; Deep Sand Savannah range site)

Eroded Loamy Land

Eroded loamy land (Er) occurs on the prairies. The slope range is 2 to 8 percent, and the soil material is deep to shallow. The upper part consists of brownish, slightly acid to strongly acid loam to fine sandy loam, and the lower part of heavy loam to light clay. Because of erosion, these materials have been mixed in about 40 percent of the acreage. Rock outcrops are common. There are gullies 50 to 300 feet apart; some of them cannot be crossed with farm machines.

This mapping unit is not used for cultivated crops. Suitable uses are native pasture, tame pasture, and wildlife habitat.

Eroded loamy land is susceptible to severe erosion. If it is used for pasture, fertilization and good pasture management are needed. (Capability unit VIe-3; Eroded Prairie range site)

Eufaula Series

The Eufaula series consists of deep, sandy, somewhat excessively drained soils on uplands along the North Canadian and the South Canadian Rivers. These soils formed in old alluvium under oaks and tall grasses. The slope range is 0 to 20 percent. The native vegetation is made up of blackjack oak, post oak, hickory, and a sparse stand of big bluestem, little bluestem, indiangrass, and switchgrass.

The surface layer in a typical profile is medium acid to strongly acid fine sand that is single grain and loose when moist. It is about 44 inches thick and is brown in the uppermost 8 inches and light yellowish brown below. The subsoil consists of about 31 inches of strongly acid, strong-brown fine sand that is single grain and is very friable when moist and soft when dry. The underlying material consists of alluvial sediments.

Eufaula soils absorb water very rapidly, are rapidly permeable, and have low water-holding capacity. Water erosion is not a hazard, but soil blowing is likely. Maintaining the organic-matter content is difficult. Only a small acreage of these soils is cultivated.

Following is a description of a typical profile of Eufaula fine sand. This profile is in a cultivated field 835 feet south and 40 feet west of the northeast corner of the NW¼ sec. 12, T. 9 N., R. 10 E.

A1—0 to 8 inches, pale-brown (10YR 6/3) fine sand; brown (10YR 5/3) when moist; single grain; loose both when dry and when moist; pH 6.0; gradual boundary.

A2—8 to 44 inches, very pale brown (10YR 7/3) fine sand; light yellowish brown (10YR 6/4) when moist; single grain; loose both when dry and when moist; pH 5.5; gradual boundary.

B2t—44 to 75 inches, reddish-yellow (7.5YR 6/6) fine sand; strong brown (7.5YR 5/6) when moist; single grain; soft when dry, very friable when moist; strong-brown horizontal bands of loamy fine sand, about 1/16 to ¼ inch thick and 4 to 8 inches apart; pH 5.1.

The A horizon ranges from 36 to 50 inches in thickness and, when moist, from brown to pale brown in color. The texture of the A1 horizon is loamy fine sand in small areas. The B horizon ranges from fine sand to loamy fine sand in texture and from medium acid to strongly acid in reaction.

Eufaula soils have a thicker surface layer and a less well developed B horizon than Dougherty, Konawa, and Stidham soils.

Eufaula fine sand, undulating (0 to 3 percent slopes) (EuB).—This soil is on uplands along the North Canadian and the South Canadian Rivers. It has the profile described as typical for the Eufaula series.

Only a small part of this soil is in cultivation. Peanuts, grain sorghum, cotton, and bermudagrass are suitable crops. Bermudagrass is the principal crop, but rye either alone or seeded with vetch also is suitable for pasture. Sudangrass provides suitable temporary pasture.

This soil is difficult to cultivate and is susceptible to severe soil blowing. Low water-holding capacity and poor tilth are severe limitations. Crop residue is needed for protection if annual crops are grown. All crops generally need to be fertilized. (Capability unit IVs–1; Deep Sand Savannah range site)

Hartsells Series

The Hartsells series consists of moderately deep, loamy, well-drained soils. These soils formed under oaks and tall grass in material weathered from acid sandstone. The slope range is 1 to 5 percent. The native vegetation is made up of blackjack oak, post oak, and hickory trees, and big bluestem, little bluestem, indiangrass, and switchgrass.

In a typical profile, the surface layer is medium acid to slightly acid fine sandy loam that has granular structure and is very friable when moist (fig. 7). It is about 15 inches thick and is dark grayish brown in the upper part and yellowish brown in the lower part. The subsoil is brownish-yellow sandy clay loam that is mottled in the lower part. It is about 26 inches thick. It has granular to subangular blocky structure, is friable when moist and hard when dry, and is very strongly acid. The underlying material is yellow and red, loosely cemented, acid sandstone.

Hartsells soils absorb water well, are moderately permeable, and have moderate water-holding capacity. Water erosion generally is a hazard, and soil blowing is likely late in fall and early in spring. About half the acreage of these soils is cultivated.

Following is a description of a typical profile of Hartsells fine sandy loam, 1 to 3 percent slopes. This profile is in a wooded pasture 500 feet west and 480 feet south of the center of sec. 24, T. 9 N., R. 11 E.

A1—0 to 8 inches, grayish-brown (10YR 5/2) fine sandy loam; dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; slightly hard when dry, very friable when moist; pH 6.2; clear boundary.

A2—8 to 15 inches, light yellowish-brown (10YR 6/4) fine sandy loam; yellowish brown (10YR 5/4) when moist; weak, fine, granular structure; few, fine, faint, gray mottles; slightly hard when dry, very friable when moist; pH 6.0; clear boundary.

B21t—15 to 23 inches, yellow (10YR 7/6) light sandy clay loam; brownish yellow (10YR 6/6) when moist; weak, medium and coarse, granular structure; common, medium, distinct, reddish-yellow and reddish-brown mottles; slightly hard when dry, friable when moist; pH 4.7; gradual boundary.

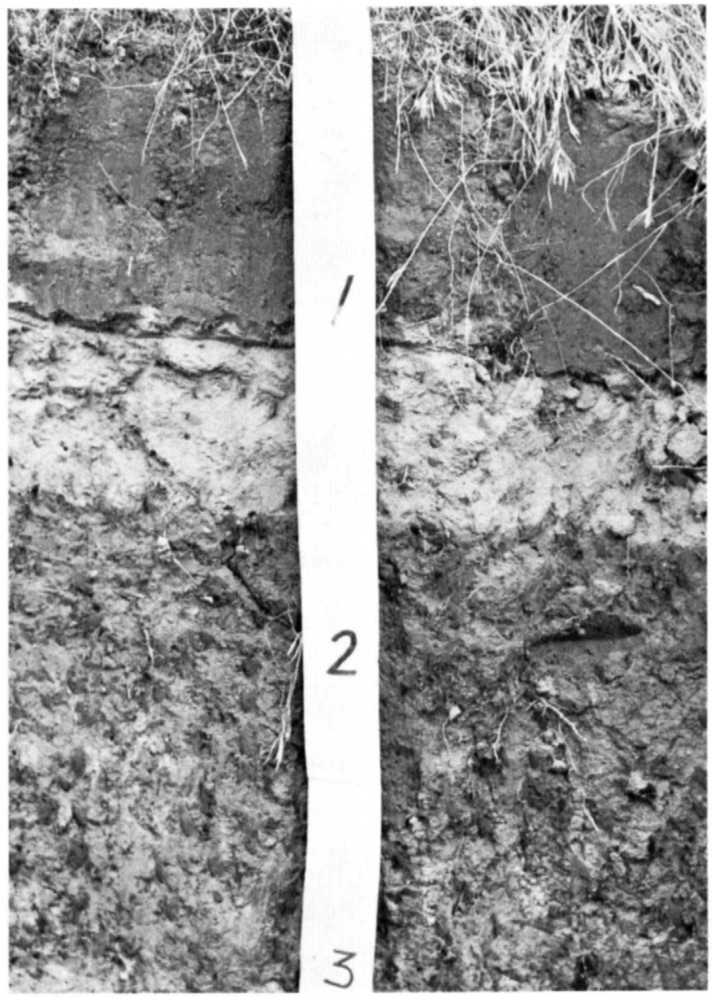

Figure 7.—**Profile of a Hartsells fine sandy loam showing good root development.**

B22t—23 to 31 inches, yellow (10YR 7/6) sandy clay loam, grading to clay loam; brownish yellow (10YR 6/8) when moist; weak, medium, subangular blocky structure; many fine, faint, gray and brown mottles; a few sandstone fragments less than ½ inch in diameter; very hard when dry, friable when moist; pH 4.5; clear boundary.

B3—31 to 41 inches, mottled red, yellowish-red, and light-gray sandy clay loam; weak, medium, subangular blocky structure; sandstone fragments less than ½ inch in diameter increase in number with depth; very hard when dry, friable when moist; pH 4.5; gradual boundary.

R—41 to 50 inches, yellow and red, loosely cemented acid sandstone.

The A horizon ranges from 5 to 18 inches in thickness but ordinarily is about 15 inches thick. When dry, this horizon ranges from grayish brown to brown and pale brown. The B horizon generally is yellow when dry, but it is brownish in small areas. It ranges from strongly acid to very strongly acid. The depth to bedrock ranges from 20 to 50 inches but commonly is about 41 inches.

Hartsells soils are better developed than Hector soils and are deeper to sandstone. Hartsells soils have a lighter colored A1 horizon than Bates soils, which lack an A2 horizon but have an A3 horizon.

Hartsells fine sandy loam, 1 to 3 percent slopes (HaB).—This soil has the profile described as representative of the series.

A large part of this soil is in cultivation. Peanuts, grain sorghum, forage sorghum, cotton, small grain, corn, bermudagrass, and vetch are suitable crops. Both native grasses and tame grasses are suitable for pasture.

This soil is easy to cultivate, but it is susceptible to moderate erosion. Runoff from adjacent uplands is a hazard in some places. Crop residue or cover crops are needed late in winter and early in spring to help prevent soil blowing and water erosion. Fertilization also is beneficial, and is especially needed in fields used for corn. (Capability unit IIe–1; Sandy Savannah range site)

Hartsells fine sandy loam, 3 to 5 percent slopes (HaC).—This soil has a profile similar to the one described for the Hartsells series.

A large part of this soil is in cultivation. Peanuts, cotton, vetch, small grain, corn, grain sorghum, forage sorghum, and bermudagrass are suitable crops. Both native grasses and tame grasses are suitable for pasture.

This soil is moderately easy to cultivate, but it is susceptible to severe erosion. Row crops should be planted on the contour and in alternate strips with sown crops. Terraces and contour farming are not needed if close-growing, soil-improving crops are grown every year. Adequate crop residue should be utilized to protect the soil. Cover crops help to control erosion during March, April, and May. Fertilization is beneficial. (Capability unit IIIe–3; Sandy Savannah range site)

Hartsells fine sandy loam, 3 to 5 percent slopes, eroded (HaC2).—This soil has a profile similar to the one described for the Hartsells series, but erosion has thinned the surface layer. In about half the acreage, the plow layer is made up of a mixture of surface soil and subsoil material. There are shallow gullies and rills 50 to 300 feet apart in some places. Between the gullies the surface layer is about 8 inches thick.

All of this soil has been cultivated, and part of it is still under cultivation. Corn, peanuts, grain sorghum, forage sorghum, cotton, oats, rye, and bermudagrass are suitable crops.

This soil is moderately easy to cultivate, but it is susceptible to severe erosion (fig. 8). Crop residue and cover crops are effective means of maintaining the soil and protecting it from erosion. Protection is especially needed during windy periods. Fertilization is beneficial. (Capability unit IIIe–7; Sandy Savannah range site)

***Figure 8.*—An area of Hartsells fine sandy loam, 3 to 5 percent slopes, eroded. Water erosion has removed part of the surface layer.**

Hartsells-Hector fine sandy loams, 2 to 5 percent slopes (HhC).—This complex is 75 percent Hartsells soil and 25 percent Hector soil. The Hartsells soil has a profile similar to the one described as representative of the series, but it is not so thick. The surface layer is 7 to 12 inches thick, and the depth to sandstone ranges from 20 to 28 inches. The Hector soil has a profile similar to the one described under the Hector series.

Only a small part of this complex is cultivated. Peanuts, grain sorghum, small grain, cotton, sudangrass, and bermudagrass are suitable crops. Both native grasses and a mixture of bermudagrass and legumes are suitable for pasture. Vetch is suitable for temporary pasture.

These soils are moderately easy to cultivate, but they are susceptible to severe erosion. If annual crops are grown, intensive management is needed to protect the soils from soil blowing and water erosion. Management should include the use of crop residue and cover crops from late in winter through summer. (Capability unit IVe–4; Hartsells soil, Sandy Savannah range site; Hector soil, Shallow Savannah range site)

Hartsells-Hector complex, 2 to 5 percent slopes, eroded (HsC2).—This complex is 75 percent Hartsells soil and 25 percent Hector soil. These soils have profiles similar to those described as typical of the series, but erosion has thinned the surface layer. This layer is 5 to 8 inches thick. There are gullies 1 to 3 feet deep 90 to 250 feet apart. About 1 percent of the acreage consists of exposed rock.

These soils are susceptible to severe erosion. They are not suitable for cultivation and are used for tame pasture, native pasture, wildlife habitat, and recreation. A mixture of bermudagrass and legumes is good for pasture. Fertilization is beneficial. (Capability unit VIe–2; Hartsells soil, Sandy Savannah range site; Hector soil, Shallow Savannah range site)

Hector Series

The Hector series consists of shallow and very shallow, stony, loamy, somewhat excessively drained soils. These soils formed under oaks and tall grass in material weathered from acid sandstone and shale. The slope range is 5 to 30 percent. The native vegetation is made up of blackjack oak, post oak, and hickory trees, and big bluestem, little bluestem, indiangrass, and switchgrass.

The surface layer in a typical profile is strongly acid to very strongly acid, dark grayish-brown and brown gravelly fine sandy loam that has granular structure and is very friable when moist (fig. 9). At a depth of about 11 inches is brownish, acid, fractured sandstone.

Hector soils have rapid permeability and limited water-absorbing and water-holding capacity. The entire acreage is used as range.

Following is a description of a typical profile of Hector fine sandy loam, 5 to 30 percent slopes. This profile is in a wooded pasture 2,350 feet south and 240 feet west of the northeast corner of sec. 1, T. 5 N., R. 11 E.

A1—0 to 3 inches, light brownish-gray (10YR 6/2) fine sandy loam; dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; 40 percent gravel; slightly hard when dry, very friable when moist; pH 5.0; clear boundary.

Figure 9.—**Profile of a Hector fine sandy loam. The underlying material is sandstone.**

A2—3 to 11 inches, pale-brown (10YR 6/3) fine sandy loam; brown (10YR 4/3) when moist; weak, fine, granular structure; 40 percent gravel; slightly hard when dry, very friable when moist; pH 5.5; abrupt, wavy boundary.

R—11 to 26 inches, yellowish-brown and strong-brown fractured, acid sandstone; less than 5 percent very pale brown fine sandy loam on faces of rock fractures; pH 5.5.

The A horizon ranges from 4 to 20 inches in thickness and from fine sandy loam to stony sandy loam in texture. When dry, this horizon is light brownish gray to pale brown. The thickness of the R horizon ranges from 4 inches to several feet.

Hector soils have a less well developed profile than Hartsells soils and are shallower to bedrock.

Hector complex, 5 to 30 percent slopes (HtE).—Except for being stony, the Hector soil in this complex has a profile similar to the one described for the series.

The complex is 50 percent stony Hector soils; 35 percent soils that have a reddish-brown to olive-brown, clayey subsoil and are 24 to 75 inches deep to shale; 10 percent soils that are 6 to 24 inches deep to shale; and 5 percent stony Hartsells soils.

These soils are not suitable for cultivation, because they are stony and have low water-holding capacity and other severe limitations. They are used for native pasture. (Capability unit VIIs–2; Shallow Savannah range site)

Konawa Series

The Konawa series consists of deep, sandy and loamy, well-drained soils. These soils formed in old alluvium under oaks and tall grass. The slope range is 1 to 8 percent. The native vegetation is made up of blackjack oak, post oak, and hickory trees, and big bluestem, little bluestem, indiangrass, and switchgrass.

In a typical profile, the surface layer is medium acid to strongly acid, brown loamy fine sand that has granular structure (fig. 10). It is about 8 inches thick. The subsurface layer is light yellowish-brown loamy fine sand about 8 inches thick. The subsoil, about 32 inches thick, is medium acid to very strongly acid, yellowish-red sandy clay loam grading to loamy sand. It has subangular blocky structure in most places and is friable when moist and hard when dry. The underlying material is old alluvium from the North Canadian and the South Canadian Rivers.

Konawa soils absorb water well to fairly well, are moderately permeable, and have high to moderately high water-holding capacity. Water erosion is a major hazard, and soil blowing is likely. Maintaining the organic-matter content is a problem. Most of the acreage of Konawa fine sandy loam is cultivated, and about half the acreage of Konawa loamy fine sand.

Following is a description of a typical profile of Konawa loamy fine sand, 3 to 8 percent slopes. This profile is in a cultivated field 425 feet south and 250 feet west of the northeast corner of the SE¼ of sec. 19, T. 6 N., R. 11 E.

Ap—0 to 8 inches, very pale brown (10YR 7/3) loamy fine sand; brown (10YR 5/3) when moist; weak, fine, granular structure; loose both when dry and when moist; pH 6.0; gradual boundary.

A2—8 to 16 inches, very pale brown (10YR 8/3) loamy fine sand; light yellowish brown (10YR 6/4) when moist; single grain; loose both when dry and when moist; pH 6.0; abrupt boundary.

B2t—16 to 36 inches, yellowish-red (5YR 5/8) sandy clay loam; yellowish red (5YR 4/8) when moist; mod-

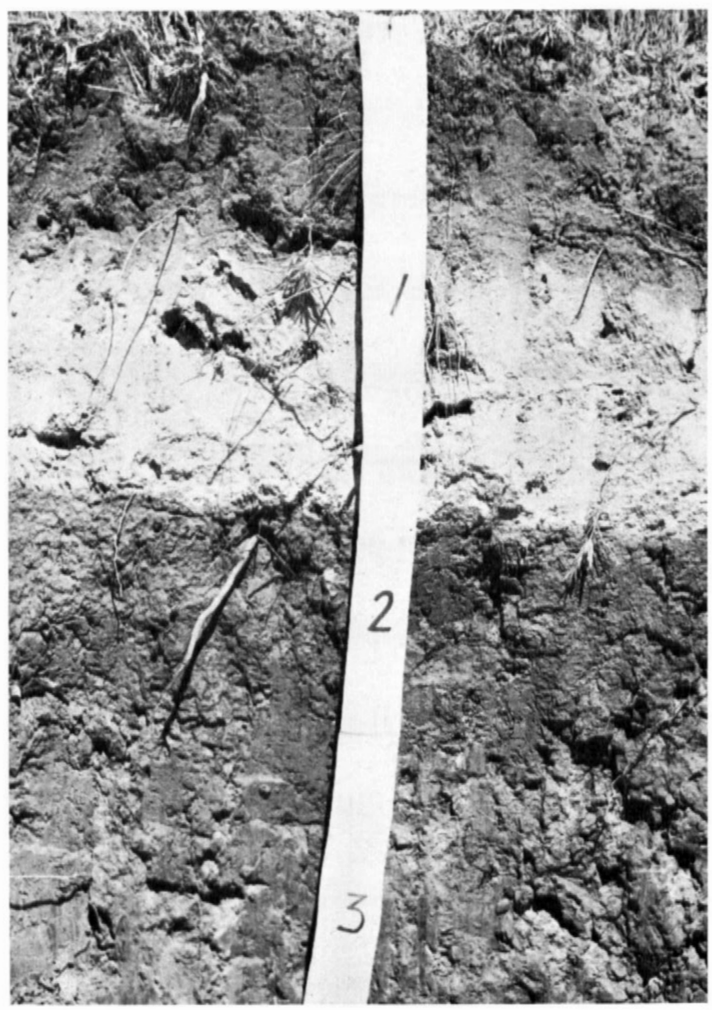

Figure 10.—**Profile of a Konawa loamy fine sand showing a light-colored A2 horizon about 14 inches thick.**

erate, medium and coarse, subangular blocky structure; hard when dry, friable when moist; pH 5.0; gradual boundary.

B3—36 to 48 inches, reddish-yellow (5YR 6/6) loamy sand, yellowish red (5YR 5/6) when moist; weak, medium, subangular blocky structure; slightly hard when dry, very friable when moist; pH 4.8; gradual boundary.

C—48 to 72 inches, reddish-yellow (5YR 7/6) fine sand, yellowish red (5YR 5/6) when moist; massive; loose both when dry and when moist; red horizontal bands of loamy fine sand, ½ inch thick and 2 to 8 inches apart; pH 5.5.

The A horizon ranges from 6 to 20 inches in thickness and, when dry, from very pale brown to pale brown in color. The B horizon ranges from sandy clay loam to loamy sand. In the upper 20 inches of this horizon, the average clay content is greater than 18 percent.

Konawa soils have a lighter colored A horizon than Vanoss soils and a redder B horizon than Vanoss and Stidham soils.

Konawa fine sandy loam, 1 to 3 percent slopes (KoB).—This soil is on uplands along the North Canadian and the South Canadian Rivers. Except for the texture of the surface layer, the profile is similar to the one described for the Konawa series.

A large part of this soil is in cultivation. Peanuts, grain sorghum, forage sorghum, cotton, small grain, corn, alfalfa, vetch, and bermudagrass are suitable crops. Both native grasses and tame grasses are suitable for pasture.

This soil is easy to cultivate, but it is susceptible to moderate erosion. Runoff from adjacent uplands is a hazard in some places. Crop residues or cover crops are needed late in winter and early in spring to help prevent soil blowing and water erosion. Fertilization also is beneficial, especially in fields used for corn. (Capability unit IIe–1; Sandy Savannah range site)

Konawa fine sandy loam, 3 to 5 percent slopes (KoC).—This soil is on uplands along the North Canadian and the South Canadian Rivers. Except for the texture of the surface layer, the profile is similar to the one described for the Konawa series.

A large part of this soil is in cultivation. Corn, peanuts, grain sorghum, forage sorghum, cotton, small grain, vetch, and bermudagrass are suitable crops. Both native grasses and tame grasses are suitable for pasture.

This soil is moderately easy to cultivate, but it is susceptible to severe erosion. Row crops should be planted on the contour, in alternate strips with sown crops. Terracing and contour farming are not needed if close-growing, soil-improving crops are grown every year. Adequate crop residue should be utilized to protect the soil. Cover crops help to control erosion during March, April, and May. Fertilization is beneficial. (Capability unit IIIe–3: Sandy Savannah range site)

Konawa fine sandy loam, 2 to 5 percent slopes, eroded (KoC2).—This soil is on uplands along the North Canadian and the South Canadian Rivers. Except for the texture and thickness of the surface layer, the profile is similar to the one described for the Konawa series. In about half the acreage, the plow layer is made up of a mixture of surface soil and subsoil material. There are shallow gullies 150 to 300 feet apart in some places. Between the gullies the surface layer is 4 to 11 inches thick.

A large part of this soil is in cultivation. Corn, peanuts, grain sorghum, forage sorghum, cotton, small grain, and bermudagrass are suitable crops.

This soil is moderately easy to cultivate, but it is susceptible to severe erosion. Crop residue and cover crops are effective means of maintaining the soil and protecting it from further erosion. Protection is especially needed during windy periods. Fertilization is beneficial. (Capability unit IIIe–7; Sandy Savannah range site)

***Figure 11.*—An area of Konawa loamy fine sand, 3 to 8 percent slopes, severely eroded.**

Konawa loamy fine sand, 3 to 8 percent slopes (KsD).—This soil is on uplands along the North Canadian and the South Canadian Rivers. It has the profile described as typical for the Konawa series. A few areas are eroded.

A large part of this soil is in cultivation. Peanuts, grain sorghum, cotton, and bermudagrass are suitable crops. Native tall grasses and tame grasses are suitable for pasture. Winter rye, alone or with vetch, is the most suitable tame pasture plant. Bermudagrass and perennial legumes also make a suitable pasture mixture.

This soil is moderately easy to cultivate, but it is susceptible to severe erosion. Stubble should be left on the surface for erosion control each year that rye or rye and vetch are grown. Fertilizer is needed in most years. (Capability unit IVe–2; Deep Sand Savannah range site)

Konawa loamy fine sand, 3 to 8 percent slopes, severely eroded (KsD3).—This soil is on uplands along the North Canadian and the South Canadian Rivers. It has a profile similar to the one described for the series, but erosion has thinned the surface layer and has formed gullies. Between the gullies the surface layer is 6 to 13 inches thick.

This soil is not suitable for cultivation, because it is highly susceptible to further erosion (fig. 11). It can be used successfully for native grass pasture, tame pasture of bermudagrass and legumes, wildlife habitat, or recreation. If it is used for pasture, fertilization and good management of grazing are needed. (Capability unit VIe–1; Deep Sand Savannah range site)

Ochlockonee Series

The Ochlockonee series consists of deep, loamy, well-drained soils that formed in alluvium. The slope range is 0 to 1 percent. The native vegetation is a mixture of big bluestem, little bluestem, indiangrass, and switchgrass; scattered cottonwood, sycamore, and elm trees; and a few pecan trees.

In a typical profile, the surface layer is medium acid to strongly acid, brown fine sandy loam that has granular structure. It is about 12 inches thick. Beneath the surface layer is about 51 inches of medium acid to very strongly acid, dark yellowish-brown light loam to very fine sandy loam. This material has subangular blocky structure breaking to massive and is friable when moist and slightly hard when dry. The underlying material consists of acid sediments.

Ochlockonee soils absorb water well and have moderately rapid permeability and moderate water-holding capacity. Water erosion is not a hazard if runoff from adjacent uplands is controlled. Soil blowing is a hazard in some areas. Most of the acreage of these soils is cultivated.

Following is a description of a typical profile of Ochlockonee fine sandy loam. This profile is in an abandoned field 1,580 feet north and 475 feet east of the southwest corner of the SE¼ sec. 32, T. 5 N., R. 10 E.

Ap—0 to 6 inches, pale-brown (10YR 6/3) fine sandy loam; brown (10YR 4/3) when moist; weak, fine, granular structure; slightly hard when dry, very friable when moist; pH 5.5; clear boundary.

A1—6 to 12 inches, pale-brown (10YR 6/3) fine sandy loam; brown (10YR 4/3) when moist; weak, medium, granular structure; hard when dry, very friable when moist; pH 5.8; gradual boundary.

AC1—12 to 24 inches, light yellowish-brown (10YR 6/4) light loam; dark yellowish brown (10YR 4/4) when moist; moderate, coarse, subangular blocky structure; few, medium, faint, reddish-yellow and brown mottles; slightly hard when dry, friable when moist; pH 5.5; gradual boundary.

AC2—24 to 63 inches, light yellowish-brown (10YR 6/4) heavy very fine sandy loam; dark yellowish brown (10YR 4/4) when moist; common, faint, coarse, strong-brown mottles; moderate, coarse, subangular blocky structure becoming massive at a depth of about 50 inches; pH 5.0.

The A horizon ranges from 10 to 15 inches in thickness and, when dry, from brown to pale brown in color. The AC horizon is medium acid to very strongly acid and ranges from loam to sandy loam. A buried soil occurs in small areas.

Ochlockonee soils are sandier than Verdigris soils and are less frequently flooded than Alluvial land.

Ochlockonee fine sandy loam (0 to 1 percent slopes) (Oc).—This soil is on the bottom lands of streams in the eastern part of the county. It has the profile described as typical for the Ochlockonee series.

A large part of this soil is cultivated. Corn, peanuts, grain sorghum, cotton, small grain, alfalfa, and bermudagrass are suitable crops. Both native grasses and tame grasses are suitable for pasture.

This soil is easy to cultivate and can be used intensively. Runoff from the adjacent uplands and occasional flooding from streams are hazards in some places. Erosion can be controlled by simple conservation measures, such as utilizing crop residue and growing cover crops. (Capability unit IIw-3; Loamy Bottomland range site)

Oil-Waste Land

Oil-waste land (Od) consists of areas that have been so badly damaged by an accumulation of salts and liquid oil wastes that they no longer support vegetation. These areas occur throughout the county. They are expensive to reclaim. Unless the cost is prohibitive, terraces can be constructed to divert the flow of wastes, and precipitation can be impounded to leach out the soluble salts. Also, salt-tolerant plants can be grown if seeded or planted during rainy periods when salts are least concentrated, and hay or straw mulch can be used to reduce evaporation and thus prevent the accumulation of salts on the surface. (Capability unit VIIIs-1; not placed in a range site)

Okemah Series

The Okemah series consists of deep, loamy, moderately well drained soils. These soils formed under tall grass in material weathered from shale and clay. The slope range is 1 to 3 percent. The native vegetation is a mixture of big bluestem, little bluestem, indiangrass, and switchgrass, and a few persimmon trees and sumac bushes.

In a typical profile, the surface layer is medium acid, very dark brown silt loam about 13 inches thick. It has granular structure and is friable when moist and slightly hard when dry. The uppermost 7 inches of the subsoil is medium acid, very dark brown clay loam that has granular structure and is hard when dry and firm when moist. The lower part, about 40 inches thick, is neutral to moderately alkaline, olive-brown to dark yellowish-brown clay that has blocky structure and is extremely hard when dry and very firm when moist. The clay content increases as the depth increases. The underlying material consists of shale and clay.

Okemah soils absorb water fairly well, are slowly permeable, and have moderate water-holding capacity. Erosion is a hazard wherever water is concentrated. A large part of the acreage is cultivated, but small areas are in native meadow and native pasture.

Following is a description of a typical profile of Okemah silt loam (1 to 3 percent slopes) in a cultivated field 350 feet east and 150 feet south of the northwest corner of sec. 5, T. 9 N., R. 9 E.

A1—0 to 13 inches, dark grayish-brown (10YR 4/2) silt loam; very dark brown (10YR 2/2) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; pH 6.0; gradual boundary.

B1—13 to 20 inches, very dark grayish-brown (10YR 3/2) clay loam; very dark brown (10YR 2/2) when moist; few, fine, distinct, strong-brown mottles; strong, fine, granular structure; hard when dry, firm when moist; pH 6.0; gradual boundary.

B2t—20 to 38 inches, light olive-brown (2.5Y 5/4) to yellowish-brown (10YR 5/6) clay; olive brown (2.5Y 4/4) to dark yellowish brown (10YR 4/4) when moist; moderate, medium, blocky structure; extremely hard when dry, very firm when moist; pH 6.8; gradual boundary.

B3—38 to 60 inches +, brownish-yellow (10YR 6/6) clay; yellowish brown (10YR 5/6) when moist; weak, coarse, blocky structure; extremely hard when dry, very firm when moist; pH 8.0.

The A horizon ranges from 11 to 15 inches in thickness but ordinarily is about 13 inches thick. When moist, this horizon ranges from very dark grayish brown to very dark brown. In most places the clay content of the B horizon increases with depth. The reaction of the B horizon ranges from medium acid to moderately alkaline.

Okemah soils are darker colored than Parsons soils, and they lack an A2 horizon. When moist, Okemah soils have a darker colored A horizon than Dennis soils. Also they have an olive color in the subsoil.

Okemah-Slickspots complex, 1 to 3 percent slopes (OkB).—This complex is mainly in the northern half of the county. The Okemah soil has the profile described as typical for the Okemah series. Slickspots cover 10 to 40 percent of the acreage but ordinarily about 20 percent. The surface layer of the Slickspots is white and ranges from 3 to 8 inches in thickness in most places. A hard crust, 1 to 2 inches thick, has formed in areas that are cultivated. Beneath the surface layer is compact, blocky clay that resembles the Okemah subsoil, except that it is high in exchangeable sodium. This clay layer generally is neutral to alkaline below a depth of 12 inches.

A large part of this complex is cultivated. Corn, peanuts, cotton, grain sorghum, sweet sorghum, wheat, oats, barley, and bermudagrass are suitable crops. The most suitable crops are those tolerant of salts and alkali. Both native grasses and tame grasses are suitable for pasture.

This complex is susceptible to severe erosion and should be tilled only enough to control weeds and prepare a seedbed. Untimely tillage causes excessive compaction. Crop residue helps to protect the soil and to increase the water-intake rate. Gypsum or other highly sulfurous material can be used in some places to improve the structure of the Slickspots. (Capability unit IIIe-1; Okemah soil, Loamy Prairie range site; Slickspots, Slickspot range site)

Okemah-Slickspots complex, 1 to 3 percent slopes, eroded (OkB2).—This complex is mainly in the northern part of the county. The Okemah soil has a profile similar to the one described for the Okemah series, but erosion has thinned the surface layer. Slickspots cover 20 to 40 percent of the acreage but ordinarily about 30 percent. The surface layer of the Slickspots is white and ranges from 2 to 6 inches in thickness in most places. A hard crust, 1 to 2 inches thick, has formed in cultivated areas. Beneath the surface layer is compact, blocky clay that is high in exchangeable sodium. In places all of the surface layer has been eroded, and the very slowly permeable clayey subsoil is exposed. In about half the acreage of this complex, the plow layer is made up of a mixture of surface soil and subsoil material. There are shallow gullies 50 to 300 feet apart in some places. Between the gullies the surface layer is mostly less than 6 inches thick.

Only a small part of this complex is in cultivation. Wheat, oats, rye, barley, and other small grain are suitable field crops. The most suitable crops are those tolerant of salts and alkali. Bermudagrass is suitable for pasture.

This complex is moderately difficult to cultivate and is susceptible to severe erosion. Maintaining soil structure in the Slickspots also is difficult. Sown crops require the least tillage and help to protect the soil. (Capability unit IVe-1; Okemah soil, Loamy Prairie range site; Slickspots, Slickspot range site)

Osage Series

The Osage series consists of deep, clayey, somewhat poorly drained soils on bottom lands along streams. These soils formed in alluvium under tall grass. The slope range is 0 to 1 percent. The native vegetation is made up of big bluestem, little bluestem, indiangrass, switchgrass, and a few hawthorn bushes.

In a typical profile, the surface layer is slightly acid, very dark grayish-brown light clay about 15 inches thick. It has subangular blocky structure and is firm when moist. Beneath the surface layer, to a depth of more than 65 inches, is neutral to mildly alkaline, very dark gray to gray clay that is massive and firm or very firm when moist and very hard when dry.

Osage soils absorb water very slowly, are very slowly permeable, and have moderate water-holding capacity. Water erosion is not a hazard. About half the acreage of these soils is cultivated.

Following is a description of a typical profile of Osage clay (0 to 1 percent slopes). This profile is in a native pasture 900 feet east and 20 feet north of the southwest corner of sec. 33, T. 9 N., R. 10 E.

A1—0 to 15 inches, dark-gray (10YR 4/1) light clay; very dark grayish brown (10YR 3/2) when moist; moderate, coarse, subangular blocky structure; few, fine, faint, yellowish-brown mottles; very hard when dry, firm when moist; pH 6.5; gradual boundary.

AC—15 to 52 inches, gray (10YR 5/1) clay; very dark gray (10YR 3/1) when moist; weak, fine, blocky structure grading to massive; few, fine, faint, yellowish-brown mottles; very hard when dry, firm when moist; pH 7.0; gradual boundary.

C—52 to 65 inches, gray (10YR 5/1) clay; dark gray (10YR 4/1) when moist; massive; very hard when dry, very firm when moist; pH 7.5.

The A horizon ranges from 10 to 20 inches in thickness but ordinarily is about 15 inches thick. When dry, this horizon ranges from dark gray to very dark gray.

Osage soils are more clayey than Verdigris soils.

Osage clay (0 to 1 percent slopes) (Os).—This soil is on the bottom lands of Wewoka Creek. It has the profile described as representative of the Osage series.

Most of this soil is used for pasture, and only a small part is cultivated. Suitable pasture plants are fescue, Ladino clover, and native tall grasses. Bermudagrass is grown in some places, though it is not so well suited as the other pasture plants. Small grain is better used for pasture than harvested for grain.

This soil is not susceptible to erosion, but runoff from the adjacent uplands creates a problem in some places. Because of the clay texture and wetness, cultivation and seedbed preparation are difficult. Surface drainage is needed. (Capability unit IIIw-1; Heavy Bottomland range site)

Parsons Series

The Parsons series consists of deep, loamy, somewhat poorly drained soils that formed under tall grass in material weathered from shale and clay. The slope range is 0 to 1 percent. The native vegetation is a mixture of big bluestem, little bluestem, indiangrass, switchgrass, and a few hawthorn bushes.

The surface layer in a typical profile is medium acid, very dark grayish-brown to dark grayish-brown silt loam about 12 inches thick. It has granular structure and is friable when moist and slightly hard when dry (fig. 12). The subsoil is about 33 inches of medium acid to neutral, very dark grayish-brown clay of blocky structure. It is extremely firm when moist and extremely hard when dry. The underlying material consists of shale or clay.

Parsons soils are very slowly permeable and have low water-holding capacity. Drainage is difficult in large, nearly flat areas, and maintaining the organic-matter content generally is a problem. Erosion is not a hazard. About 80 percent of the acreage of these soils is cultivated.

Following is a description of a typical profile of Parsons silt loam, 0 to 1 percent slopes. This profile is in a cultivated field 2,100 feet east and 180 feet north of the southwest corner of sec. 16, T. 9 N., R. 12 E.

Ap—0 to 9 inches, grayish-brown (10YR 5/2) silt loam; very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; pH 6.0; clear boundary.

A2—9 to 12 inches, light brownish-gray (10YR 6/2) silt loam; dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure to nearly massive; slightly hard when dry, friable when moist; pH 6.0; abrupt boundary.

B21t—12 to 30 inches, grayish-brown (10YR 5/2) clay; very dark grayish brown (10YR 3/2) when moist; moderate, medium and coarse, blocky structure; common, medium, distinct, strong-brown and gray mottles; extremely hard when dry, extremely firm when moist; pH 6.2; diffuse boundary.

B22t—30 to 45 inches, grayish-brown (10YR 5/2) clay; very dark grayish brown (10YR 3/2) when moist; weak, coarse, blocky structure; few, medium, faint, strong-brown mottles; extremely hard when dry, extremely firm when moist; pH 6.5; gradual boundary.

C—45 to 70 inches, mottled gray and strong-brown clay; massive; extremely hard when dry, extremely firm when moist; pH 7.5.

The A horizon ranges from 8 to 15 inches in thickness but ordinarily is about 12 inches thick. The A2 horizon is indistinct in many places. The B horizon ranges from about neutral to medium acid. The C horizon ranges from neutral to moderately alkaline in most places but is slightly acid to medium acid in small areas.

Parsons soils have a lighter colored A horizon than Okemah soils, have a thinner A horizon than Taloka soils, and have a more clayey B horizon than Dennis soils.

Parsons silt loam, 0 to 1 percent slopes (PaA).—This soil occurs throughout the prairies. It has the profile described as typical for the Parsons series.

A large part of this soil is in cultivation. Wheat, oats, and other small grain are the most suitable crops, but grain sorghum, sweet sorghum, soybeans, cotton, and peanuts grow fairly well. Both native grasses and tame grasses are suitable for pasture.

This soil is moderately easy to cultivate. Management problems consist of reducing surface crusting, increasing the water-intake rate, maintaining soil structure, retaining fertility, and overcoming seasonal wetness and droughtiness. Directing crop rows toward a drainage outlet is beneficial in some areas. Adequate crop residue should be left on the surface. Tillage and other operations needed to prepare a seedbed should be kept to a minimum and should be timed so as not to compact the soil. (Capability unit IIs-1; Claypan Prairie range site)

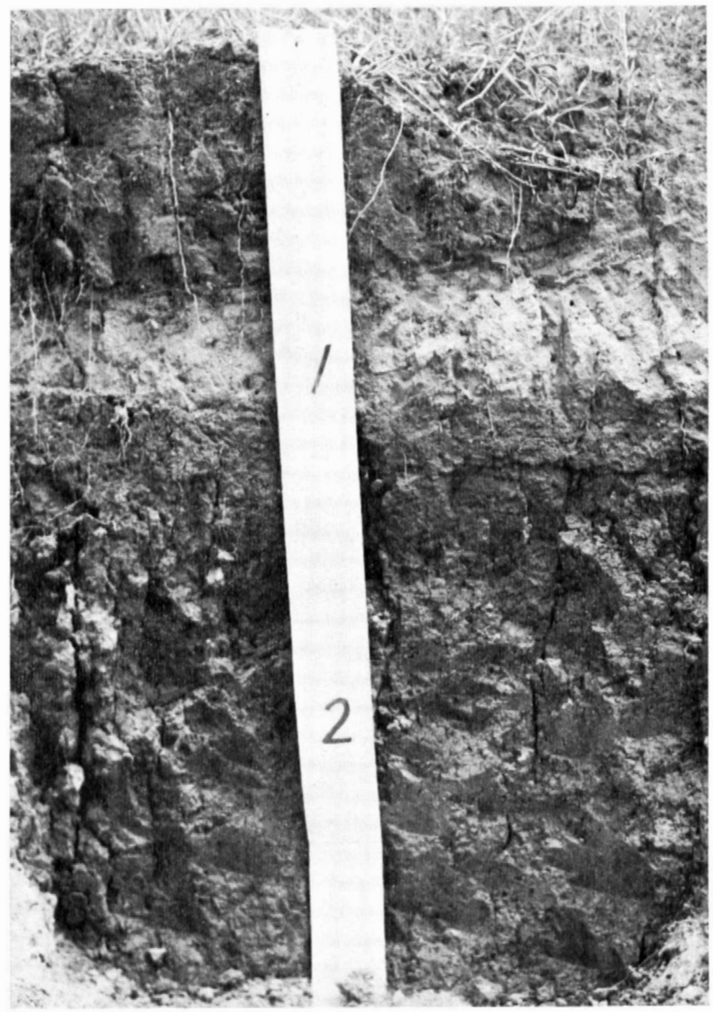

Figure 12.—**Profile of Parsons silt loam, 0 to 1 percent slopes.**

Reinach Series

The Reinach series consists of deep, loamy, well-drained soils along the North Canadian and the South Canadian Rivers. These soils formed under tall grass and scattered trees in recent sandy and loamy alluvium. The slope range is 0 to 1 percent. The native vegetation consists of big bluestem, little bluestem, indiangrass, switchgrass, and scattered pecan, sycamore, cottonwood, and cedar trees.

In a typical profile, the surface layer, to a depth of 27 inches, is dark-brown to brown very fine sandy loam that has granular structure and is very friable when moist. The profile normally is calcareous at a depth of 15 inches. The underlying material consists of calcareous, brown loamy very fine sand.

Reinach soils absorb water well, are moderately permeable, and have high water-holding capacity. Water erosion is a hazard where runoff from the uplands is uncontrolled, and soil blowing is likely in some places. A large part of the acreage is cultivated.

Following is a description of a typical profile of Reinach very fine sandy loam (0 to 1 percent slopes). This profile is in a cultivated field 300 feet west and 1,850 feet south of the northwest corner of sec. 15, T. 6 N., R. 9 E.

A1—0 to 14 inches, brown (7.5YR 5/3) very fine sandy loam; dark brown (7.5YR 3/3) when moist; weak, fine, granular structure; slightly hard when dry, very friable when moist; pH 7.0; gradual boundary.

AC—14 to 27 inches, light-brown (7.5YR 6/4) very fine sandy loam; brown (7.5YR 4/4) when moist; weak, medium and fine, granular structure; soft when dry, very friable when moist; calcareous; gradual boundary.

C—27 to 70 inches, light-brown (7.5YR 6/4) loamy very fine sand; brown (7.5YR 4/4) when moist; single grain; loose both when dry and when moist; calcareous.

The A horizon is very fine sandy loam in most places but is loam or fine sandy loam in some. It ranges from brown to reddish brown in color when dry, from 10 to 16 inches in thickness, and from slightly acid to neutral in reaction. Reinach soils are calcareous below a depth of 15 inches.

These soils are less sandy in the uppermost 24 inches than Brazos soils and are less clayey throughout than Brewer soils.

Reinach very fine sandy loam (0 to 1 percent slopes) (Rf).—This soil is on the bottom lands of the North Canadian and the South Canadian Rivers. It has the profile described as representative of the series.

A large part of this soil is in cultivation. Corn, peanuts, cotton, small grain, grain sorghum, alfalfa, and bermudagrass are suitable crops. Both native grasses and tame grasses are suitable for pasture.

This soil is easy to cultivate and can be used intensively. Runoff from the adjacent uplands and occasional stream flooding are hazards in some places, but they can be controlled by simple measures. Cover crops, a suitable rotation, fertilization, and the use of crop residue usually provide adequate protection. (Capability unit I–1; Loamy Bottomland range site)

Rough Stony Land

Rough stony land (Ro) is made up of very shallow, rough, stony areas that have slopes of more than 30 percent. In a few places the soil material is deep. This land type is associated with Hartsells soils and Hector soils.

Sandstone rocks cover between 20 and 60 percent of any given area, and most commonly about 35 percent. About 45 percent of each area consists of acid, brownish fine sandy loam that is 4 to 10 inches thick over rock. About 20 percent consists of a weakly developed soil that has a brownish surface layer of fine sandy loam to clay loam and a subsoil of strongly acid, reddish-brown to olive clay and is 6 to 48 inches deep over shale.

Rough stony land is not suitable for cultivation. All of the acreage is in native range. (Capability unit VIIs–3; Savannah Breaks range site)

Slickspots

Slickspots are mapped in this county only as a part of two Okemah-Slickspots complexes, which are described under the Okemah Series.

Stidham Series

The Stidham series consists of deep, sandy, well-drained soils that formed under oaks and tall grass in sandy old alluvium. The slope range is 0 to 2 percent. The native vegetation consists of blackjack oak, post oak, and hickory trees, and an understory of big bluestem, little bluestem, indiangrass, and switchgrass.

In a typical profile, the surface layer is loamy fine sand about 23 inches thick. It has granular structure and is very dark grayish brown in the upper part and is single grain and brown in the lower part. It is very friable when moist and slightly hard when dry. The subsoil is about 32 inches of slightly acid to strongly acid, dark yellowish-brown to yellowish-brown light sandy clay loam to fine sandy loam. It has subangular blocky structure in most places and is friable when moist and hard when dry. The underlying material is old sandy alluvium.

Stidham soils absorb water well, are moderately permeable, and have moderately high water-holding capacity, especially in the lower part of the subsoil. Water erosion is not a hazard, but soil blowing is likely in fall, in winter, and early in spring. Less than half the acreage of these soils is cultivated.

Following is a description of a typical profile of Stidham loamy fine sand, 0 to 2 percent slopes. This profile is in a wooded pasture 200 feet south and 700 feet east of the northwest corner of sec. 25, T. 4 N., R. 10 E.

A1—0 to 6 inches, light brownish-gray (10YR 6/2) loamy fine sand; very dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; slightly hard when dry, very friable when moist; pH 6.5; clear, wavy boundary.

A2—6 to 23 inches, light-gray (10YR 7/2) loamy fine sand; brown (10YR 5/3) when moist; single grain; slightly hard when dry, very friable when moist; pH 6.3; clear, wavy boundary.

B21t—23 to 33 inches, light yellowish-brown (10YR 6/4) light sandy clay loam; dark yellowish brown (10YR 4/4) when moist; moderate, medium, coarse, subangular blocky structure; hard when dry, friable when moist; pH 6.0; diffuse boundary.

B22t—33 to 45 inches, yellow (10YR 7/6) light sandy clay loam; yellowish brown (10YR 5/6) when moist; prismatic structure breaking to subangular blocky; hard when dry, friable when moist; pH 6.0; diffuse boundary.

B3—45 to 55 inches, yellow (10YR 7/6) fine sandy loam; yellowish brown (10YR 5/6) when moist; weak, coarse, prismatic structure; few, medium, distinct, grayish-brown mottles; hard when dry, friable when moist; pH 6.0; diffuse boundary.

C—55 to 69 inches +, very pale brown (10YR 8/4) heavy loamy fine sand; light yellowish brown (10YR 6/4) when moist; single grain; few, coarse, distinct, grayish-brown, gray, yellowish-red, and reddish-brown mottles; slightly hard when dry, friable when moist; pH 6.0.

The A horizon ranges from 20 to 30 inches in thickness but ordinarily is about 23 inches thick. When dry, this horizon ranges from light gray to light yellowish brown. The reaction ranges from slightly acid to strongly acid.

Stidham soils have a more yellowish B horizon than Konawa soils and a more clayey B horizon than Eufaula soils.

Stidham loamy fine sand, 0 to 2 percent slopes (StB).—This soil occurs along Panther Creek and the South Canadian River and near Gerty. It has the profile described as typical for the Stidham series, but in about 40 percent of the acreage, the surface layer is only 10 to 20 inches thick.

Only a small part of this soil is in cultivation. Corn, peanuts, grain sorghum, sweet sorghum, cotton, bermudagrass, ryegrass, and vetch are suitable crops. Both native grasses and tame grasses are suitable for pasture.

This soil is moderately easy to cultivate, but it is susceptible to severe erosion. Adequate crop residue should be left each year for erosion control and soil improvement. A cover crop consisting of rye or a mixture of rye and vetch should follow cotton and other crops that leave only a small amount of residue. Waterways should have a cover of sod. (Capability unit IIIe–4; Deep Sand Savannah range site)

Talihina Series

The Talihina series consists of stony, somewhat excessively drained soils that formed under tall grass in material weathered from shale. The slope range is 5 to 20 percent. The native vegetation is a mixture of big bluestem, little bluestem, indiangrass, and switchgrass.

In a typical profile, the surface layer is very dark grayish-brown clay loam that has granular structure and is firm when moist and slightly hard when dry. It is about 5 inches thick. Stones are on the surface in most places. Beneath the surface layer is 10 inches of olive-brown, massive clay that is medium acid and is very firm when moist and very hard when dry. Between depths of 15 and 20 inches is olive-gray, massive, mildly alkaline clay. The underlying material is soft weathered shale.

Talihina soils absorb water slowly, are slowly permeable, and have somewhat limited water-holding capacity. All the acreage is rangeland.

Talihina soils in this county are mapped only in a complex with Collinsville soils.

Following is a description of a typical profile of Talihina clay loam (5 to 20 percent slopes). This profile is in a native pasture 500 feet north and 550 feet west of the southeast corner of sec. 10, T. 7 N., R. 9 E.

A1—0 to 5 inches, grayish-brown (2.5Y 5/2) clay loam; very dark grayish brown (2.5Y 3/2) when moist; moderate, fine, granular structure; few sandstone and siltstone fragments; slightly hard when dry, firm when moist; pH 6.0; clear boundary.

AC—5 to 15 inches, light brownish-gray (2.5Y 6/2) clay; olive brown (2.5Y 4/3) when moist; massive; few, medium, distinct, brownish-yellow mottles; siltstone fragments increase in number with depth; very hard when dry, very firm when moist; pH 6.0; gradual boundary.

C—15 to 20 inches +, light olive-gray (5Y 6/2) clay; olive gray (5Y 4/2) when moist; massive; siltstone fragments increase in number with depth; very hard when dry, very firm when moist; pH 7.5.

The A horizon is light clay in minor areas. When dry, it ranges from grayish brown to dark grayish brown. The depth to the C horizon ranges from 4 to 20 inches.

Talihina soils are more clayey than Collinsville soils. They are shallower than Dennis soils, which have a B horizon.

Talihina-Collinsville complex, 5 to 20 percent slopes (TcE).—This complex is mainly in the northern half of the county. It is 70 percent Talihina soils and 30 percent Collinsville soils. These soils have profiles similar to the ones described as representative of the respective series, except that much of the acreage is stony.

These soils are not eroded, but their use is severely limited by low water-holding capacity, stones, shallowness, slope, and other unfavorable features. They are not suitable for cultivation and are mostly in native pasture. (Capability unit VIIs-1; Shallow Prairie range site)

Taloka Series

The Taloka series consists of deep, loamy, somewhat poorly drained soils that formed under tall grass in old alluvium. The slope range is 0 to 3 percent. The native vegetation consists of big bluestem, little bluestem, indiangrass, and switchgrass.

In a typical profile, the surface layer is very dark grayish-brown to brown silt loam that has granular structure and is very friable when moist and hard when dry (fig. 13). The thickness is about 22 inches. The subsoil is about 26 inches of mildly alkaline to moderately alkaline, yellowish-brown clay. It has blocky structure and is very firm when moist and very hard when dry. The underlying material is clay.

Taloka soils absorb water fairly well, are very slowly permeable, and have high water-holding capacity. Water erosion is not a serious hazard, and soil blowing is not likely. Most of the acreage of these soils is cultivated.

Following is a description of a typical profile of Taloka silt loam, 0 to 1 percent slopes. This profile is in a cultivated field 1,200 feet south and 65 feet east of the northwest corner of sec. 29, T. 9 N., R. 12 E.

A1—0 to 15 inches, grayish-brown (10YR 5/2) silt loam; very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; hard when dry, very friable when moist; pH 6.0; clear, wavy boundary.

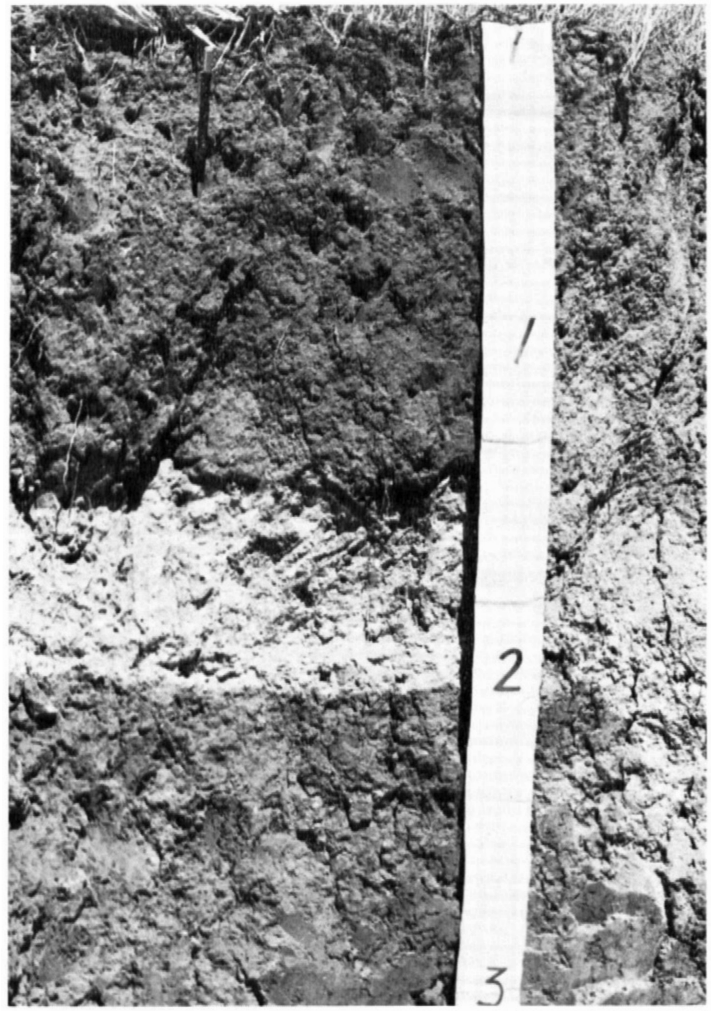

Figure 13.—**Profile of a Taloka silt loam.**

A2—15 to 22 inches, pale-brown (10YR 6/3) silt loam; brown (10YR 4/3) when moist; weak, fine, granular structure; few, fine, faint, dark-brown mottles; hard when dry, very friable when moist; pH 6.0; clear, wavy boundary.

B2t—22 to 32 inches, light yellowish-brown (10YR 6/4) clay; yellowish brown (10YR 5/4) when moist; moderate, medium, blocky structure; common, medium and coarse, distinct, strong-brown and reddish-yellow mottles; very hard when dry, very firm when moist; pH 7.5; clear boundary.

B3—32 to 48 inches, brownish-yellow (10YR 6/6) light clay; yellowish brown (10YR 5/6) when moist; weak blocky structure; few, coarse, faint, grayish-brown mottles; iron concretions common; very hard when dry, very firm when moist; pH 8.0; gradual boundary.

C—48 to 72 inches +, yellow (10YR 7/8) light clay; brownish yellow (10YR 6/8) when moist; massive; many, coarse, distinct, gray and brownish mottles; few iron concretions, increasing in number with depth; very hard when dry, very firm when moist; pH 8.0.

The A horizon ranges from 16 to 28 inches in thickness; the A2 part ranges from about 4 to 10 inches. The reaction ranges from medium acid in the surface layer to moderately alkaline in the subsoil.

Taloka soils have a thicker A horizon than Parsons soils and are finer textured in the upper B horizon than Dennis soils.

Taloka silt loam, 0 to 1 percent slopes (TkA).—This soil occurs throughout the prairies. It has the profile described as typical for the series.

A large part of this soil is in cultivation. Corn, peanuts, grain sorghum, cotton, soybeans, small grain, alfalfa, and bermudagrass are suitable crops. Both native grasses and tame grasses are suitable for pasture.

This soil is moderately easy to cultivate and is not susceptible to erosion. Management problems consist of maintaining soil structure, improving the water-intake rate, and, in some places, controlling runoff from higher areas. Minimum tillage and timely tillage help to maintain the soil structure. Cornstalks and other residue should be left to protect the soil and increase the water-intake rate. Diversion terraces are needed in some places. Surface drainage can be provided by directing crop rows toward a prepared waterway. (Capability unit IIs–2; Loamy Prairie range site)

Taloka silt loam, 1 to 3 percent slopes (TkB).—This soil occurs throughout the prairies. It has a profile similar to the one described for the Taloka series.

A large part of this soil is in cultivation. Wheat, oats, and barley are the most suitable crops, and corn, peanuts, grain sorghum, sweet sorghum, alfalfa, cotton, and bermudagrass can be grown successfully. Both native grasses and tame grasses are suitable for pasture.

This soil is easy to cultivate, but it is susceptible to moderate erosion. Adequate residue should be managed for soil improvement. Wheat can be grown continuously if crop residue is used for soil improvement. Diversion terraces leading to suitable waterways are needed in some places. (Capability unit IIe–3; Loamy Prairie range site)

Vanoss Series

The Vanoss series consists of deep, loamy, well-drained soils that developed under tall grass in old alluvium. The slope range is 0 to 3 percent. The native vegetation consists of big bluestem, little bluestem, indiangrass, and switchgrass.

In a typical profile, the surface layer is dark-brown loam about 16 inches thick. It has granular structure and is friable when moist and hard when dry. The subsoil, about 49 inches thick, consists of slightly acid to very strongly acid, dark-brown and brown clay loam grading to yellowish-red sandy clay loam. It has subangular blocky structure in most places. It is hard when dry, but when moist is friable in the upper part and firm in the lower part. The color is brown in the upper part and reddish in the lower part. The underlying material is old alluvium.

Vanoss soils absorb water well, are moderately permeable, and have high water-holding capacity. They are not readily susceptible to water erosion or soil blowing. Most of the acreage is cultivated.

Following is a description of a typical profile of Vanoss loam, 0 to 1 percent slopes. This profile is in a cultivated field 120 feet south and 90 feet east of the northwest corner of the SW¼ sec. 25, T. 6 N., R. 9 E.

A1—0 to 16 inches, brown (7.5YR 5/3) heavy loam; dark brown (7.5YR 3/3) when moist; moderate, fine and medium, granular structure; hard when dry, friable when moist; pH 6.5; gradual boundary.

B21t—16 to 29 inches, brown (7.5YR 5/4) light clay loam; dark brown (7.5YR 3/4) when moist; moderate, medium and coarse, subangular blocky structure; hard when dry, friable when moist; pH 6.3; gradual boundary.

B22t—29 to 48 inches, brown (7.5YR 5/5) clay loam; brown (7.5YR 4/5) when moist; moderate, medium and coarse, subangular blocky structure; a few iron concretions; hard when dry, firm when moist; pH 6.0; gradual boundary.

B3—48 to 65 inches +, yellowish-red (5YR 5/6) sandy clay loam; yellowish red (5YR 4/8) when moist; weak, coarse, subangular blocky structure breaking to weak, fine and medium, granular; hard when dry, firm when moist; pH 5.0; gradual boundary.

The A horizon ranges from 12 to 19 inches in thickness but ordinarily is about 16 inches thick. The B horizon ranges from sandy clay loam to clay loam in texture, from slightly acid to very strongly acid in reaction, and, when dry, from brown to dark grayish brown and yellowish red in color.

Vanoss soils are darker colored than Konawa and Stidham soils, and they lack an A2 horizon, which occurs in those soils.

Vanoss loam, 0 to 1 percent slopes (VaA).—This soil occurs on prairie uplands. It has the profile described as typical for the Vanoss series.

A large part of this soil is in cultivation. Corn, peanuts, grain sorghum, forage sorghum, cotton, small grain, alfalfa, and bermudagrass are suitable crops. Both native grasses and tame grasses are suitable for pasture.

This soil can be used intensively and does not require special conservation measures. It is easy to cultivate and is not susceptible to erosion. Effective measures for soil improvement include growing legumes along with small grain, or growing small grain each year and using crop residue for soil improvement. (Capability unit I–2; Loamy Prairie range site)

Vanoss loam, 1 to 3 percent slopes (VaB).—This soil is on prairie uplands. The profile is similar to the one described for the Vanoss series.

A large part of this soil is in cultivation. Peanuts, cotton, small grain, corn, grain sorghum, forage sorghum, alfalfa, and bermudagrass are suitable crops. Both native grasses and tame grasses are suitable for pasture.

This soil is easy to cultivate, but it is susceptible to moderate erosion. Runoff from adjacent uplands is a hazard in some places. Effective conservation measures include returning crop residue, using a good cropping system, and planting a cover crop after harvest. Peanuts should be followed by a fall-sown crop, such as rye or vetch, for protection against soil blowing. If row crops are grown, the long slopes should be terraced and contour farmed. (Capability unit IIe–2; Loamy Prairie range site)

Verdigris Series

The Verdigris series consists of deep, loamy, moderately well drained soils on bottom lands along streams. These soils formed in alluvium under tall grass. The slope range is 0 to 1 percent. The native vegetation is made up of big bluestem, little bluestem, indiangrass, and switchgrass; pecan, elm, and hackberry trees; and hawthorn bushes.

In a typical profile, the surface layer is about 22 inches thick. It is very dark grayish brown. It has granular structure and is friable when moist and hard when dry. Beneath the surface layer is about 38 inches of medium acid to slightly acid, very dark grayish-brown to very dark gray silt loam to silty clay loam. This material has subangular blocky structure and is friable when moist and hard or very hard when dry. The underlying material is alluvium.

Verdigris soils absorb water fairly well, are moderately slowly permeable, and have high water-holding capacity. Water erosion is not a hazard, but in some areas standing water creates a problem. Only a small acreage of these soils is cultivated.

Following is a description of a typical profile of Verdigris silt loam (0 to 1 percent slopes). This profile is in a cultivated field 1,200 feet east and 1,450 feet north of the southwest corner of sec. 19, T. 9 N., R. 10 E.

A1—0 to 22 inches, grayish-brown (10YR 5/2) silt loam; very dark grayish brown (10YR 3/2) when moist; weak, medium, granular structure; hard when dry, friable when moist; pH 6.3; gradual boundary.

AC1—22 to 36 inches, grayish-brown (10YR 5/2) silt loam; very dark grayish brown (10YR 3/2) when moist; weak, medium, subangular blocky structure; slightly hard when dry, friable when moist; common, medium, distinct, strong-brown and gray mottles; pH 6.0; gradual boundary.

AC2—36 to 60 inches, gray (10YR 5/1) light silty clay loam; very dark gray (10YR 3/1) when moist; weak, medium, subangular blocky structure; common, medium, distinct, strong-brown mottles; pH 6.3.

The A horizon is 16 to 26 inches thick but most commonly is about 22 inches. It ranges from silt loam to clay loam in texture and, when dry, from grayish brown to dark brown in color. This horizon is coarser textured near the stream channel and finer textured at the outer edge of the bottom land. The AC horizon ranges from silt loam to clay loam or light silty clay loam.

Verdigris soils are less clayey and better drained than Osage soils. They are more clayey and less acid than Ochlockonee soils.

Verdigris clay loam (0 to 1 percent slopes) (Vd).—This soil occurs on bottom lands throughout the prairie areas. Except for the texture of the surface layer, the profile is similar to the one described for the Verdigris series.

Only a small part of this soil is cultivated. Pecans, cotton, small grain, corn, grain sorghum, alfalfa, and bermudagrass are suitable crops. Both native grasses and tame grasses are suitable for pasture.

This soil can be used intensively and does not require special conservation measures. It is moderately easy to cultivate and is not susceptible to erosion. Runoff from the adjacent uplands and occasional flooding from streams are hazards in some places. Working crop residue and other organic material into the surface every year helps to improve tilth and aeration (fig. 14). Excessive tillage and untimely tillage compact this soil. (Capability unit IIw–2; Loamy Bottomland range site)

Verdigris silt loam (0 to 1 percent slopes) (Vg).—This soil occurs on bottom lands throughout the prairie areas. It has the profile described as representative of the Verdigris series.

Only a small part of this soil is in cultivation. Pecans, peanuts, cotton, corn, small grain, grain sorghum, alfalfa, and bermudagrass are suitable crops. Both native grasses and tame grasses are suitable for pasture.

This soil can be used intensively and does not require special conservation measures. It is moderately easy to cultivate and is not susceptible to erosion. Runoff from the adjacent uplands and occasional flooding from streams are hazards in some places. Working crop residue and other organic material into the surface every year helps to improve tilth and aeration. Excessive tillage and untimely tillage compact this soil. (Capability unit IIw–2; Loamy Bottomland range site)

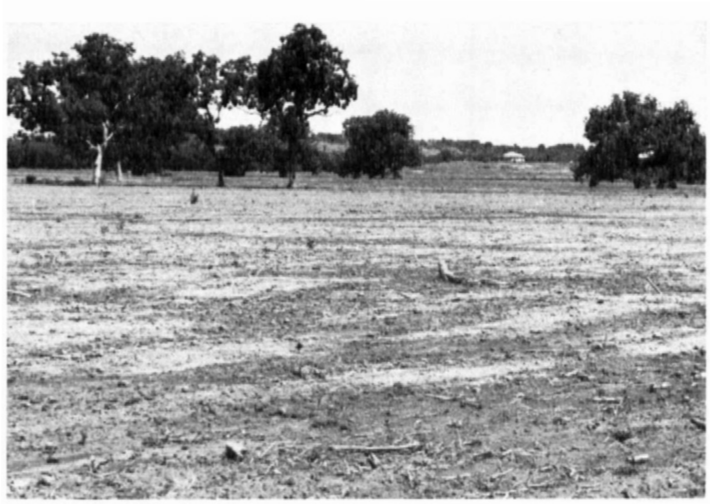

Figure 14.—An area of Verdigris clay loam. Crop residue has been worked into the surface layer.

Use of the Soils for Crops and Pasture [1]

This section explains the system of classifying soils according to relative suitability for crops and pasture, describes some of the management practices generally applicable, and provides predictions of yields of the principal cultivated crops and pasture crops under defined levels of management.

The suitability of each soil for use as cropland and pasture, and the management needs of each soil when so used, are discussed in the descriptions of the individual soils (pages 5 through 21).

The Capability Classification System

Capability classification is the grouping of soils to show, in a general way, their suitability for most kinds of farming. It is a practical classification based on the limitations of the soils, the risk of damage when they are used, and the way they respond to treatment when used for the common field crops and pasture plants. The classification does not apply to most horticultural crops or to rice and other crops that have special requirements. The soils are classified according to degree and kind of permanent limitation but without consideration of major and generally expensive land-forming that would change the slope, depth, or other characteristics of the soils, and without consideration of possible but unlikely major reclamation projects.

In the capability system, all the kinds of soil are grouped at three levels: the capability class, the subclass, and the unit. The eight capability classes in the broadest grouping 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

[1] ERNEST O. HILL, conservation agronomist, Soil Conservation Service, assisted in preparing this section.

landforms so rough, so shallow, or otherwise so limited that they do not produce worthwhile yields of crops, forage, or wood products.

The subclasses indicate major kinds of limitations within the classes. Within most of the classes there can be as many as four subclasses. The subclass is indicated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* means that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the country, indicates that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only subclasses *w*, *s*, and *c*, because the soils in it are subject to little or no erosion but have other limitations that restrict their use.

Within the subclasses are the capability units, which are groups of soils enough alike to be suited to the same crops and pasture plants, to require similar management, and to be similar in productivity and other responses to management. The capability unit is a convenient grouping for making many statements about management of soils. Capability units generally are identified by numbers assigned locally, for example, IIe-1 or IIIe-2.

The eight classes in the capability system and the subclasses and units in Hughes County are described in the list that follows. The unit designation for each soil in the county can be found in the "Guide to Mapping Units."

Class I. Soils that have few limitations that restrict their use.
- Unit I-1. Deep, brownish, well-drained, level to nearly level soils on low terraces of the North Canadian and the South Canadian Rivers.
- Unit I-2. Deep, brownish, well-drained, level to nearly level soils on prairie uplands.

Class II. Soils that have some limitations that reduce the choice of plants or that require moderate conservation practices.
- Subclass IIe. Soils subject to moderate erosion if they are not protected.
  - Unit IIe-1. Deep and moderately deep, brownish, well-drained, very gently sloping soils on oak-timbered uplands.
  - Unit IIe-2. Deep and moderately deep, well drained and moderately well drained, very gently sloping soils on prairie uplands.
  - Unit IIe-3. Deep, brownish, moderately well drained and somewhat poorly drained, very gently sloping soils on prairie uplands.
- Subclass IIw. Soils that have moderate limitations because of excess water.
  - Unit IIw-1. Deep, brownish, moderately well drained, level to nearly level soils on low terraces along the North Canadian and the South Canadian Rivers.
  - Unit IIw-2. Deep, brownish, moderately well drained, level to nearly level soils on flood plains.
  - Unit IIw-3. Deep, brownish, well-drained, level to nearly level soils on flood plains.
- Subclass IIs. Soils that have moderate limitations of moisture capacity or tilth.
  - Unit IIs-1. Deep, brownish, somewhat poorly drained, level to nearly level soils that have a thin surface layer; on prairie uplands.
  - Unit IIs-2. Deep, brownish, somewhat poorly drained, level to nearly level soils that have a thick surface layer; on prairie uplands.

Class III. Soils that have severe limitations that reduce the choice of plants, require special conservation practices, or both.
- Subclass IIIe. Soils subject to severe erosion if they are cultivated and not protected.
  - Unit IIIe-1. Deep, brownish, moderately well drained, very gently sloping soils and slickspots on prairie uplands.
  - Unit IIIe-2. Deep and moderately deep, well drained and moderately well drained, gently sloping soils on prairie uplands.
  - Unit IIIe-3. Deep and moderately deep, well-drained, brownish, gently sloping soils on timbered uplands.
  - Unit IIIe-4. Deep, grayish, well-drained, nearly level to very gently sloping, sandy soils on timbered uplands.
  - Unit IIIe-5. Moderately deep and shallow, brownish, well-drained, very gently sloping soils on prairie uplands.
  - Unit IIIe-6. Deep and moderately deep, brownish, well drained and moderately well drained, gently sloping, eroded soils on prairie uplands.
  - Unit IIIe-7. Deep and moderately deep, brownish, well-drained, gently sloping soils on timbered uplands.
- Subclass IIIw. Soils that have severe limitations because of excess water.
  - Unit IIIw-1. Deep, grayish, somewhat poorly drained, level soils on flood plains.
- Subclass IIIs. Soils that have severe limitations of moisture capacity or tilth.
  - Unit IIIs-1. Deep, brownish, somewhat excessively drained, level soils on low terraces of the North Canadian and the South Canadian Rivers.

Class IV. Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both.
- Subclass IVe. Soils subject to very severe erosion if they are cultivated and not protected.
  - Unit IVe-1. Deep, brownish, moderately well drained, very gently sloping, eroded soils and slickspots on prairie uplands.
  - Unit IVe-2. Deep, brownish, well-drained, gently sloping to sloping soils.
  - Unit IVe-3. Moderately deep and shallow, brownish, well-drained, gently sloping soils on prairie uplands.

Unit IVe-4. Moderately deep and shallow, brownish, well-drained, gently sloping soils on timbered uplands.

Subclass IVs. Soils that have very severe limitations of moisture capacity or tilth.

Unit IVs-1. Deep, brownish, somewhat excessively drained, level to very gently sloping, sandy soils.

Class V. Soils that are not likely to erode, but that have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife food and cover.

Subclass Vw. Soils too wet for cultivation; drainage or protection not feasible.

Unit Vw-1. Deep, brownish, level and very gently sloping soils on frequently flooded flood plains.

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

Subclass VIe. Soils severely limited, chiefly by risk of erosion, if protective cover is not maintained.

Unit VIe-1. Deep, brownish, gently sloping to sloping, sandy, severely eroded soils.

Unit VIe-2. Moderately deep and shallow, brownish, well-drained, gently sloping, eroded soils on timbered uplands.

Unit VIe-3. Deep and shallow, brownish, gently sloping to sloping, severely eroded soils on prairie uplands.

Unit VIe-4. Deep and shallow, brownish, nearly level to moderately steep, stony soils on prairie uplands and alluvial bottom lands.

Unit VIe-5. Deep, brownish, strongly sloping and moderately steep, sandy soils.

Class VII. Soils that have very severe limitations that make them unsuitable for cultivation and restrict their use largely to grazing, woodland, or wildlife.

Subclass VIIs. Soils very severely limited by moisture capacity, stones, or other soil features.

Unit VIIs-1. Shallow and very shallow, brownish, sloping to moderately steep, stony soils on prairie uplands.

Unit VIIs-2. Very shallow to deep, brownish, sloping to steep, stony soils on oak-timbered uplands.

Unit VIIs-3. Very shallow, brownish, steep, rough, stony soils on oak-timbered uplands.

Unit VIIs-4. Very shallow and shallow, brownish, sloping, stony soils on prairie uplands.

Class VIII. Soils and landforms that have limitations that preclude their use for commercial production of plants.

Subclass VIIIs. Soil materials that have little potential for production of plants.

Unit VIIIs-1. Soil material affected by oil waste and salts.

Common Management Problems and Practices

Controlling water erosion, maintaining good tilth, and supplying plant nutrients are the major management problems in this county. The Konawa and Stidham soils should be protected by cover crops after peanuts or row crops are harvested. Small grain planted alone or with a legume is a suitable cover crop. It can either be grazed or be turned under as a green-manure crop. Sudangrass and other close-growing crops are suitable as summer cover.

In planning a pasture program, the choice of a basic grass is most important. It should be a grass that is suited to the soils and that provides forage as much of the year as possible. Overseeding with legumes helps to increase forage production. A bermudagrass-legume mixture, which is used extensively in this county, grows best on the Vanoss and other loamy soils and grows better than most other tame grasses on the Stidham and other sandy soils. Tall fescue grows well on the Verdigris soils and other soils on bottom lands.

About 22,200 acres in Hughes County is flooded too frequently for crops. Drainage is needed in some places, largely because the soils, such as Osage soils, are not permeable enough for rainwater to soak in and not sloping enough for it to run off. Plants are injured if the water remains on and in the soil for long periods.

Predicted Yields

Table 2 lists, for each mapping unit in Hughes County, the predicted average yields per acre of the principal dry-farmed crops, under two levels of management. Irrigation farming is not extensive in this county, and data on yields of irrigated crops are not available.

Dryland farming.—The predicted yields in table 2 represent long-term averages and include periods of crop failures. They are based partly on interviews with farmers and partly on records of fertility studies, crop variety tests, and rotation and tillage trials by the Oklahoma Agricultural Experiment Station.

The figures in columns A represent yields that can be expected under common management. Such management includes (1) using proper rates of seeding, proper dates of planting, and efficient methods of harvesting; (2) controlling weeds, insects, and diseases sufficiently to insure the growth of plants; (3) using terraces and contour tillage where necessary; (4) using little or no fertilizer; and (5) using a moldboard or one-way plow.

The figures in columns B represent yields that can be expected under improved management, which consists of using the first three practices listed in the foregoing paragraph, plus (1) applying fertilizer in amounts indicated by soil tests; (2) using suitable crop varieties; (3) planting cover crops on sandy soils subject to blowing; (4) using stubble-mulch tillage on sandy and loamy soils; (5) plowing early and leaving a rough, trashy surface if erosion is a hazard; and (6) using a suitable cropping system.

Irrigation farming.—Most of the irrigated acreage in this county is on the bottom land of the South Canadian River. Sufficient water of good quality for irrigation can be obtained from fairly shallow wells, and smaller amounts can be obtained from large ponds and lakes.

Detention reservoirs and large storage ponds could increase the amount of water available for irrigation, but at present the cost of construction is too high, compared to the benefit to be derived. From 2.5 to 3.0 acre-feet of storage space is required for each acre to be irrigated.

TABLE 2.—*Predicted average acre yields of principal dryfarmed crops under two levels of management*

[The figures in columns A indicate yields under common management; those in columns B indicate yields under improved management. Absence of a figure indicates that the crop is not suited to the particular soil or is not commonly grown under the level of management specified]

Mapping unit	Peanuts		Cotton		Oats		Corn		Grain sorghum		Alfalfa		Native hay		Bermudagrass pasture			
															Common		Improved	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	Bu.	Lb. of lint	Lb. of lint	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Tons	Tons	Tons	Tons	AUM[1]	AUM[1]	AUM[1]	AUM[1]
Alluvial land	----	----	----	----	----	----	----	----	----	----	----	----	----	----	4.0	6.0	4.0	6.5
Bates fine sandy loam, 1 to 3 percent slopes	23	40	235	400	32	44	31	44	28	42	1.7	2.7	1.2	1.5	4.0	6.0	4.0	6.5
Bates fine sandy loam, 3 to 5 percent slopes	20	30	160	300	26	37	20	32	24	40	1.4	2.5	1.1	1.5	3.0	5.5	4.0	6.5
Bates fine sandy loam, 3 to 5 percent slopes, eroded	15	24	140	250	20	32	----	----	20	30	----	----	----	----	2.5	4.5	3.5	5.0
Bates-Collinsville fine sandy loams, 1 to 3 percent slopes [2]	14	23	140	250	20	30	----	----	20	30	----	----	1.1	1.4	2.5	4.5	3.5	5.0
Bates-Collinsville fine sandy loams, 3 to 5 percent slopes [2]	----	----	----	----	15	25	----	----	----	----	----	----	1.0	1.3	2.0	4.0	3.0	4.5
Brazos loamy fine sand	18	35	150	250	----	----	----	----	22	35	----	----	1.3	1.7	3.5	4.5	3.5	6.5
Breaks-Alluvial land complex	----	----	----	----	----	----	----	----	----	----	----	----	1.0	1.3	2.5	4.0	3.0	4.5
Brewer clay loam, ponded	----	----	260	525	38	55	45	70	44	65	3.5	4.5	1.4	1.9	4.5	6.0	5.0	8.0
Collinsville soils, 5 to 8 percent slopes	----	----	----	----	----	----	----	----	----	----	----	----	1.0	1.5	----	----	----	----
Dennis loam, 1 to 3 percent slopes	25	44	238	420	32	46	32	46	36	48	1.7	2.8	1.4	1.8	4.0	5.5	4.5	7.5
Dennis loam, 3 to 5 percent slopes	22	39	192	330	26	38	22	35	32	44	----	----	1.3	1.7	3.8	5.5	4.0	7.0
Dennis loam, 2 to 5 percent slopes, eroded	15	24	150	275	20	34	----	----	28	40	----	----	----	----	3.5	4.5	3.8	6.0
Dougherty-Eufaula complex, 8 to 20 percent slopes	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Eroded loamy land	----	----	----	----	----	----	----	----	----	----	----	----	----	----	2.0	3.0	----	----
Eufaula fine sand, undulating	----	----	----	----	----	----	----	----	----	----	----	----	----	----	2.0	3.0	2.0	4.0
Hartsells fine sandy loam, 1 to 3 percent slopes	20	40	220	390	22	39	20	38	22	36	----	----	.7	.9	3.5	5.5	4.0	7.0
Hartsells fine sandy loam, 3 to 5 percent slopes	16	34	150	280	20	32	20	32	16	29	----	----	.7	.9	3.0	5.0	3.5	6.5
Hartsells fine sandy loam, 3 to 5 percent slopes, eroded	14	22	130	220	16	25	12	20	14	24	----	----	----	----	2.5	4.5	3.0	5.5
Hartsells-Hector fine sandy loams, 2 to 5 percent slopes [2]	----	----	----	----	----	----	----	----	----	----	----	----	.6	.8	2.5	4.0	2.5	5.0
Hartsells-Hector complex, 2 to 5 percent slopes, eroded [2]	----	----	----	----	----	----	----	----	----	----	----	----	----	----	2.0	3.5	----	----
Hector complex, 5 to 30 percent slopes	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Konawa fine sandy loam, 1 to 3 percent slopes	27	53	240	460	35	48	28	42	28	48	2.0	3.2	1.3	1.7	3.5	5.6	5.3	7.0
Konawa fine sandy loam, 3 to 5 percent slopes	22	45	200	325	26	38	22	35	24	40	1.5	2.3	1.3	1.7	3.5	5.6	5.3	7.0
Konawa fine sandy loam, 2 to 5 percent slopes, eroded	15	30	160	275	20	34	18	27	20	33	----	----	----	----	2.1	4.5	3.0	6.3
Konawa loamy fine sand, 3 to 8 percent slopes	----	----	----	----	----	----	----	----	----	----	----	----	----	----	2.0	3.0	2.5	4.0
Konawa loamy fine sand, 3 to 8 percent slopes, severely eroded	----	----	----	----	----	----	----	----	----	----	----	----	----	----	2.0	3.0	----	----
Ochlockonee fine sandy loam	28	56	240	475	34	46	35	55	33	48	2.8	3.7	1.4	1.8	4.5	6.0	5.5	8.0
Oil-waste land	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Okemah-Slickspots complex, 1 to 3 percent slopes [2]	15	30	125	300	26	40	20	33	20	30	----	----	1.0	1.3	2.5	4.5	3.0	5.5
Okemah-Slickspots complex, 1 to 3 percent slopes, eroded [2]	----	----	----	----	20	34	----	----	----	----	----	----	----	----	2.0	4.0	3.0	5.0
Osage clay	----	----	130	330	25	40	----	----	25	42	----	----	1.2	1.6	3.0	4.5	4.0	5.5
Parsons silt loam, 0 to 1 percent slopes	15	30	125	300	26	42	----	----	27	44	----	----	1.0	1.3	3.0	4.5	4.0	5.5
Reinach very fine sandy loam	30	62	250	510	36	50	38	60	36	60	3.0	4.0	1.4	1.8	4.5	6.5	6.0	8.0
Rough stony land	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Stidham loamy fine sand, 0 to 2 percent slopes	20	40	130	240	----	----	17	35	20	36	----	----	.9	1.2	3.0	5.5	4.5	6.0

See footnotes at end of table.

TABLE 2.—*Predicted average acre yields of principal dryfarmed crops under two levels of management*—Continued

Mapping unit	Peanuts		Cotton		Oats		Corn		Grain sorghum		Alfalfa		Native hay		Bermudagrass pasture			
															Common		Improved	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Bu	*B*	*Lb. of lint*	*Lb. of lint*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*AUM* [1]	*AUM* [1]	*AUM* [1]	*AUM* [1]
Talihina-Collinsville complex, 5 to 20 percent slopes	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Taloka silt loam, 0 to 1 percent slopes	26	50	245	420	35	55	31	44	28	48	2. 1	3. 2	1. 2	1. 7	3. 0	4. 5	4. 0	6. 0
Taloka silt loam, 1 to 3 percent slopes	26	45	240	460	35	55	26	40	28	48	2. 1	3. 2	1. 3	1. 7	3. 0	4. 5	4. 0	6. 0
Vanoss loam, 0 to 1 percent slopes	28	55	248	500	40	55	37	50	35	55	2. 4	3. 4	1. 4	1. 8	5. 5	6. 5	6. 0	8. 5
Vanoss loam, 1 to 3 percent slopes	27	53	240	460	35	51	32	45	28	45	2. 2	3. 2	1. 4	1. 8	5. 5	6. 5	6. 0	8. 5
Verdigris clay loam	----	----	275	550	40	55	52	74	50	70	3. 3	4. 4	1. 5	2. 0	5. 5	7. 5	7. 0	9. 0
Verdigris silt loam	26	52	270	535	40	55	50	72	48	68	3. 2	4. 2	1. 5	2. 0	5. 5	7. 5	7. 0	9. 0

[1] AUM, animal-unit-months, is a term used to express the number of months that 1 animal unit can graze 1 acre without injury to the pasture. An animal unit is 1 cow, 1 steer, 1 horse, 5 hogs, or 7 sheep.

[2] Yields on the soils of this complex differ from yields on each soil where it occurs alone.

Use of the Soils for Range [2]

About 40 percent of Hughes County is in native range. The soils used as range are very shallow to deep and nearly level to steep. The better soils are cultivated. Most of the range has been taken over by livestock farms, but there are a few large ranches. The stock is sold mainly as weaner calves. The rangeland normally is grazed the year around, but the forage is supplemented with protein cubes, hay, and pasture of tame grasses or small grain.

On well-managed range, the vegetation is a mixture of grass, perennial legumes, forbs, shrubs, and other forage plants. The common kinds of grass are little bluestem, big bluestem, indiangrass, and switchgrass.

Range Sites and Condition Classes

Effective range management requires knowledge of the kind and quantity of forage that different soils are capable of producing and of the present condition of the vegetation in relation to the potential vegetation.

For the purpose of discussing range management, soils are placed in groups called range sites. A range site is an area of range that, because of its particular combination of soil, climate, and topography, has a particular potential for producing native forage plants.

The plants on any given range site are grouped, according to their response to grazing, as decreasers, increasers, and invaders. Decreasers are plants in the potential plant community that tend to decrease if heavily grazed. These plants generally are the tallest, most productive, and most palatable perennials. Increasers are plants in the potential community that normally increase as the decreasers decline. These plants generally are the shorter, less productive, less palatable plants. Under prolonged heavy grazing, the increasers become dominant. Invaders are plants that are not part of the original vegetation but that become established if both the decreasers and the increasers decline. They may be woody plants or herbaceous annuals or perennials, and they may originate nearby or at a great distance.

Four condition classes represent the degree to which the composition of the existing plant community is different from that of the potential plant community. Condition class is determined by estimating the relative production, by weight, of the various species that make up the existing plant community.

A range is in excellent condition if 76 to 100 percent of the present vegetation is of the same kind as the original vegetation. It is in good condition if the percentage is between 51 and 75, in fair condition if the percentage is between 26 and 50, and in poor condition if the percentage is 25 or less.

A range site in excellent condition is at or near its maximum productivity. It has a plant cover that adequately protects the soil, encourages the absorption of moisture, and helps to maintain fertility. A site in good condition has lost some of its decreaser plants, but it is still productive and can be maintained and improved by good management of grazing. A site in fair condition has a severely altered plant community in which increasers are dominant and invaders are becoming prominent. Generally, the amount of litter is inadequate for protection against compaction and erosion. Such areas ordinarily need to be closed to grazing for an entire growing season to bring about an improvement in their condition. A site in poor condition has lost almost all of the desirable forage plants, has few plants that are part of the original vegetation, and has many invaders.

Trends in range condition are indicated by the vigor of the plants, the abundance of desirable seedlings, changes in plant composition, accumulation of plant residue, and condition of the soil surface.

Descriptions of Range Sites

The soils of Hughes County have been grouped into 12 range sites, which are described in the following pages.

[2] By NEAL STIDHAM, range conservationist, Soil Conservation Service.

Soils that produce similar kinds and amounts of vegetation and that require and respond to about the same management have been grouped together. In each description are shown important soil characteristics, principal plants, and estimates of yields. The estimates are based on samples clipped at ground level and air dried. They represent total herbage production, not production of usable forage.

To find the range site in which each soil has been placed, turn to the "Guide to Mapping Units." Oil-waste land is not in any range site.

Claypan Prairie range site

Parsons silt loam, 0 to 1 percent slopes, is the only soil in this site. It has a subsoil of very slowly permeable, compact clay, which restricts the penetration of moisture and the development of roots. Because of the clay, this site is wetter in wet periods and drier in dry periods than the adjacent Loamy Prairie range site.

This site is moderately productive. If it is in excellent condition, 70 percent of the vegetation consists of little bluestem, big bluestem, indiangrass, switchgrass, fringeleaf paspalum, purpletop, gayfeather, sunflower, and heath aster. The remaining 30 percent consists of meadow dropseed, Scribner panicum, hairy grama, wild-indigo, slimflower scurfpea, and goldenrod. After prolonged overgrazing, this site is invaded by narrowleaf sumpweed, lanceleaf ragweed, bitter sneezeweed, annual brome, three-awn, jointtail, lovegrass, and broomsedge bluestem.

In favorable years, forage production is about 4,800 pounds per acre. In unfavorable years, it is about 2,300 pounds per acre.

Eroded Prairie range site

Eroded loamy land makes up this site. As a result of severe sheet and gully erosion, the root zone is shallow and stores little moisture.

This site is capable of producing a mixture of indiangrass, big bluestem, and little bluestem, but maximum production is only about half that of the Loamy Prairie range site. Deferment of grazing for an entire growing season may be required to protect the soils from erosion until the grass can become reestablished.

In favorable years, forage production is about 3,500 pounds per acre. In unfavorable years, it is about 1,500 pounds per acre.

Loamy Prairie range site

This site consists of nearly level to sloping soils that have a granular, porous surface layer of loam, silt loam, or fine sandy loam. They have good capacity for storing moisture and for root development.

This site is the most productive of the upland sites (fig. 15). If it is in excellent condition, about 80 percent of the vegetation consists of big bluestem, little bluestem, indiangrass, and switchgrass, and about 5 percent of legumes and of forbs such as tickclover, leadplant, gayfeather, and sunflower. The rest consists of increasers.

Common increasers are meadow dropseed, Scribner panicum, heath aster, sticky goldenrod, Louisiana sagewort, purpletop, wild-indigo, and jointtail. Invaders include western ragweed, lanceleaf ragweed, narrowleaf sumpweed, common broomweed, white snakeroot, annual brome, annual three-awn, broomsedge bluestem, splitbeard bluestem and, in the low places, hawthorn and persimmon.

***Figure 15.*—A Dennis loam in a lightly used area of the Loamy Prairie range site. The pond helps to distribute grazing.**

In favorable years, forage production is about 7,000 pounds per acre. In unfavorable years, it is about 3,500 pounds per acre.

Shallow Prairie range site

This site consists of very shallow and shallow, medium-textured soils. Most of the acreage has sandstone fragments on or near the surface, but some areas are fairly free of stones. A good mulch forms if the forage is not overgrazed, and this mulch absorbs water readily.

This site (fig. 16) produces almost the same kind of vegetation as the Loamy Prairie range site, but the potential production is about 25 percent less. If the site is in excellent condition, about 70 percent of the vegetation consists of little bluestem, big bluestem, indiangrass, switchgrass, wildrye, tall dropseed, Virginia tephrosia, catclaw sensitivebrier, and perennial sunflower. The rest consists of increasers, among which are side-oats grama, hairy grama, meadow dropseed, silver bluestem, jointtail, ashy sunflower, heath aster, sticky goldenrod, coralberry, and sumac. Invaders are annual brome, three-awn, splitbeard bluestem, broomsedge bluestem, ragweed, broomweed, bitter sneezeweed, hawthorn, and persimmon.

***Figure 16.*—Collinsville soils in an area of the Shallow Prairie range site. The site is in excellent condition.**

In favorable years, forage production is about 4,400 pounds per acre. In unfavorable years, it is about 2,600 pounds per acre.

Slickspot range site

The Slickspot range site is made up of slickspots, which have a hard surface crust. The site is surrounded by areas of the Loamy Prairie range site. As a result of a concentration of salts and a subsoil of compact clay, the vegetation is limited to plants that tolerate salt and resist drought.

If this site is in excellent condition, about 65 percent of the vegetation consists of little bluestem, switchgrass, and wildrye. The rest consists of increasers, among which are longspike tridens, meadow dropseed, Scribner panicum, sedges, and rushes. Invaders are lanceleaf ragweed, narrowleaf sumpweed, bitter sneezeweed, croton, and three-awn.

In favorable years, forage production is about 1,800 pounds per acre. In unfavorable years, it is about 800 pounds per acre.

Deep Sand Savannah range site

This site consists of deep sandy soils on uplands.

If this site is in excellent condition, about 75 percent of the vegetation consists of grasses and forbs and 25 percent consists of woody plants. About 80 percent of the forage is made up of little bluestem, big bluestem, indiangrass, switchgrass, broadleaf uniola, and beaked panicum. The rest consists of increasers, among which are purpletop, tall dropseed, Scribner panicum, sand lovegrass, and Texas bullnettle. After fires or prolonged overgrazing, this site is invaded by broomsedge bluestem, splitbeard bluestem, annual three-awn, showy partridgepea, ragweed, marestail, and white snakeroot. The principal trees are post oak, blackjack oak, red oak, hickory, flowering dogwood, winged elm, persimmon, and sassafras. Dense, scrubby stands of post oak, blackjack oak, elm, and persimmon sprouts develop if the site is overgrazed for a long time.

In favorable years, forage production is about 4,000 pounds per acre. In unfavorable years, it is about 2,500 pounds per acre.

Sandy Savannah range site

This site consists of fine sandy loams.

If this site is in excellent condition, about 80 percent of the vegetation consists of little bluestem, big bluestem, indiangrass, and switchgrass. The rest consists of purpletop, Scribner panicum, goldenrod, aster, and perennial sunflower. After prolonged overgrazing, heavy use, or fires, this site is invaded by broomsedge bluestem, annual three-awn, ragweed, bitter sneezeweed, and croton. Areas in poor condition have the appearance of a solid stand of post oak, blackjack oak, elm, hawthorn, and persimmon.

In favorable years, forage production is about 5,000 pounds per acre. In unfavorable years, it is about 3,000 pounds per acre.

Savannah Breaks range site

Rough stony land makes up this site. It has slopes of more than 30 percent. The soil material is dominantly very shallow but is deep in places. The water-holding capacity is low, and much of the rainfall is lost as runoff.

If this site is in excellent condition, about 80 percent of the vegetation consists of little bluestem, big bluestem, indiangrass, switchgrass, legumes, and forbs. About 10 percent consists of post oak, 5 percent of blackjack oak, and 5 percent of other woody plants. Common increasers are purpletop, Scribner panicum, goldenrod, aster, and perennial sunflower. After fires or prolonged heavy grazing, the plant cover becomes almost a solid stand of scrubby post oak, blackjack oak, elm, hawthorn, and scattered persimmon trees. The forage plants deteriorate into a thin, weak stand of little bluestem, broomsedge bluestem, annual three-awn, poverty oatgrass, ragweed, croton, and bitter sneezeweed.

In favorable years, forage production is about 3,500 pounds per acre. In unfavorable years, it is about 1,750 pounds per acre.

Shallow Savannah range site

This site consists of gently sloping to steep, very shallow and shallow soils on upland ridges. The ridges have horizontal beds of sandstone, which limit the water-holding capacity and restrict penetration by plant roots. Runoff is excessive.

If this site is in excellent condition, about 75 percent of the vegetation consists of big bluestem, little bluestem, indiangrass, switchgrass, legumes, and forbs. The rest consists of open stands of post oak, blackjack oak, and scattered hickory trees. Weeds and oak sprouts invade areas that are overgrazed. Chemicals or foliage sprays can be used to control unwanted plants until the grass can be reestablished.

In favorable years, forage production is about 3,000 pounds per acre. In unfavorable years, it is about 1,500 pounds per acre.

Heavy Bottomland range site

This site consists of nearly level, deep, clayey soils that become waterlogged in wet periods and are dry in summer.

Between 60 and 70 percent of the vegetation on this site is herbaceous, and the rest is woody. A large part of the vegetation consists of wildrye, uniola, sedges, and rushes, plants which grow mainly during cool periods. Switchgrass, prairie cordgrass, big bluestem, and Florida paspalum grow in the better drained parts if the site is in excellent condition. The woody plants are American elm, bois-d'arc, poison-ivy, and indigobush. Common invaders are sumpweed, buffalograss, meadow dropseed, ragweed, windmillgrass, trumpetvine, possumhaw, and hawthorn, elm, and ash trees.

In favorable years, forage production is about 7,000 pounds per acre. In unfavorable years, it is about 4,000 pounds per acre.

Loamy Bottomland range site

This site consists of deep, dark-colored, loamy soils.

This is the most productive site in the county. If it is in excellent condition, about 65 percent of the vegetation is made up of eastern gamagrass, prairie cordgrass, big bluestem, switchgrass, broadleaf uniola, and wildrye. The rest consists of pecan and walnut trees, indigobush, passionvine, trumpetvine, and other woody plants. In areas that are flooded, the vegetation consists mainly of johnsongrass, bermudagrass, pecan sprouts, trumpetvine, seacoast sumpweed, marestail, ragweed, white snakeroot, hawthorn, persimmon, and a few patches of indiangrass, big bluestem, and switchgrass.

In favorable years, forage production is about 10,000 pounds per acre. In unfavorable years, it is about 6,000 pounds per acre.

Sandy Bottomland range site

Brazos loamy fine sand makes up this site. It is on the bottom lands of the North Canadian and the South Canadian Rivers. The water-intake rate is rapid, and the water-holding capacity is low.

The vegetation is about 70 percent switchgrass, indiangrass, and big bluestem; 10 percent fringeleaf paspalum, purpletop, and beaked panicum; and 20 percent cottonwood and willow trees, sand plum, and wild grape. Bermudagrass is carried in by floods and becomes established. The common invaders are sandbur, sand dropseed, Texas bullnettle, snake cotton, camphor weed, annual wild buckwheat, and prickly poppy.

In favorable years, forage production is about 4,000 pounds per acre. In unfavorable years, it is about 2,000 pounds per acre.

Use of the Soils for Woodland, Windbreaks, and Post Lots[3]

Nearly half of Hughes County has a woody cover. Evidently some of the soils formerly supported red oak and post oak of commercial quality, but fires, close grazing, and the clear cutting of all commercial species have eliminated these desirable trees from the uplands. Generally, the bottom lands also have been cleared so they could be put to more remunerative uses, but native stands, mostly of scrub oak, still occur on the sandy soils and in rough, stony areas along the North Canadian and the South Canadian Rivers and the principal tributaries of these streams. These stands are of sufficient extent and quality that their potential productivity can be estimated.

Following are some suggestions for owners of woodland who may wish to maintain and manage their soils for post-lot plantings and windbreaks. Woodland can also be used for wildlife habitat or recreation or maintained for its esthetic value.

Post-Lot Plantings

Less than half the acreage of Hughes County is suitable for post-lot plantings, which require a deep, permeable soil. Posts can be grown on the same kinds of soils as field crops. Rapid growth is essential for both.

Windbreak Plantings

Farmstead windbreaks help to protect dwellings and livestock from winds and winter storms. They are especially needed where there is no natural shelter.

Windbreak plantings are not so exacting in their requirements as post-lot plantings. Different kinds of trees can be used, and kinds suitable for a specific site can be chosen after consideration of the characteristics of the soils. Furthermore, windbreak sites can be improved by irrigation, drainage, and tillage. The trees should be spaced far enough apart to allow for cultivation. Cottonwood, elm, sycamore, and other fast growing and moderately fast growing trees need wider spacing than other trees.

A multiple-row windbreak in this county should include one or more rows of evergreens, such as Austrian pine, ponderosa pine, shortleaf pine, Arizona cypress, and eastern redcedar. Shortleaf pine is suited only to the sandy or loamy soils. Evergreens increase the attractiveness of the windbreak and furnish year-round protection. They outlive most deciduous trees.

The outside row of a multiple-row windbreak should consist of a dense growth of low-growing shrubs and small trees. Suitable plants include common lilac, American plum, and Tatarian honeysuckle, which is not to be confused with the honeysuckle vine. Russian mulberry also can be planted in the outside row, but it should be pruned severely to keep it low and dense.

Windbreak and Post-Lot Groups

The soils of Hughes County have been placed in four groups according to their suitability for windbreak and post-lot plantings. Each group consists of soils that have about the same potential for producing the same kinds of trees under similar management. The groups are described in the following paragraphs. Shown in the descriptions of groups 1 and 2 are site indexes for specified trees that are suited to the soils. A site index is the average height, in feet, that the dominant trees in a fully stocked, even-aged stand will attain in 50 years.

The names of soil series represented are mentioned in the description of each group, but this does not mean that all the soils of a given series are in the group. To find the names of all the soils in any given group, refer to the "Guide to Mapping Units."

Group 1 is made up of deep, nearly level to gently sloping, loamy and sandy soils on bottom lands and uplands. In the group are Alluvial land and soils of the Brazos, Konawa, Ochlockonee, Reinach, Vanoss, and Verdigris series.

Black locust, catalpa, and red mulberry trees are suitable for post-lot plantings on these soils. Bois-d'arc, in addition, grows well on the Verdigris soils. Fast-growing trees suitable for windbreak plantings include American elm, Siberian elm, sycamore, black locust, and green ash.

Only the Brazos, Konawa, Ochlockonee, and Reinach soils are suitable for trees of commercial value. Brazos soils have a site index of 73 for cottonwood, 53 for black oak, and 43 for post oak. Konawa soils have a site index of 66 for red oak and 74 for cottonwood; Ochlockonee soils have a site index of 57 for black oak; and Reinach soils have a site index of 66 for red oak and 74 for cottonwood.

Group 2 is made up of deep and moderately deep, nearly level to gently sloping, well-drained to somewhat poorly drained, loamy and sandy soils on low terraces and uplands. In the group are soils of the Bates, Brewer, Dennis, Hartsells, Stidham, and Taloka series.

Only black locust trees are suitable for post-lot plantings on all these soils; bois-d'arc also is suitable for plantings on Brewer soils. Fast-growing trees suitable for windbreak plantings include American elm, Siberian elm,

[3] Prepared by CHARLES P. BURKE, woodland conservationist, Soil Conservation Service.

sycamore, black locust, and green ash. These trees need to be watered during extended droughts.

Only the Brewer and Stidham soils are suitable for trees of commercial value. Brewer soils have a site index of 70 for cottonwood, and Stidham soils have a site index of 63 for black oak.

Group 3 is made up of deep and moderately deep, nearly level to moderately steep, somewhat poorly drained to somewhat excessively drained, clayey, loamy, and sandy soils on uplands. The erosion hazard is slight to severe. In the group are soils of the Bates, Dennis, Dougherty, Eufaula, Hartsells, Hector, Konawa, Okemah, and Osage series.

Post-lot plantings of black locust on the Dougherty, Eufaula, and uneroded Konawa soils are successful except during droughts. Bois-d'arc is suitable for planting on the Dennis, Okemah, and Osage soils. Eroded Bates, Dennis, Hartsells, Hector, and Konawa soils in this group are not suitable for post-lot plantings.

All the soils in the group can be managed for windbreak plantings. Suitable fast-growing trees include American elm, Siberian elm, sycamore, black locust, and green ash. These trees require extra space between the rows and need to be cultivated intensively during the first two growing seasons. Even then, the mortality rate may be so high in dry periods that replanting is needed.

None of the soils in this group have potential for commercial timber production.

Group 4 is made up of deep to very shallow, level to steep, somewhat poorly drained to somewhat excessively drained, loamy soils on bottom lands and uplands. The erosion hazard is slight to severe. In the group are Breaks-Alluvial land complex, Eroded loamy land, Oil-waste land, Rough stony land, and soils of the Bates, Collinsville, Hector, Okemah, Parsons, and Talihina series.

Shallowness, rockiness, salinity, erosion hazard, and other unfavorable features make these soils unsuitable for trees.

Use of the Soils for Wildlife and Fish[4]

Wildlife habitats in Hughes County are mainly on prairie uplands and on timbered uplands and bottom lands. The most extensive prairies are in the northwestern quarter of the county; there are smaller areas in the northeastern and southern parts. The timbered uplands are in the eastern and southern parts. The timbered bottom lands are along Long George Creek, Wewoka Creek, Little Wewoka Creek, and the North Canadian River in the northern part of the county and along the South Canadian River, which flows eastward across the central part.

The important kinds of wildlife are bobwhite quail, mourning dove, fox squirrels, deer, cottontail rabbits, raccoons, foxes, minks, opossums, skunks, and muskrats. In recent years small numbers of armadillos have migrated from the south. Predatory animals and birds are foxes, coyotes, wolves, bobcats, and many species of hawks and owls. There are also many species of songbirds and, during the migration seasons, small numbers of waterfowl.

Bobwhite quail is the most sought after game bird in this county. Unless the weather has been exceptionally unfavorable, a large number of these birds is available for hunting each year. The season for hunting mourning doves begins about September 1 and normally is open for at least a month. The take generally is small.

Coyotes, raccoons, foxes, and bobcats are chased with hounds, mainly for sport. The skins are seldom pelted and sold for fur. Some opossums, skunks, muskrats, and minks are trapped for their pelts, but there are only small numbers of these animals. Minks are the most valuable furbearers in the county. Cottontail rabbits are hunted only when snow is on the ground. Restocking of deer began some years ago, and some deer are shot each year. Waterfowl are hunted only for short periods during the migration season in fall.

The larger streams in this county contain black bass, channel catfish, bullhead catfish, flathead catfish, crappie, carp, buffalo, and numerous species of small sunfish. Many farm ponds and water-detention structures are stocked with black bass, bluegill (shell-cracker), and channel catfish. Most of these ponds, however, remain turbid and, as a result, produce low yields of fish. Only bullhead catfish and channel catfish are likely to reproduce in these waters. Bass, bluegill, and sunfish cannot tolerate muddy water during the spawning season. The Osage, Verdigris, Parsons, and Okemah soils are not suitable for fish ponds, because the water becomes too muddy. Ponds built in the more permeable or excessively drained soils, such as the Reinach and Brazos soils, cannot normally maintain a high enough water level for fish.

Assistance in the management of fishponds can be obtained from local representatives of the Soil Conservation District, the Soil Conservation Service, the State Wildlife Conservation Department, the U.S. Fish and Wildlife Service, the State universities and their wildlife specialist extension services, and the county extension director. Fish for stocking can be obtained from State and Federal hatcheries.

The availability of food and cover for wildlife coincides in a general way with the five soil associations. These associations are discussed in the section "General Soil Map" and are shown on the map at the back of this publication.

Soil association 1, which consists mainly of Dennis, Bates, and Talihina soils, furnishes good habitat for quail, mourning doves, and rabbits. Since these soils are largely in cultivation, many kinds of desirable foods are available to wildlife. Quail and rabbits find woody cover along fence rows, field edges, and drainageways (fig. 17). Deer prefer areas bordered by timbered bottom lands.

Soil association 2, which consists mainly of Verdigris and Osage soils, furnishes good habitat for deer, quail, squirrels, and rabbits. These soils are fertile and nearly level. They occur near the larger streams. About half the acreage is in cultivation. Uncultivated areas have a good cover of hawthorn shrubs, which provide both food and cover for wildlife.

Soil association 3, which consists mainly of Hector and Hartsells soils, furnishes mast, browse, and a heavy wooded cover, mainly of oak and hickory, for deer and squirrel. The soils in this association support less palatable, and fewer kinds of plants than the other soil associations, but a small acreage is planted to corn, peanuts, cotton, oats, grain sorghum, and other crops. The habitat for deer and

[4] Prepared by JEROME F. SYKORA, biologist, Soil Conservation Service.

Figure 17.—**Multiflora rose hedge along the edge of a field of Dennis loam.**

quail is enhanced by waste grain in the fields and by native plants that thrive near the cultivated areas.

Soil association 4, which consists mainly of Konawa and Stidham soils, furnishes good habitat for all the important kinds of wildlife. Although this association makes up only a small part of the county, it supports more kinds of wildlife food and cover than the other associations. Because the soils are deep, plants develop an extensive root system and grow well even when they lack moisture. About half the acreage is planted to corn, grain sorghum, oats, alfalfa, peanuts, cotton, and other crops.

Soil association 5, which consists mainly of Reinach and Brazos soils, furnishes good wildlife habitat, particularly for deer, squirrels, and songbirds. A large acreage is cultivated, but field edges and untillable areas near streams offer an abundance of food and cover. There are many kinds of woody plants, including oak, cottonwood, pecan, bois-d'arc, mulberry, elm, plum, wild cherry, ash, hackberry, walnut, hawthorn, huckleberry, and sumac.

Use of the Soils in Engineering[5]

Some soil properties are of special interest to engineers because they affect the construction and maintenance of roads, airports, pipelines, building foundations, facilities for water storage, erosion control structures, drainage systems, and sewage disposal systems. The properties most important to engineers are permeability to water, shear strength, compaction characteristics, soil drainage, shrink-swell characteristics, grain size, plasticity, and reaction (pH). The depth to the water table, the depth to bedrock, and topography also are important.

Information in this survey can be used to—

1. Make studies that will aid in selecting and developing industrial, business, residential, and recreational sites.
2. Make preliminary estimates of soil properties that are significant in the planning of agricultural drainage systems, farm ponds, irrigation systems, and diversion terraces.
3. Make preliminary evaluations of soil and ground conditions that will aid in selecting locations for highways, airports, pipelines, and cables, and in planning detailed investigations at the selected locations.
4. Locate probable sources of topsoil and other construction materials.
5. Correlate performance of engineering structures with soil mapping units to develop information for overall planning that will be useful in designing and maintaining certain engineering practices and structures.
6. Determine the suitability of soils for cross-country movement of vehicles and construction equipment.
7. Supplement the information obtained from other published maps and reports and aerial photographs to make maps and reports that can be used readily by engineers.
8. Develop other preliminary estimates for construction purposes pertinent to the particular area.

With the use of the soil map for identification, the engineering interpretations in this section can be useful for many purposes. It should be emphasized that they do not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads and excavations deeper than the depths of layers here reported. Even in these situations, the soil map is useful in planning more detailed field investigations and for suggesting the kinds of problems that may be expected.

Agricultural and Engineering Classification Systems

The system of classifying soils used by the American Association of State Highways Officials (AASHO)[6] is based on field performance of the soils in highways. In this system soils are placed in seven principal groups. The groups range from A–1, which consists of gravelly soils of high bearing capacity, to A–7, which consists of clayey soils that have low strength when wet. Within each group the relative engineering value of the soil material is indicated by a group index. Group indexes range from 0 for the best material to 20 for the poorest. The group index number is shown in parentheses following the soil group symbol, for example, A–4(5).

The Unified classification system[7] is based on the identification of soils according to texture, plasticity, and performance as material for engineering structures. Soil materials are identified as coarse grained—gravel (G) and sand (S); fine grained—silt (M) and clay (C); and highly organic (O). Clean sand is designated by the symbols SW and SP; silty and clayey sand by the symbols SM and SC; silt or clay that has a low liquid limit by the symbols ML and CL; and clay that has a high liquid limit by the symbols MH and CH.

[5] Prepared by FORREST MCCLUNG, engineer, Soil Conservation Service.

[6] AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS. STANDARD SPECIFICATIONS FOR HIGHWAY MATERIALS AND METHODS OF SAMPLING AND TESTING. Part 1, Ed. 8, 1961.

[7] WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS. UNIFIED SOIL CLASSIFICATION SYSTEM. Tech. Memo No. 3–357, v. 1, 1953.

The system used by the U.S. Department of Agriculture (USDA) [8] is primarily for agricultural use. It is helpful to engineers, however, because it classifies soil material according to texture. Of primary importance in this system is the relative proportion of the various-sized individual grains in a mass of soil. Textural classes are based on different combinations of sand (2.0 millimeters to 0.05 millimeter in diameter), silt (0.05 to 0.002 millimeter), and clay (less than 0.002 millimeter).

Estimated Engineering Properties

Table 3 shows estimates of soil properties that affect engineering. These estimates are based on available test data for the modal, or typical, profiles. Estimates of properties of soils not tested are based on test data for similar soils in this county or other counties, and on past experience in engineering construction. Since the estimates are only for modal soils, considerable variation from the values shown in table 3 should be anticipated. More information on the range of properties of the soils can be obtained from the section "Descriptions of the Soils." In that section a profile typical of each series in Hughes County is described in detail.

Available water capacity refers to the amount of capillary water in a soil that is wet to field capacity. If the moisture content is at the wilting point for plants, this amount of water will wet the soil material described to a depth of 1 inch without deeper percolation.

Reaction (pH) refers to the degree of acidity or alkalinity of a soil. The degrees are defined under "Reaction" in the Glossary.

Shrink-swell potential indicates the volume change to be expected with a change in moisture content. The estimates are based on volume-change tests or observed physical properties and characteristics of the soil. For example, soil material from the A horizon of Osage clay is very sticky when wet and develops extensive shrinkage cracks when dry; it therefore has a high shrink-swell potential. Material from the A horizon of Eufaula fine sand is structureless and nonplastic and has a low shrink-swell potential.

Permeability indicates the rate at which water moves through undisturbed soil material. The estimates are based on soil structure and porosity. Mechanically developed features, such as plowpans and surface crusting, have not been considered. In table 3 the rates are expressed in inches per hour, which can be expressed verbally as follows:

Inches per hour:	
Less than 0.05	Very slow.
0.05 to 0.20	Slow.
0.20 to 0.80	Moderately slow.
0.80 to 2.50	Moderate.
2.50 to 5.00	Moderately rapid.
5.00 to 10.00	Rapid.
More than 10.00	Very rapid.

The last column in table 3 shows the classification of the soils in four hydrologic soil groups. The entire soil profile is considered, to the greatest depth shown in the column "Depth from surface." The classification is based on intake of water at the end of a long-duration storm that occurred after the soil had had prior wetting and an opportunity for swelling and when the soil was without the protection of vegetation. Group A consists mostly of sandy soils and has the lowest runoff potential. Group D consists mostly of clays and has the highest runoff potential.

Engineering Interpretations

Table 4 lists, for each soil in Hughes County, interpretations of its features or characteristics that may affect its suitability for specific engineering purposes. These interpretations are based on information in table 3, on available test data, and on field experience.

Normally, only the surface layer of a soil is rated as a source of topsoil; suitability depends largely upon the texture of the material and the thickness of the layer. The material must be friable enough to be worked into a good seedbed for seeding or sodding, yet clayey enough to resist erosion on steep slopes.

The suitability rating for select material depends primarily upon the grain size and the kind of binding material that holds the material together. Soils that are predominantly sand are good if a binder is added for cohesion. Clay soils compress under load but rebound when unloaded; thus, they are rated poor.

Most kinds of soil material are used as road fill. Some kinds, such as sandy clay and sandy clay loam, present few problems in placement or compaction. Clay, which has a high shrink-swell potential, requires special compaction techniques and close moisture control both during and after construction. Sand compacts well but is difficult to confine in a fill. The rating reflects the ease with which these problems can be overcome.

Engineering Test Data

Table 5 shows test data for soil samples collected during the survey of Hughes County and tested by the State Highway Department. Test data for some of the other soils may be found in other published soil surveys.

As moisture leaves a soil, the soil shrinks and decreases in volume in proportion to the loss in moisture, until a point is reached where shrinkage stops even though additional moisture may still be removed from the soil. The moisture content at which shrinkage stops is called the shrinkage limit. The shrinkage limit of a soil is a general index of clay content and generally decreases as the clay content increases. The shrinkage limit of sand that contains little or no clay gives a test result that is close to the liquid limit and, therefore, is considered insignificant. As a rule, the load-carrying capacity of a soil is at a maximum when its moisture content is at or below the shrinkage limit. Sand is an exception. If confined, it has a uniform load-carrying capacity within a considerable range in moisture content.

The shrinkage ratio is calculated by dividing the volume change resulting from the drying of a soil material by the amount of moisture lost. The volume change used in computing shrinkage ratio is the change in volume that will take place in a soil when it dries from a given moisture content to the point where no further shrinkage takes place.

The field moisture equivalent is the minimum moisture content at which a smooth soil surface will absorb no more water in 30 seconds when the water is added in individual

[8] UNITED STATES DEPARTMENT OF AGRICULTURE. SOIL SURVEY MANUAL. U.S. Dept. Agr. Handbook 18, 503 pp., 1951.

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TABLE 3.—*Estimated engineering*

Soil series and map symbols	Depth from surface	Classification		
		USDA texture	Unified	AASHO
	Inches			
Alluvial land (Al). Material variable; no estimates except for hydrologic group.	----------	----------	----------	----------
Bates (BaB, BaC, BaC2, BcB, BcC). For Collinsville part of BcB and BcC, see Collinsville series.	0–12	Fine sandy loam	ML, SM	A–4
	12–38	Loam	ML, CL	A–4
	38	Sandstone.		
Brazos (Bf).	0–8	Loamy fine sand	SM	A–2
	8–67	Fine sand	SP, SM	A–3
Breaks-Alluvial land complex (Bk). Material variable; no estimates except for hydrologic group.	----------	----------	----------	----------
Brewer (Bp).	0–40	Clay loam	CL	A–6
	40–56	Sandy clay loam	SC, CL	A–4
Collinsville (CoD).	0–9	Fine sandy loam	SM, ML	A–4
	9	Sandstone.		
Dennis (DnB, DnC, DnC2).	0–12	Loam	ML, CL	A–4
	12–28	Clay loam	CL	A–6
	28–63	Clay	CL, CH	A–7
Dougherty-Eufaula complex (DtE). For Eufaula part, see Eufaula series.	0–24	Loamy fine sand	SM	A–2
	24–50	Sandy clay loam	SC, CL	A–4
	50–65	Loamy fine sand	SM	A–2, A–4
Eroded loamy land (Er). Material variable; no estimates except for hydrologic group.	----------	----------	----------	----------
Eufaula (EuB).	0–75	Fine sand	SM, SP	A–2, A–3
Hartsells (HaB, HaC, HaC2, HhC, HsC2). For Hector part of HhC and HsC2, see Hector series.	0–15	Fine sandy loam	ML, SM	A–4
	15–41	Sandy clay loam	SC, ML-CL	A–6, A–7
	41–50	Loosely cemented sandstone.		
Hector (HtE).	0–11	Gravelly fine sandy loam	SM	A–2
	11–26	Sandstone.		
Konawa (KoB, KoC, KoC2).	0–10	Fine sandy loam	ML	A–4
	10–36	Sandy clay loam	ML, CL	A–4
	36–62	Fine sandy loam	ML, CL	A–4
Konawa (KsD, KsD3).	0–16	Loamy fine sand	SM	A–2
	16–36	Sandy clay loam	SC, CL	A–4
	36–48	Loamy sand	SM	A–2, A–4
	48–72	Fine sand	SM	A–2
Ochlockonee (Oc).	0–12	Fine sandy loam	ML, SM	A–4
	12–24	Loam	ML, CL	A–4
	24–63	Very fine sandy loam	ML, CL	A–4
Oil-waste land (Od). Material variable; no estimates except for hydrologic group.	----------	----------	----------	----------
Okemah (OkB, OkB2).	0–13	Silt loam	ML, CL	A–4
	13–20	Clay loam	CL	A–6
	20–60	Clay	CH	A–7
Osage (Os).	0–65	Clay	MH, CH	A–7

properties of the soils

Percentage passing sieve— No. 4 (4.76 mm.)	Percentage passing sieve— No. 10 (2.0 mm.)	Percentage passing sieve— No. 200 (0.074 mm.)	Available water capacity	Reaction	Shrink-swell potential	Permeability of the least permeable layer	Hydrologic group
			Inches per inch of soil	*pH value*			
--	--	--	--	--	--	--	C
--	100	45–65	0.12	5.6–6.5	Low	0.80–2.50	B
--	100	60–85	.14	5.5–6.5	Low		
--	100	15–35	.07	7.4–8.4	Low	5.00–10.00	B
--	100	5–10	.05	7.4–8.4	Low		
--	--	--	--	--	--	--	C
--	100	70–80	.17	6.1–7.3	Moderate	0.05–0.20	D
--	100	40–70	.14	6.0–8.4	Low		
--	100	40–55	.12	5.6–6.5	Low	2.50–5.00	C
--	100	60–75	.14	5.6–6.5	Low	0.05–0.20	C
--	100	70–80	.17	5.6–7.3	Moderate		
--	100	85–95	.17	7.4–8.4	High		
100	90–100	15–35	.07	5.8–6.7	Low	0.80–2.50	B
--	100	40–55	.14	5.3–6.5	Low		
--	100	30–40	.07	5.6–6.5	Low		
--	--	--	--	--	--	--	C
--	100	10–20	.05	4.5–6.5	Low	5.00–10.00	A
--	100	45–80	.12	5.6–6.5	Low	0.80–2.50	B
--	100	45–75	.14	4.5–5.5	Low		
55–80	55–80	20–35	.09	4.5–5.5	Low	2.50–5.00	B
--	100	60–80	.12	5.1–6.0	Low	0.80–2.50	B
--	100	60–80	.14	6.1–7.3	Low		
--	100	55–75	.12	5.6–6.5	Low		
100	90–100	15–35	.07	5.6–6.5	Low	0.80–2.50	B
--	100	40–55	.14	4.8–5.3	Low		
--	100	30–40	.07	4.5–5.0	Low		
--	100	11–20	.05	5.1–5.8	Low		
--	100	45–65	.12	5.1–6.0	Low	2.50–5.00	B
--	100	60–75	.14	5.1–6.0	Low		
--	100	60–80	.14	4.5–5.5	Low		
--	--	--	--	--	--	--	D
--	100	70–90	.14	5.6–6.5	Low	0.05–0.20	C
--	100	75–95	.17	5.6–6.5	Moderate		
--	100	75–95	.17	6.6–8.4	High		
--	100	95–98	.17	6.1–7.8	High	<0.05	D

TABLE 3.—*Estimated engineering*

Soil series and map symbols	Depth from surface	Classification		
		USDA texture	Unified	AASHO
	Inches			
Parsons (PaA).	0–12	Silt loam	ML	A–4
	12–70	Clay	CL, CH	A–7
Reinach (Rf).	0–27	Very fine sandy loam	ML	A–4
	27–70	Loamy very fine sand	SM, ML	A–2, A–4
Rough stony land (Ro). Material variable; no estimates except for hydrologic group.				
Stidham (StB).	0–23	Loamy fine sand	SM	A–2
	23–45	Sandy clay loam	SC, CL	A–4
	45–55	Fine sandy loam	ML, SM	A–4
	55–69	Loamy fine sand	SM	A–2
Talihina (TcE). For Collinsville part, see Collinsville series.	0–5	Clay loam	CL	A–6
	5–20	Clay	CL, CH	A–7
Taloka (TkA, TkB).	0–22	Silt loam	ML	A–4
	22–72	Clay	CH	A–7
Vanoss (VaA, VaB).	0–16	Loam	ML, CL	A–4
	16–48	Clay loam	CL	A–6
	48–65	Sandy clay loam	SC, CL	A–6
Verdigris (Vd).	0–60	Clay loam	CL	A–6
Verdigris (Vg).	0–36	Silt loam	ML, CL	A–4, A–6
	36–60	Silty clay loam	CL	A–6

properties of the soils—Continued

Percentage passing sieve—			Available water capacity	Reaction	Shrink-swell potential	Permeability of the least permeable layer	Hydrologic group
No. 4 (4.76 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)					
			Inches per inch of soil	*pH value*			
------	100	70–90	.14	5.6–6.5	Low	<0.05	D
------	100	90–98	.17	5.6–7.8	High		
------	100	60–80	.14	6.3–7.8	Low	0.80–2.50	B
------	100	25–55	.07	7.4–8.4	Low		
------	------	------	------	------	------	------	C
------	100	15–35	.07	5.1–6.5	Low	0.80–2.50	B
------	100	40–55	.14	5.6–6.5	Low		
------	100	40–55	.12	5.6–6.5	Low		
------	100	15–35	.07	5.6–6.5	Low		
------	100	70–80	.17	5.6–6.5	Moderate	0.05–0.20	D
------	100	75–95	.17	5.6–7.8	High		
96–100	95–100	70–90	.14	5.6–6.5	Low	<0.05	D
96–100	90–100	75–95	.17	7.4–8.4	High		
------	100	60–75	.14	6.1–7.3	Low	0.80–2.50	B
------	100	70–80	.17	5.6–6.5	Moderate		
------	100	40–55	.14	4.5–5.5	Low		
------	100	70–80	.17	5.6–7.3	Moderate	0.20–0.80	B
------	100	70–90	.14	5.6–6.5	Low	0.20–0.80	B
------	100	90–95	.17	6.1–6.5	Moderate		

TABLE 4.—*Interpretations of*

[No interpretations are shown for Alluvial land, Breaks-Alluvial land complex,

Soil series and map symbols	Suitability as source of—			Soil features affecting—
	Topsoil	Select material	Road fill	Highway location
Bates (BaB, BaC, BaC2, BcB, BcC). For Collinsville part of BcB and BcC, see Collinsville series.	Fair to good; surface material easily eroded.	Good	Good	Sandstone at depth of about 3 feet, lateral seepage along rock.
Brazos (Bf)	Unsuitable; too sandy.	Fair; good if binder is added.	Good if slopes are stabilized.	Features favorable
Brewer (Bp)	Good	Unsuitable; too clayey.	Poor; requires close moisture control, unstable when wet.	Poor surface drainage.
Collinsville (CoD)	Poor; limited in quantity, easily eroded.	Poor; limited in quantity, stony.	Fair; fractured sandstone.	Broken topography, sandstone at depth of 1 foot or less.
Dennis (DnB, DnC, DnC2)	Fair to good	Unsuitable	Poor; unstable when wet.	Subsoil unstable when wet, moderate to high shrink-swell potential in subsoil.
Dougherty-Eufaula complex (DtE). For Eufaula part, see Eufaula series.	Poor; easily eroded.	Good	Good	Cuts easily eroded
Eufaula (EuB)	Unsuitable; too sandy.	Fair; good if binder is added.	Good if confined and if slopes are stabilized.	Cuts easily eroded
Hartsells (HaB, HaC, HaC2, HhC, HsC2). For Hector part of HhC and HsC2, see Hector series.	Poor; easily eroded.	Good	Good if material is mixed.	Features favorable
Hector (HtE)	Poor; stony, shallow.	Poor; limited in quantity, stony.	Fair; sandstone at depth of about 1 foot.	Steep topography, sandstone at depth of about 1 foot.
Konawa (KoB, KoC, KoC2, KsD, KsD3)	Poor; easily eroded.	Good	Good	Cuts easily eroded
Ochlockonee (Oc)	Fair; easily eroded.	Good	Good if slopes are stabilized.	Nearly level topography, susceptibility to flooding.
Okemah (OkB, OkB2)	Poor to fair; numerous slickspots.	Unsuitable; too elastic.	Poor; moderate to high shrink-swell potential in subsoil.	Very gently sloping topography, unstable soils.

engineering properties of the soils

Eroded loamy land, Oil-waste land, Rough stony land, and Slickspots

Soil features affecting—Continued							Limitations for septic tank drainage fields
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways		
Reservoir area	Embankment						
Limited natural storage.	Features favorable.	Sloping topography, drainage not needed.	Sloping topography.	Features favorable.	Features favorable.		Severe: sandstone at depth of about 3 feet.
High seepage potential.	Easily eroded	Somewhat excessive drainage.	Low water-holding capacity, rapid intake rate.	Level topography.	Level topography.		Moderate: coarse texture, poor filtering qualities.
High seepage potential below depth of 4 feet in some places.	Features favorable.	Depressional areas that need to be drained.	Somewhat poor surface drainage.	Level topography.	Level topography.		Severe: slow percolation rate, poor drainage.
Broken topography, sandstone at depth of 1 foot or less.	Limited material, rocky.	Broken topography, somewhat excessive drainage.	Nonarable	Nonarable	Nonarable		Severe: sandstone at depth of 1 foot or less.
Features favorable.	Features favorable.	Moderately good drainage.	Features favorable.	Features favorable.	Features favorable.		Severe: slow percolation rate.
High seepage potential.	Unstable slopes	Drainage not needed.	Rapid intake rate.	Susceptibility to soil blowing and water erosion.	Susceptibility to soil blowing, water erosion, and gullying.		Slight: features favorable.
High seepage potential.	High erosion hazard, high seepage potential.	Somewhat excessive drainage.	Low water-holding capacity, rapid intake rate.	Susceptibility to soil blowing and water erosion.	Susceptibility to soil blowing and water erosion.		Slight: coarse texture, poor filtering qualities.
Limited depth to sandstone.	Features favorable.	Sloping topography, drainage not needed.	Sloping topography.	Features favorable.	Features favorable.		Severe: sandstone at depth of 3 to 4 feet.
Steep topography	Limited borrow material.	Somewhat excessive drainage.	Nonarable	Nonarable	Nonarable		Severe: steep topography, sandstone at depth of about 1 foot.
High seepage potential.	Unstable slopes	Sloping topography, drainage not needed.	Rapid intake rate.	Susceptibility to soil blowing and water erosion.	Susceptibility to soil blowing, water erosion, and gullying.		Slight: features favorable.
Nearly level topography, susceptibility to flooding.	Easily eroded, unstable slopes.	Good drainage	Susceptibility to flooding.	Nearly level topography.	Nearly level topography.		Severe: flooding.
Features favorable.	Features favorable, except in slickspots.	Moderately good drainage.	Very gently sloping topography, slow permeability.	Features favorable.	Features favorable.		Severe: slow percolation rate.

TABLE 4.—*Interpretations of engineering*

Soil series and map symbols	Suitability as source of—			Soil features affecting—
	Topsoil	Select material	Road fill	Highway location
Osage (Os)	Unsuitable; too clayey.	Unsuitable; too clayey.	Very poor; very plastic when moist, high shrink-swell potential.	Somewhat poor drainage, susceptibility to flooding, unstable soils.
Parsons (PaA)	Poor; easily eroded.	Unsuitable; too elastic.	Very poor; highly plastic, unstable when wet.	Very slow internal drainage, high shrink-swell potential in subsoil, unstable clayey subsoil.
Reinach (Rf)	Fair; easily eroded.	Fair to good	Good	Features favorable
Stidham (StB)	Poor; easily eroded.	Good	Good	Erodible material
Talihina (TcE) For Collinsville part, see Collinsville series.	Poor; surface rocks, shallow soils.	Poor	Poor	Moderately steep, broken topography.
Taloka (TkA, TkB)	Fair; easily eroded.	Unsuitable; too elastic.	Very poor; unstable when wet, high shrink-swell potential in subsoil.	Very slow internal drainage, unstable clay subsoil.
Vanoss (VaA, VaB)	Good	Fair	Fair	Unstable when wet
Verdigris (Vd, Vg)	Good	Unsuitable; too elastic or too clayey.	Poor; plastic when wet.	Unstable when wet, susceptible to flooding.

properties of the soils—Continued

Soil features affecting—Continued							Limitations for septic tank drainage fields
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways		
Reservoir area	Embankment						
Features favorable for dug ponds.	High shrink-swell potential, low shear strength.	Subject to flooding, very slow permeability.	Very slow intake rate, susceptibility to flooding.	Nearly level topography, susceptibility to flooding.	Nearly level topography; susceptibility to flooding.		Severe: very slow percolation rate, flooding.
Features favorable for dug ponds.	High shrink-swell potential in subsoil, low shear strength.	Somewhat poor drainage.	Very slow intake rate, slow internal drainage.	Slow internal drainage.	Droughty, difficult to establish vegetation.		Severe: very slow percolation rate.
Nearly level topography, high seepage potential.	Easily eroded	Drainage not needed.	Rapid intake rate.	Nearly level topography.	Nearly level topography.		Slight: features favorable.
High seepage potential.	Easily eroded, unstable slopes.	Good drainage	Features favorable.	Susceptibility to soil blowing, water erosion, and gullying.	Susceptibility to soil blowing, water erosion, and gullying.		Slight: features favorable.
Moderately steep topography.	Moderately steep topography, limited borrow material.	Moderately steep topography, somewhat excessive drainage.	Nonarable	Nonarable	Nonarable		Severe: slow percolation rate, moderately steep slopes.
Features favorable for dug ponds.	High shrink-swell potential in subsoil, low shear strength.	Somewhat poor drainage.	Very slow intake rate, slow internal drainage.	Features favorable.	Features favorable.		Severe: very slow percolation rate.
Features favorable.	Features favorable.	Good drainage	Features favorable.	Features favorable.	Features favorable.		Moderate: moderate permeability.
Features favorable for dug ponds.	Features favorable.	Flooding for short periods.	Occasional flooding.	Susceptibility to flooding.	Susceptibility to flooding.		Severe: flooding.

TABLE 5.—*Engineering*

[Tests performed by the Oklahoma Department of Highways, in accordance with

Soil type and location	Parent material	Oklahoma report No.	Depth	Horizon	Shrinkage		Volume change from field moisture equivalent [1]
					Limit	Ratio	
			Inches				*Percent*
Bates fine sandy loam: 825 feet E. and 300 feet S. of NW. corner of NE¼ sec. 15, T. 7 N., R. 9 E.	Sandstone.	SO-7848	0-15	A1	19	1.76	7
		SO-7849	21-31	B2	17	1.83	17
Eufaula fine sand: 835 feet S. and 40 feet W. of NE. corner of NW¼ sec. 12, T. 9 N., R. 10 E.	Old alluvium.	SO-7821	0-8	A1	(5)	(5)	(5)
		SO-7822	8-48	A2	(5)	(5)	(5)
		SO-7823	48-72	B2	(5)	(5)	(5)
Hartsells fine sandy loam: 500 feet W. and 480 feet S. of center of sec. 24, T. 9 N., R. 11 E.	Sandstone.	SO-7827	0-8	A1	(5)	(5)	(5)
		SO-7828	16-25	B2	17	1.78	8
		SO-7829	33-46	B3	12	1.95	48
Konawa fine sandy loam: 1,290 feet N. and 820 feet E. of SW. corner of SE¼ sec. 15, T. 6 N., R. 9 E.	Old alluvium.	SO-7854	0-14	A1	(5)	(5)	(5)
		SO-7855	22-39	B2	17	1.80	18
		SO-7856	63-75	C	16	1.81	13
Ochlockonee fine sandy loam: 1,580 feet N. and 470 feet E. of SW. corner of SE¼ sec. 32, T. 5 N., R. 10 E.	Alluvium.	SO-7857	6-10	A1	(5)	(5)	(5)
		SO-7858	31-44	AC	15	1.83	14
		SO-7859	44-80	AC	15	1.86	18
Osage clay: 900 feet E. of SW. corner of sec. 33, T. 9 N., R. 10 E.	Alluvium.	SO-7818	10-24	A1	10	2.04	67
		SO-7819	24-52	AC	9	2.07	80
Parsons silt loam: 1,200 feet W. and 60 feet S. of NE. corner of SE¼ sec. 21, T. 9 N., R. 10 E.	Shale.	SO-7842	6-10	A2	20	1.69	2
		SO-7843	26-38	B2	11	1.96	48
		SO-7844	56-70	C	11	1.98	54
Taloka silt loam: 1,200 feet S. and 65 feet E. of NW. corner of sec. 29, T. 9 N., R. 12 E.	Old alluvium.	SO-7836	0-18	A1	21	1.71	5
		SO-7837	32-48	B3	10	2.00	66
		SO-7838	48-72	C	11	2.01	62

[1] Based on AASHO Designation: T 99-57, "The Moisture-Density Relations of Soils Using a 5.5-lb. Rammer and a 12-in. Drop," (Method A) in "Standard Specifications for Highway Materials and Methods of Sampling and Testing," pt. 2, Ed. 8 (1961), published by AASHO.

[2] According to AASHO Designation: T 88-57, "Mechanical Analysis of Soils," in "Standard Specifications for Highway Materials and Methods of Sampling and Testing," pt. 2, Ed. 8 (1961), published by AASHO. Results by this procedure may differ somewhat from results 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 material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analysis data used in this table are not suitable for use in naming textural classes for soils.

test data

standard procedures of the American Association of State Highway Officials (AASHO)]

Mechanical analysis [2]								Liquid limit	Plasticity index	Classification	
Percentage passing sieve—					Percentage smaller than—					AASHO [3]	Unified [4]
¾-in.	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.				
--------	--------	100	99	60	43	16	13	23	2	A-4(5)	ML
--------	--------	100	98	66	48	25	22	27	9	A-4(6)	CL
--------	--------	100	98	18	13	5	4	[5]	[5]	A-2-3(0)	SM
--------	--------	100	97	16	13	6	4	[5]	[5]	A-2-3(0)	SM
--------	--------	100	98	10	8	5	4	[5]	[5]	A-3(0)	SP-SM
--------	--------	100	99	48	34	10	9	[5]	[5]	A-4(3)	SM
--------	--------	100	99	52	35	19	17	22	4	A-4(3)	ML-CL
100	97	93	91	75	52	32	28	45	19	A-7-6(13)	ML-CL
--------	--------	100	99	79	61	13	9	[5]	[5]	A-4(8)	ML
--------	--------	100	98	80	63	23	20	27	7	A-4(8)	ML-CL
--------	--------	100	98	66	47	19	17	23	4	A-4(6)	ML-CL
--------	--------	--------	100	63	45	9	7	[5]	[5]	A-4(6)	ML
--------	--------	--------	100	66	50	20	18	22	5	A-4(6)	ML-CL
--------	--------	--------	100	69	51	22	20	24	7	A-4(7)	ML-CL
--------	--------	--------	--------	98	95	56	46	57	28	A-7-6(19)	MH-CH
--------	--------	--------	100	98	95	65	49	56	28	A-7-6(18)	MH-CH
--------	--------	100	99	86	72	15	13	23	2	A-4(8)	ML
--------	--------	--------	100	94	86	41	35	44	21	A-7-6(13)	CL
--------	--------	100	99	92	83	41	38	47	25	A-7-6(15)	CL
100	99	98	96	78	62	14	11	23	2	A-4(8)	ML
--------	100	97	94	86	75	46	43	62	35	A-7-6(20)	CH
100	97	92	86	77	70	38	35	53	30	A-7-5(19)	CH

[3] Based on AASHO Designation: M 145-49, "The Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes," in "Standard Specifications for Highway Materials and Methods of Sampling and Testing," pt. 1, Ed. 8 (1961), published by AASHO. The Oklahoma Department of Highways classification procedure further subdivides the A-2-4 subgroup into the following: A-2(0) when PI=nonplastic to 5; and A-2-4(0) when PI=5 to 10.

[4] SCS and the Bureau of Public Roads have agreed to consider that all soils having plasticity indexes within 2 points of the A-line are to be given a borderline classification. Examples of borderline classifications obtained by this use are SM-SC, ML-CL, MH-CH, and SP-SM.

[5] Nonplastic.

drops. It is the moisture content required to fill all the pores in sands and to approach saturation in cohesive soils. The volume change from field moisture equivalent is the volume change, expressed as a percentage of the dry volume, of the soil mass when the moisture content is reduced from the field moisture equivalent to the shrinkage limit.

In mechanical analysis, the soil components are sorted by particle size. Sand and other granular material are retained on a number 200 sieve. Silt-clay materials are those soil particles smaller than the openings in a number 200 sieve. Clay is the fraction smaller than 0.002 millimeter in diameter. The material intermediate in size between that held on the number 200 sieve and that having a diameter of 0.002 millimeter is called silt in the AASHO textural ratings.

The tests for liquid limit measure the effect of water on the consistence of the soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a semisolid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material passes from a semisolid to a plastic state. The liquid limit is the moisture content at which the material 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 material is plastic.

Formation and Classification of the Soils

This section discusses the factors of soil formation and tells how these factors have affected the soils of Hughes County. It also discusses the classification of the soils according to the current system.

Factors of Soil Formation

The properties of the soil at a given place result from the integrated effects of five major factors of soil formation: parent material, climate, plant and animal life, relief, and time.

Parent material

Differences in parent material bring about corresponding differences in the characteristics of the soils that form. For example, the parent material of the Bates, Dennis, and Parsons soils, which are on uplands, consisted of weathered, slightly compact clay and medium-hard shale and sandstone. Wind-deposited and water-deposited material gave rise to the Konawa and Eufaula soils, which are also on uplands. Loose sand and friable sandy loam, clay loam, and clay were the parent material of the Brazos, Osage, Reinach, and Verdigris soils, which are on flood plains and terraces.

The surface rocks of Hughes County belong to three geologic systems: the Pennsylvanian, the Quaternary, and the Recent. Figure 18 shows the distribution of these systems.

The *Pennsylvanian system* is represented in Hughes County by ten formations, each of which contains shale and sandstone. Seven are under prairie vegetation, and three are under forest. Those under prairie are Boggy shale, Stuart shale, Wetumka shale, Holdenville shale, and the Wewoka, Seminole, and Coffeyville formations. Ridges of sandstone, which resists weathering better than shale, extend northeastward across the county. The Bates and Collinsville soils are on these ridges, and below them on the shale slopes are the Talihina soils. The Dennis, Okemah, Taloka, and Parsons soils are in the valleys, which are underlain by shale. The Hartsells and Hector soils, which formed under forest, were derived from Thurman sandstone, Calvin sandstone, and the Senora formation.

The *Quaternary system* is represented in this county by terrace deposits, which once were on bottom lands but now are above the normal flood plain. These deposits occur along the North Canadian and the South Canadian Rivers and other large streams and in a large area near Gerty and Non. The Dougherty, Eufaula, Konawa, Stidham, and Vanoss soils formed on the terraces. They have been altered by windblown material.

The *Recent system* gave rise to the Brazos, Brewer, Ochlockonee, Osage, Reinach, and Verdigris soils. These soils occur on the flood plains of the North Canadian and the South Canadian Rivers and the other streams.

Climate

Hughes County has a warm-temperate, subhumid climate. The average temperature in summer is about 81° F. During the growing season the wind generally is hot and the humidity is low. The rainfall is fairly well distributed and is sufficient to soak into the subsoil of most soils, but only about 12 inches of rain falls during summer, and much of this is lost through evaporation and transpiration.

Climate either directly or indirectly causes differences in plant and animal life and consequently affects the changes in soils that are brought about by plants and animals. Also, the extent of translocation of weathered material within a soil depends on climate. But the effects of climate are always interwoven with the effects of the other factors of soil formation. For example, the Parsons and Collinsville soils formed in the same kind of climate. Yet the Parsons soils, which are nearly level, have had much more weathering and translocation of soil material than the Collinsville soils, which are moderately steep.

Plant and animal life

Herbaceous plants, trees and shrubs, micro-organisms, earthworms, and various other forms of plants and animals are active agencies in the formation of soils. The kinds of plants and animals are determined by environmental factors, which include climate, parent material, relief, and age of the soils. Micro-organisms and burrowing animals help to mix the uppermost layers of the soils, and bacteria help to decompose organic matter so that nutrients can be released to plants.

Grasses and trees differ in their effects on soil formation. Grasses, for example, use nearly all of the rain that falls during the growing season and thus help to prevent the leaching of basic elements. Also, they have thick, fibrous roots that penetrate the soil to a depth of 18 to 36 inches. The organic matter that remains after the grasses die helps to maintain the granular structure that is typical of a soil formed under grass, and it also increases the capacity of the soil to hold available moisture.

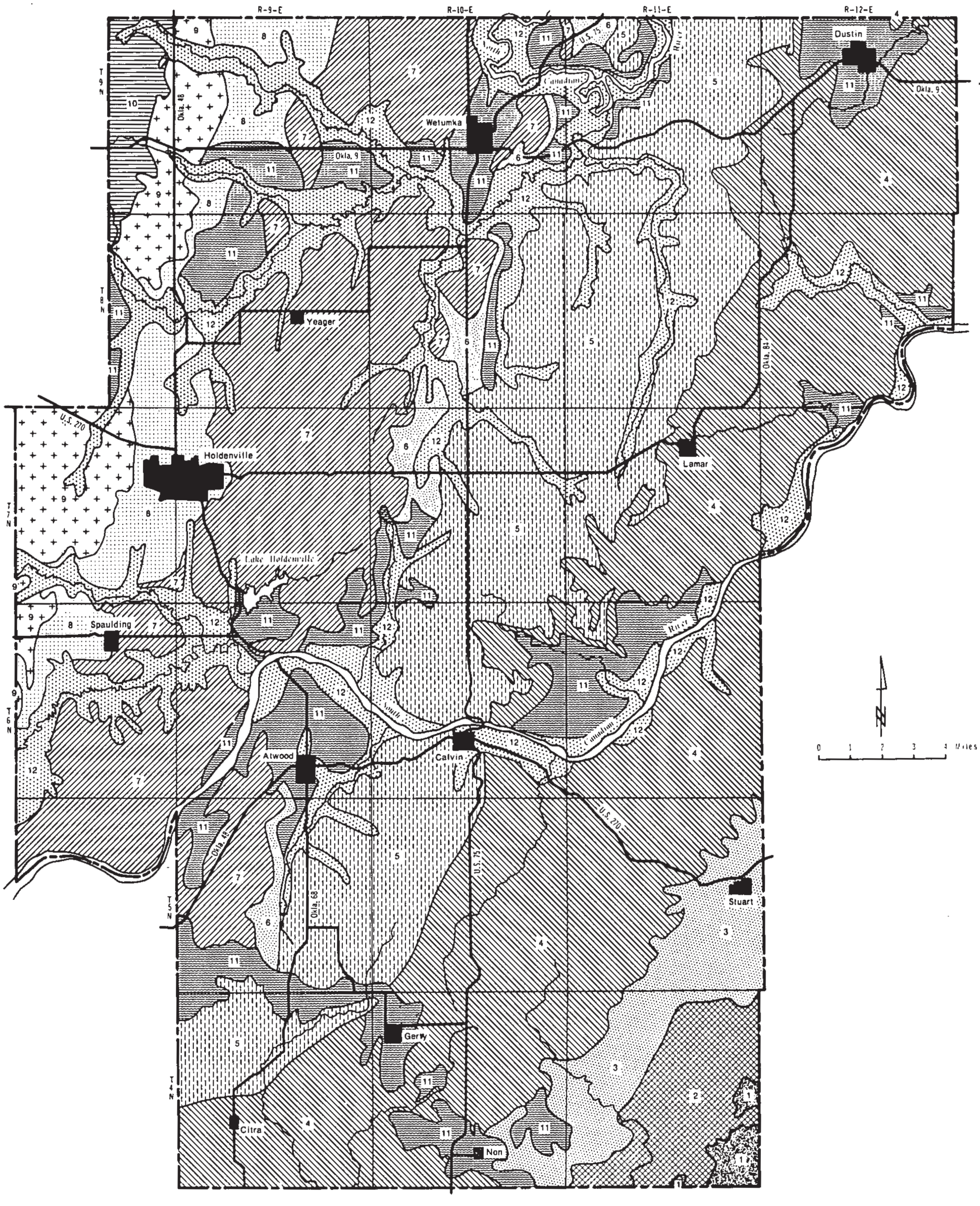

Figure 18.—Geologic formations in Hughes County. The Pennsylvanian system is represented by (1) Boggy shale, (2) Thurman sandstone, (3) Stuart shale, (4) Senora formation, (5) Calvin sandstone, (6) Wetumka shale, (7) Wewoka formation, (8) Holdenville shale, (9) Seminole formation, and (10) Coffeyville formation. The Quaternary system is represented by (11) terrace deposits. The Recent system is represented by (12) recent alluvium.

Trees supply less organic matter to soils than grasses, partly because they characteristically have roots that are deep but not fibrous. They do produce a large amount of litter each year in the form of twigs and leaves, but this material remains largely on the surface. The Konawa and Eufaula soils, which formed under trees, contain less organic matter than soils that formed under grass.

Even under the same kinds of trees, soils of the uplands differ from soils of the bottom lands. Most of the soils in Hughes County that formed in alluvium on the flood plains are deep and fertile, and nearly all have a surface layer that has been visibly darkened by organic matter. The effects of leaching are largely offset by an occasional deposition of fresh alluvium that contains organic matter.

Relief

The relief of Hughes County ranges from level to steep. It modifies somewhat the effects of climate and vegetation as factors of soil formation. Water runs off the steep areas, and as a result, geologic erosion keeps an almost even pace with formation of the soils. For example, the Collinsville and other moderately steep soils lack genetic horizons because water erosion and gravity are constantly removing the soil material. In contrast, the Parsons and other level soils remain in place and develop distinguishable genetic horizons.

Time

The length of time required for the formation of a mature soil profile depends largely on the intensity of the soil-forming factors and on the nature of the material from which the soils formed. The Parsons soils are examples of mature soils, and the Collinsville soils are examples of immature soils.

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 within 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 [9] and revised later [10]. The system currently used by the National Cooperative Soil Survey was adopted in 1965. It is under continual study. Readers interested in the development of the system should refer to the latest literature available [11] [12].

[9] BALDWIN, MARK, KELLOGG, CHARLES E., and THORP, JAMES. SOIL CLASSIFICATION. U.S. Dept. Agr. Ybk. 1938: 979–1001.

[10] THORP, JAMES, and SMITH, GUY D. HIGHER CATEGORIES OF SOIL CLASSIFICATION: ORDER, SUBORDER, AND GREAT SOIL GROUP. Soil Sci. 67 117–126, 1949.

[11] SIMONSON, ROY W. SOIL CLASSIFICATION IN THE UNITED STATES. Science, v. 137, No. 3535, pp. 1027–1034, illus., 1962.

[12] UNITED STATES DEPARTMENT OF AGRICULTURE. SOIL CLASSIFICATION, A COMPREHENSIVE SYSTEM. 7TH APPROXIMATION. Soil Surv. Staff, Soil Cons. Serv., 1960. [Amendment issued March 1967]

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 6 shows the classification of the soil series of Hughes County according to the current system and according to the great soil group of the 1938 system. Some of the soils in this county do not fit in a series that has been recognized in the classification system, but recognition of a separate series would not serve a useful purpose. Such soils are named for series they strongly resemble because they differ from those series in ways too small to be of consequence in interpreting their usefulness or behavior. Soil scientists designate such soils as taxadjuncts to the series for which they are named. In this survey soils named in the Okemah, Hartsells, Reinach, and Taloka series are taxadjuncts to those series.

Following are brief descriptions of each of the categories in the current system.

ORDER: In the order, soils are grouped according to properties that seem to result from the same processes acting to about the same degree on soil material. Ten soil orders are recognized in the current system: Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. Entisols, Inceptisols, Mollisols, Alfisols, and Ultisols are represented in Hughes County.

SUBORDER: Each order is divided into suborders, primarily on the basis of soil characteristics that seem to produce classes having the greatest genetic similarity. A suborder has a narrower climatic range than an order. The criteria for suborders reflect either (1) the presence or absence of waterlogging or (2) differences in climate or vegetation.

GREAT GROUP: Each suborder is divided into great groups according to the presence or absence of genetic horizons and the arrangement of these horizons.

SUBGROUP: Each great group is divided into subgroups, one representing the central (typic) concept of the group, and others, called intergrades, representing the soils that have mostly the properties of one great group but also have one or more properties of the soils of another great group, suborder, or order.

FAMILY: Each subgroup is divided into families, primarily on the basis of properties important to plant growth. Some of the properties considered are texture, mineral composition, reaction, soil temperature, permeability, consistence, and thickness of horizons.

SERIES: Series are explained in the section "How This Survey Was Made" and in the Glossary.

General Nature of the County

The area that is now Hughes County was inhabited almost exclusively by Indians until the 1890's. Holdenville, the county seat, was officially incorporated in 1898, nine years before Oklahoma became a State.

TABLE 6.—*Classification of soil series*

Series	Current system			1938 system—Great soil group
	Family	Subgroup	Order	
Bates	Fine-loamy, mixed, thermic	Typic Argiudolls	Mollisols	Prairie soils.
Brazos	Sandy, mixed, thermic	Typic Ustifluvents	Entisols	Alluvial soils.
Brewer	Fine, mixed, thermic	Pachic Argiustolls	Mollisols	Prairie soils.
Collinsville	Loamy, mixed, thermic	Lithic Hapludolls	Mollisols	Lithosols.
Dennis	Fine, mixed, thermic	Aquic Paleudolls	Mollisols	Prairie soils.
Dougherty	Loamy, mixed, thermic	Arenic Haplustalfs	Alfisols	Red-Yellow Podzolic soils.
Eufaula	Sandy, siliceous, thermic	Psammentic Paleustalfs	Alfisols	Red-Yellow Podzolic soils.
Hartsells	Fine-loamy, siliceous, mesic	Typic Hapludults	Ultisols	Red-Yellow Podzolic soils.
Hector	Loamy, siliceous, thermic	Lithic Dystrochrepts	Inceptisols	Lithosols.
Konawa	Fine-loamy, mixed, thermic	Ultic Haplustalfs	Alfisols	Red-Yellow Podzolic soils.
Ochlockonee	Coarse-loamy, siliceous, acid, thermic	Typic Udifluvents	Entisols	Alluvial soils.
Okemah	Fine, mixed, thermic	Aquic Paleudolls	Mollisols	Prairie soils.
Osage	Fine, montmorillonitic, noncalcareous, thermic.	Vertic Haplaquolls	Mollisols	Alluvial soils.
Parsons	Fine, mixed, thermic	Mollic Albaqualfs	Alfisols	Planosols.
Reinach	Coarse-silty, mixed, thermic	Pachic Haplustolls	Mollisols	Alluvial soils.
Stidham	Loamy, mixed, thermic	Arenic Haplustalfs	Alfisols	Red-Yellow Podzolic soils.
Talihina	Clayey, mixed, thermic, shallow	Typic Hapludolls	Mollisols	Lithosols.
Taloka	Fine, mixed, thermic	Mollic Albaqualfs	Alfisols	Planosols.
Vanoss	Fine-silty, mixed, thermic	Udic Argiustolls	Mollisols	Reddish Prairie soils.
Verdigris	Fine-silty, mixed, thermic	Cumulic Hapludolls	Mollisols	Alluvial soils.

Geology [13]

The soils of Hughes County are underlain by sedimentary rocks that belong mostly to the Krebs and Cabaniss groups of the Des Moines series of the Pennsylvanian system. Each group contains both sandstone and shale and, in some places, beds of sandy limestone as much as 1 foot thick. Some limestone crops out south of Dustin.

The Pennsylvanian rocks were deposited in nearly level areas by the sea, were later raised and tilted by earth movements, and now slope to the northwest at a gradient of about 90 feet per mile. Most of the rocks consisted originally of sand and clay, but they have hardened into sandstone and shale. They have been above sea level for millions of years and have been weathered and eroded by freezing and thawing, wind and rain, and other agencies. Long, conspicuous ridges of sandstone extend northwestward across the county. The shale, which is softer than the sandstone, is in the valleys. Clay, or weathered shale, can be seen in open roadside ditches. The visible sandstone is chiefly rubble brought down by gravity or runoff from the hills nearby, but layers of sandstone are only a few feet below the surface.

The topographic pattern in Hughes County is a succession of ridges and valleys. If one crossed the county from east to west, one would find a general repeating pattern consisting of a steep, east-facing slope, called a scarp slope; a ridge; a gentle, west-facing slope, called a dip slope; and then a valley and drainageway. The Bates, Collinsville, and Talihina soils are on the slopes and ridges, and the Verdigris soils are in the valleys. Streams with wide bottom lands cut across the ridges and interrupt the pattern in some parts of the county. In the western part, there are isolated hills, some of which are capped with weather-resistant sandstone.

Remnants of Quaternary terrace deposits occur along the flanks of the hills and in the lower parts of the uplands, near Gerty and Non. The Konawa and Stidham soils formed from this material. Alluvium of the Recent system is continually being carried down by streams and deposited on the bottom lands.

Only a small part of the Pennsylvanian rock in the county is exposed. Most of this rock is covered by loose colluvium, a few inches to many feet thick, that has moved downhill only a short distance.

[13] Prepared by MALCOLM C. OAKS, geologist, Oklahoma Geological Survey.

Relief, Drainage, and Flood Control

Hughes County is in the gently rolling, southern part of the Great Plains. The elevation at Holdenville is about 900 feet. Most of the uplands are very gently sloping to sloping, but there are also broad, nearly level uplands in most parts of the county. Several isolated hills are capped with sandstone. Flood plains make up nearly 12 percent of the total acreage of the county.

The northern part of this county is drained by the North Canadian River, Wewoka Creek, Little Wewoka Creek, Grief Creek, Greasy Creek, Fish Creek, and Long George Creek. The central and southern parts are drained by the South Canadian River, the Little River, and several tributary creeks.

The North Canadian and the South Canadian Rivers are fairly wide after heavy rains, but they are narrow during periods of normal or below-normal rainfall. There are deep deposits of old alluvium on the narrowed

***Figure 19.*—A flood-control structure. The soil below the structure is Verdigris silt loam.**

streambeds. Winds have reworked these deposits and have blown sand and silt onto the surrounding ridges and hills. The Dougherty, Eufaula, and Konawa soils formed in such windblown material. Frequent floods have scoured a large acreage of the bottom lands, and sheet erosion, streambank erosion, and gullying have washed soil material from the Hartsells, Hector, Bates, Dennis, Parsons, and Collinsville soils onto nearby soils and into streams.

Two watershed projects help to protect 162,416 acres in Hughes County from damaging floods, which once occurred frequently. About 717 farms are protected. The Wewoka Creek project protects about 59,145 acres, and the Little Wewoka and Graves Creek project, 103,271 acres. Figure 19 shows one of the flood-control structures built as part of the latter project.

Nearly all the acreage on the flood plains consists of deep, fertile soils that, if protected, can be used for crops. Many formerly flooded areas of Verdigris and Osage soils, for example, can now be safely planted to bermudagrass, tall fescue, Ladino clover, and row crops.

Climate [14]

Hughes County has a warm-temperate, subhumid climate. The weather is mild and pleasant as long as warm, moisture-laden air from the Gulf of Mexico prevails. It becomes unsettled when cool, dry air moves in from the West Coast, and even greater variations in temperature, precipitation, cloudiness, and wind occur when cold, dry air moves in from around the Arctic Circle.

Changes between seasons are gradual, but seasonal characteristics are rather well defined. Winters generally are mild and sunny, but occasionally there are several days of rather low temperatures and some snow. Precipitation is heaviest in spring. Spring is also the season of severe local storms and an occasional tornado. Summer comes early and is hot but is eased by frequent showers, cool nights, moderately low humidity, and fresh breezes. Fall is a long, pleasant season. The days are mostly sunny, but there are a few days of moderate to heavy soaking rains.

Table 7 gives temperature and precipitation data based on records kept at the Weather Bureau station at Holdenville. The average annual temperature, based on these records, is 62.4° F. Average monthly temperatures range from 40.8° in January to 82.9° in August. The daily range

[14] By STANLEY G. HOLBROOK, State climatologist, U.S. Weather Bureau.

TABLE 7.—*Temperature and precipitation data*

[All data from Holdenville, Okla., based on records for the period 1931–60]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Two years in 10 will have at least 4 days with— Maximum temperature equal to or higher than—	Two years in 10 will have at least 4 days with— Minimum temperature equal to or lower than—	Average total	One year in 10 will have— Less than—	One year in 10 will have— More than—	Days with snow cover of 1 inch or more	Average depth of snow on days with snow cover
	° F.	*° F.*	*° F.*	*° F.*	*In.*	*In.*	*In.*	*No.*	*In.*
January	51. 4	30. 2	68	14	2. 02	0. 5	3. 6	3	2
February	55. 8	33. 5	71	18	2. 50	. 4	5. 1	1	2
March	63. 8	40. 0	80	24	3. 06	. 7	5. 8	(1)	3
April	73. 6	50. 6	85	36	4. 27	1. 2	8. 7		
May	80. 1	59. 1	90	47	6. 34	2. 4	11. 5		
June	89. 1	67. 6	99	58	5. 23	1. 4	10. 4		
July	94. 6	71. 2	102	64	3. 97	. 4	6. 8		
August	95. 3	70. 5	106	61	3. 10	. 5	6. 8		
September	88. 2	62. 9	101	50	3. 75	. 5	8. 8		
October	77. 4	52. 6	92	39	3. 26	. 7	5. 4		
November	63. 1	39. 5	79	25	2. 41	. 2	5. 4		
December	54. 0	33. 2	70	19	2. 30	. 5	4. 7	2	2
Year	73. 9	50. 9	(2) 106	(3) 6	42. 21	32. 1	55. 7	6	2

[1] Less than 0.5 day.
[2] Average annual highest temperature.
[3] Average annual lowest temperature.

TABLE 8.—*Probabilities of freezing temperatures in spring and in fall*

[All data from Holdenville, Okla., based on records for the period 1921–50]

Probability	Dates for given probability and temperature				
	16° F.	20° F.	24° F.	28° F.	32° F.
Spring:					
1 year in 10 later than	March 7	March 15	March 24	April 8	April 14
2 years in 10 later than	February 26	March 8	March 18	April 2	April 9
5 years in 10 later than	February 9	February 22	March 7	March 21	March 31
Fall:					
1 year in 10 earlier than	November 29	November 23	November 10	October 27	October 18
2 years in 10 earlier than	December 6	November 30	November 17	November 3	October 23
5 years in 10 earlier than	December 19	December 13	November 29	November 15	November 2

of temperature averages 23°. The lowest temperature of record, which occurred on January 18, 1930, is −12°; the highest, which occurred on August 10, 1936, is 118°. Temperatures of 90° or above occur on an average of 85 days a year from March through October. Temperatures of 100° or above can be expected on an average of 20 days from June through October. The hottest summer on record was in 1936 when the temperature at Holdenville exceeded 100° on 59 days, 27 of which were consecutive days in August. The temperature was at least 105° on 12 days, 110° on 4 days, and 115° on 2 days. Holdenville has an average annual total of 3,107 degree days; there are none during the period June through September and a maximum of 750 during January.

Table 8 shows the probabilities of freezing temperatures in spring and fall, based on the Holdenville records. The dates in other parts of the county may be somewhat different because of frost pockets and cold-air drainage. Freezing temperatures occur on an average of 64 days a year, from October through April, and on 5 of these days the temperature does not go above freezing. Subzero temperatures occur in only about 1 year out of 3; the coldest days are mainly during January. The average length of the freeze-free season is about 220 days in the northwestern and southwestern parts of the county and about 215 days along the west-central border. A freeze has occurred as late as April 22 and as early as October 8.

The average precipitation is 39 inches a year in the northwestern corner of the county and 41.5 inches in the southeastern part. In 1 year out of 6 at Holdenville and in 1 year out of 10 at Calvin, there is a chance that the precipitation will total less than 30 inches or more than 50 inches. About half the rain falls during the growing season. May is the wettest month, and January is the driest. Heavy rains of 2 to 5 inches are not uncommon. The most precipitation in any single month was 17.70 inches, in October 1941; the most in a single 24-hour period was 6.63 inches, on October 30, 1941; and the most in a single 72-hour period was 11.10 inches, in June 1904. Such rains occasionally result in erosion and siltation.

Evaporation is a problem only during dry, windy spells in summer. The average annual lake evaporation is 55 inches, and 38.5 inches of this takes place in the period May through October.

About 4.3 inches of snow falls each year in the southern part of the county, and 5.5 inches in the northern part. The seasonal average is 5.2 inches at Holdenville, but there is no snow in one winter out of seven. The records at Holdenville show that the heaviest snowfall in a winter was 20.0 inches, in 1920–21, and the heaviest in a month was 13.0 inches, in February 1921. The heaviest in a day was 10.0 inches, on February 18, 1921; the next day a record 11.0 inches covered the ground. Snowfalls of 3 to 11 inches occur about every 2 years; the average depth is 4.7 inches. The snow usually melts in 2 to 6 days, but in January 1930, it remained on the ground for 24 days.

The prevailing surface wind at Holdenville is from the north during January and February and from the south during the rest of the year. The average hourly windspeed is 11 miles an hour. The average monthly speed ranges from 8.5 miles an hour during July and August to 13.0 miles an hour in March. Winds of 25 to 45 miles an hour accompany the passage of most frontal systems, and gusts of 70 to 85 miles an hour accompany violent squalls and severe thunderstorms.

Only 17 tornadoes have been recorded within the county since 1875. The most destructive were the ones that moved through the southern half of Wetumka in 1924 and through Holdenville and vicinity in 1950.

Thirteen severe hailstorms have been recorded in Hughes County since 1924; some areas have had as many as four. The threat of hailstorms continues from April through August; seven have occurred in May. Hailstones as much as 3 inches in diameter have been observed. There have been only two hailstorms per 100 square miles in Hughes County compared with 4.3 per 100 square miles in some counties in the western part of Oklahoma.

Glossary

AC soil. A soil that has an A and a C horizon but no B horizon. These are commonly immature soils, such as those developing from alluvium or those on steep, rocky slopes.

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

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; will not hold together in a mass.

Friable.—When moist, soil crushes easily under gentle to moderate pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, soil crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, soil is readily deformed by moderate pressure but can be pressed into a lump; forms a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, soil adheres to other material; tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, soil moderately resists pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, soil breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Clay. As a soil separate, mineral particles less than 0.002 milimeter in diameter. As a textural class, soil that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

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.

Horizon, soil. A layer of soil, approximately parallel to the soil 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 (1) distinctive characteristics caused by 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. The 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.

Mapping unit. Areas of soil of the same kind outlined on the detailed soil map and identified by a symbol.

Mottled. 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.

Parent material. The horizon of weathered rock or partly weathered soil material from which soil has formed. Horizon C of the soil profile.

Permeability, soil. The quality that enables a soil to transmit water and air. Terms used to describe permeability are *very slow, slow, moderately slow, moderate, moderately rapid rapid,* and *very rapid*

Phase, soil. A subdivision of a soil type, series, or other unit in the soil classification system, made because of differences that affect the management of soils but not their classification. A soil type, for example, may be divided into phases because of differences in slope, stoniness, thickness, or some other characteristic that affects management.

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

Reaction. 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	Neutral	6.6 to 7.3
Very strongly acid.	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
		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		

Relief. The elevations or inequalities of a land surface, considered collectively.

Sand. As a soil separate, individual rock or mineral fragments 0.05 to 2.0 millimeters in diameter. Most sand grains consist of quartz, but 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.

Series, soil. A group of soils having genetic horizons that, except for the texture of the surface layer, are similar in differentiating characteristics and in arrangement in the profile.

Silt. As a soil separte, 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.

Slope, soil. The amount of rise or fall in feet for each 100 feet of horizontal distance. It is normally expressed in percent. The slope terms and their numerical equivalents used in this survey are—

	Percent
Level and nearly level	0 to 1
Very gently sloping	1 to 3
Gently sloping	3 to 5
Sloping	5 to 8
Strongly sloping	8 to 12
Moderately steep	12 to 20
Steep	20+

Soil. A natural three-dimensional body on the earth's surface that supports plants. Soil has properties resulting from the integrated effects of climate and living matter acting upon parent material, as conditioned by relief, over periods of time.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *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 profile below plow depth.

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."

Type, soil. A subdivision of a soil series, made on the basis of differences in the texture of the surface layer.

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