Series 1958, No. 32 Issued August 1965

SOIL SURVEY
Ford County, Kansas

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

HOW TO USE THE SOIL SURVEY REPORT

THIS SOIL SURVEY of Ford County, Kans., will serve several groups of readers. It will help farmers in planning the kind of management that will protect their soils and provide good yields; assist engineers in selecting sites for roads, buildings, ponds, and other structures; aid farmers in managing windbreaks; and add to our knowledge of soil science.

Locating Soils

Use the index to map sheets at the back of this report to locate areas on the large map. The index is a small map of the county on which numbered rectangles have been drawn to show where each sheet of the large map is located. When the correct sheet of the large map has been found, it will be seen that boundaries of the soils are outlined, and that there is a symbol for each kind of soil. All areas marked with the same symbol are the same kind of soil, wherever they occur on the map. The symbol is inside the area if there is enough room; otherwise it is outside the area and a pointer shows where the symbol belongs.

Finding Information

This report contains sections that will interest different groups of readers, as well as some sections that may be of interest to all.

Farmers and those who work with farmers can learn about the soils in the section "Descriptions of the Soils" and then turn to the section "Use and Management of Soils." In this way, they first identify the soils on their farm and then learn how these soils can be managed and what yields can be expected. The "Guide to Mapping Units, Capability Units, Range Sites, and Windbreak Suitability Groups" at the back of the report will simplify use of the map and report. This guide lists each soil and land type mapped in the county, and the page where each is described. It also lists, for each soil and land type, the capability unit, range site, and windbreak suitability group, and the page where each of these occurs.

Farmers and others interested in windbreaks can refer to the section "Windbreak Management." In this section the soils in the county are grouped according to their suitability as sites for shelterbelts and windbreaks, and some factors affecting management are discussed.

Engineers and builders will want to refer to the section "Engineering Interpretations of the Soils." Tables in that section show characteristics of the soils that affect engineering.

Persons interested in science will find information about how the soils were formed and how they were classified in the section "Formation, Classification, and Morphology of Soils."

Students, teachers, and other users will find information about soils and their management in various parts of the report, depending on their particular interest. The soil survey map and report also are useful to land appraisers, credit agencies, and others who are concerned with the use and management of soils.

Newcomers in Ford County will be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "Additional Facts About the County."

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Fieldwork for this survey was completed in 1958. Unless otherwise indicated, all statements in the report refer to conditions in the county at that time. This soil survey of Ford County was made as part of the technical assistance furnished by the Soil Conservation Service to the Ford County Soil Conservation District, which was established in 1946.

Cover picture: **Contour farming in a field of grain sorghum and winter wheat. The grain sorghum is on the right, and the residue from winter wheat is on the left.**

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SOIL SURVEY OF FORD COUNTY, KANSAS

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FORD COUNTY is in the southwestern part of Kansas in the central part of the High Plains. The valley of the Arkansas River cuts the county in half from west to east. Except for this valley, the county is mainly a rolling upland.

Dodge City is the county seat. The air mileage from Dodge City to Topeka, the State capital, and to Manhattan and Wichita, is shown in figure 1. The area of the county is 693,120 acres. The county has 30 townships.

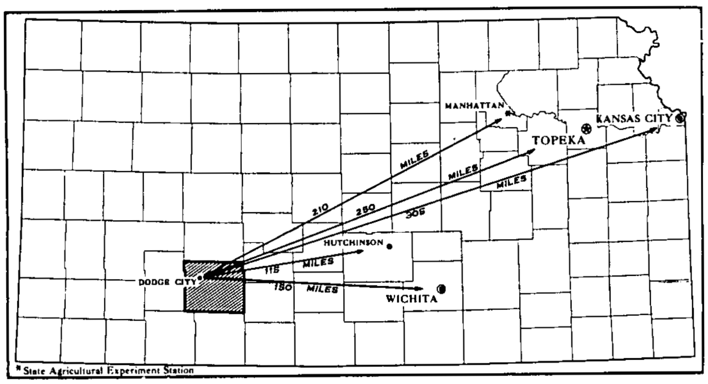

Figure 1.—**Location of Ford County in Kansas.**

The southwestern part of the county drains to the Cimarron River through Crooked Creek. The rest of the county drains to the Arkansas River. The main tributaries are Coon Creek, Cow Creek, Five Mile Creek, and Mulberry Creek.

The elevation above sea level north of the Arkansas River ranges from 2,660 feet on the west side of the county to 2,280 feet in the northeastern corner. The elevation above sea level south of the Arkansas River ranges from 2,720 feet in the southwestern corner of the county to 2,390 feet in the southeastern corner.

This is primarily an agricultural county. The principal crop is wheat, but sorghum is grown on a large acreage. Other crops are barley, oats, alfalfa, and some corn. Alfalfa is grown only on alluvial land or in areas that are irrigated.

How Soils Are Mapped and Classified

Soil scientists made this survey to learn what kinds of soils are in Ford 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 into the parent 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 report 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, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Holdrege and Ulysses, 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 go with their behavior in the natural, untouched 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. Holdrege fine sandy loam and Holdrege silt loam are two soil types in the Holdrege series. The difference in texture of their surface layers is apparent from their names.

Some soil 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 soil phases. The name of a soil phase indicates a feature that affects management. For example, Ulysses silt loam, 1 to 3 percent slopes, is one of several phases of Ulysses silt loam, a soil type that ranges from nearly level to gently sloping.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew boundaries of the individual soils on aerial photographs. These photographs show windbreaks, buildings, field borders, trees, and other details that greatly help in drawing boundaries accurately. The soil map in the back of this report 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 soil type or soil phase.

In preparing some detailed soil maps, the soil scientists have a problem of delineating areas where different kinds of soils are so intricately mixed, and so small in size, that it is not practical to show them separately on the map. Therefore, they show this mixture of soils as one mapping unit and call it a soil complex. Ordinarily, a soil complex is named for the major kinds of soil in it, for example, Dalhart-Lubbock complex. Also, on most soil maps, areas are shown that are so rocky, so shallow, or so frequently worked by wind and water that they scarcely can be called soils. These areas are shown on a soil map like other mapping units, but they are given descriptive names, such as Broken alluvial land or Active dunes, and are called land types rather than soils.

If two or more soils that normally do not occur in regular geographic association are so intricately mixed that separate mapping is impractical, the soils are mapped as an undifferentiated mapping unit. The unit is named for the soils in it. An example in this county is Dale and Humbarger clay loams.

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 a way that it is readily useful to different groups of readers, among them farmers, ranchers, 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 reports. Based on the yield and practice tables and other data, the soil scientists set up trial groups, and test them by further study and by consultation with farmers, agronomists, engineers, and others. Then, the scientists adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

As one travels over a county or other large tract, it is easy to see differences in the landscape from place to place. There are many obvious differences. Some of them are in shape, steepness, and length of slopes, in the course, depth, and speed of the streams, in the width of the bordering valleys, in kinds of plants, and in the kind of agriculture. With these more obvious differences, there are other differences, less easily noticed, in the patterns of soils. The soils differ along with the other parts of the environment.

By drawing lines around the different patterns of soils on a small map, one may obtain a general map of the soils. Each kind of pattern is called a soil association. Such a map is useful to those who want a general idea of the soil, who want to compare different parts of a county, or who want to locate large areas suitable for some particular kind of farming or other broad land use. It does not show accurately the kinds of soils on a single farm or a small tract.

The seven soil associations in Ford County are shown on the colored general soil map at the back of this report. The associations are named for the major soil series in them, but soils of other series may be present in any of the areas. Also, the major soil series of one association may occur in the others. Each soil association has a distinct pattern of soils, and the soil differences are important to the farms in each association.

One of the seven soil associations consists of soils on flood plains along the Arkansas River and other streams. Three associations are mostly loamy soils of the upland. Two consist of sandy soils, and one, of the steep breaks just below the margin of the High Plains.

1. Dale-Leshara-Las Animas Association

This association consists of nearly level, loamy, alluvial soils. It occurs in the valley of the Arkansas River and in valleys of other major streams. These valleys are nearly level and somewhat channeled. The association covers 72,310 acres, or about 11 percent of Ford County.

Dale, Humbarger, and Canadian soils make up about 60 percent of the association. These soils consist of alluvium on the flood plains and have a water table at a depth of about 10 to 30 feet. They are seldom flooded and generally are not affected by salinity.

Leshara, Las Animas, and Lincoln soils make up about 29 percent of the association. These soils are on flood plains and have a fluctuating water table near the surface. They are affected by moderate salinity.

Alluvial land and slickspots make up 4 percent of the association. This land type ranges from clay loam to sandy loam in texture and has saline-alkali spots. Crop growth is adversely affected by soluble salts, especially on the saline-alkali spots.

The Las Animas, Lincoln, and Canadian soils are generally more sandy than the Leshara, Dale, and Humbarger soils, which are silt loams and clay loams.

The Arkansas River and Broken alluvial land make up about 7 percent of the association. All of Broken alluvial land is nonarable. The areas along the channel of the Arkansas River are suitable as wildlife habitats. Annual grass and deciduous trees cover Broken alluvial land and provide some grazing and protection for livestock.

Most soils of the association are used for winter wheat, other small grains, and sorghum; however, some alfalfa is grown. The soils with a shallow, fluctuating water table are not well suited to alfalfa; those with a deeper water table are better suited. Moderate yields of alfalfa are obtained if stands are established successfully.

About 15 percent of this association is irrigated. The main source of water is shallow wells and the Arkansas River. The same crops are grown on irrigated as on dryland areas. Truck crops are grown under irrigation in a few areas.

Wind erosion, the shallow, fluctuating water table, lack of drainage, and salinity and alkalinity are the major hazards on cropland.

2. Harney-Spearville-Ulysses Association

This association consists of deep, nearly level and gently sloping, well-drained, loamy and clayey soils of the upland. It occurs north and south of Mulberry Creek in a large, continuous area that extends eastward to the Kiowa County line and westward to the Gray County line. It also lies north of the Arkansas River in a large area that extends eastward to Edwards County and westward to Gray County. The association covers 421,100 acres, or 61 percent of the county.

About 78 percent of the association consists of Harney soils, which occur throughout the association. These soils have a surface layer of granular silt loam and a subsoil that is blocky and clayey. They are deep, well drained, and moderately permeable. These soils are highly suitable for both dryland and irrigated crops.

About 8 percent of the association consists of Spearville soils. The Spearville soils are in two major areas—one near the communities of Spearville and Windhorst, and the other in the northwestern corner of the county. They have a surface layer of silty clay loam and a subsoil of firm clay. The Spearville soils are well drained and deep, but they are slowly permeable. They are better suited to wheat than to sorghum.

The Ulysses soils make up 8 percent of the association. These are deep and permeable silt loams that are gently sloping and sloping. They occur in a discontinuous pattern throughout the association.

The Mansic and Mansker soils make up 3 percent of the association. These soils are clay loams that also occur in a discontinuous pattern in sloping areas along streams. In many places the Mansic soils occur in complex with the Hobbs soils.

The Hobbs soils make up 1 percent of the association. They are deep, dark-colored alluvial soils of silt loam texture that are subject to short periods of flooding. They can be cultivated between floods but are better suited to grass.

Randall clay and Alluvial land make up slightly more than 1 percent of the association. The Randall soil occurs in small spots or depressions throughout the association. It is associated with the Harney and Spearville soils and in a few places, with the Ulysses or Mansic soils. The Randall soil is commonly ponded by runoff from the Harney and Spearville soils. The water often delays farming. Alluvial land consists of deep, dark, frequently flooded, stratified loamy soil material along drainageways. It receives runoff from the other soils in the association.

The Colby soils make up slightly less than 1 percent of the association. They occur in complex with the Ulysses soils on eroded slopes along drainageways. They are lighter colored and more calcareous than the Ulysses soils.

Except for the strongly sloping Mansic soils, Alluvial land, intermittent lakes, and borrow pits, most of this association is cultivated. The common dryland crops are winter wheat and sorghum. The irrigated crops are the same as those on dryland, except for scattered fields of beans, onions, and squash. Some livestock, mainly beef cattle, are on nearly all farms.

Wind erosion is a hazard in the nearly level areas. Wind and water erosion are hazards in the gently sloping and sloping areas. Stubble mulching on the contour, used with terraces, is necessary for controlling erosion, maintaining organic matter, and conserving moisture.

3. Holdrege Association

This association is made up of deep, nearly level and gently sloping, well-drained loamy soils of the upland. It lies in a transitional area between the Harney-Spearville-Ulysses association and the Pratt-Tivoli-Ortello association. This association occurs in two separate areas, each of which is 2 to 3 miles wide. The first extends eastward from the town of Ford to the Ford-Kiowa County line. The other extends westward from the Mulberry Creek watershed to the Gray County line. Both areas lie nearly parallel to the Arkansas River. The association occupies 40,750 acres, or 6 percent of Ford County.

The Holdrege soils make up 97 percent of the association. Their surface layer is silt loam and fine sandy loam, and their subsoil is granular silt loam and silty clay loam. They have a moderate water-intake rate and high water-holding capacity. The Holdrege soils are well suited to both dryland and irrigation farming, especially the nearly level areas. In these areas they have a somewhat less granular subsoil than elsewhere, a moderate water-intake rate, and a high water-holding capacity.

Sandy broken land makes up 3 percent of the association. It occurs in the drainageways that cross this association to the Pratt-Tivoli-Ortello association, the Harney-Spearville-Ulysses association, or the Dale-Leshara-Las Animas association. In most areas this land type is sandy, but some nearly vertical banks and other areas of clay loam are included. Nearly all areas are in grass and are nonarable.

Most of the soils in this association are cultivated. Crops are well suited to both dryland and irrigated soils; the major crops are wheat and sorghum.

In cultivated areas the dominant problem is erosion. Wind erosion is especially hazardous on Holdrege fine sandy loam, but all Holdrege soils will blow if left unprotected. Conserving water and maintaining fertility and organic matter are necessary for good crop production.

4. Ortello-Dalhart-Lubbock-Carwile Association

This association consists of well-drained loamy soils and imperfectly drained clayey soils of the upland. The soils are deep and are nearly level and undulating. The association lies between Coon Creek and the Arkansas River in the east-central part of the county. Soils of the

Ortello-Carwile and the Dalhart-Lubbock complexes make up most of the acreage. The association covers 15,820 acres, or 2 percent of the county.

Undulating Ortello soils that occur in a complex with Carwile soils make up 32 percent of this association. They have slopes that are generally about 3 percent, and they are on ridges and knobs of the complex. The Ortello soils are deep and well drained, and they have a surface layer and subsoil of sandy loam. At a depth of more than 4 feet, the soil material ranges from sand to clay. These soils are well suited to dryland and irrigation farming. Nearly all of the acreage is in cultivated crops, mainly wheat and sorghum.

Gently undulating Dalhart soils that occur in a complex with the Lubbock soils make up 19 percent of this association. The surface layer of the Dalhart soils is fine sandy loam, and their subsoil is sandy clay loam. These soils have high water-holding capacity and are well drained and permeable. They are used mainly for wheat and sorghum.

Lubbock soils make up 17 percent of this association. They occur in a complex with the Dalhart soils in shallow depressions or in slightly concave areas. The Lubbock soils are deep, well-drained clay loams that have sand or clay at a depth of more than 3 feet. They have high water-holding capacity. The Lubbock soils are well suited to wheat and sorghum, the common dryland crops, and nearly all of the acreage is used for those crops. Because they are slowly permeable, the Lubbock soils are better suited to dryland farming than to irrigation.

Carwile soils make up 15 percent of the association. These soils are imperfectly drained. They have a surface layer of fine sandy loam and a subsoil that is clayey. They are in low, concave areas of the Ortello-Carwile complex, which is used mainly for wheat and sorghum. The primary problems where this complex is used for crops are wind erosion, mainly in areas of Ortello soils, and wetness, mainly in areas of Carwile soils.

Mansic soils make up 9 percent of the association. They are deep, highly calcareous clay loams of the upland and range from nearly level to sloping. Nearly all of the acreage is cultivated. Wheat and sorghum are the main crops.

Sandy broken land makes up about 4 percent of this association. It lies south of the Arkansas River in the transitional zone between the Holdrege association and the Pratt-Tivoli-Ortello association. Slightly more than half of the acreage of Sandy broken land is loamy, and the rest is sandy. Within the loamy areas are areas of alluvial land. Nearly all of the areas are used for grass and are nonarable.

The Mansker and Otero soils of the upland make up about 3 percent of this association. They are along the northern slopes of the valley of the Arkansas River and along the major streams in the county. These soils are light colored. The Mansker soils are highly calcareous and loamy, and the Otero are calcareous and sandy. The Mansker and Otero soils are used mainly for wheat and sorghum.

Randall soils make up 1 percent of the association. They are gray, poorly drained, and clayey, and they are in depressions or on the nearly level upland. The Randall soils are closely associated with the Lubbock soils. Nearly all of the acreage is used for crops, but farming operations are often delayed because of ponding after rains.

5. Pratt-Tivoli-Ortello Association

This association consists of nearly level, undulating, or hummocky, deep soils that are well drained or excessively drained. The soils are on the upland. The association lies south of the Arkansas River in a narrow, discontinuous band that is about 1 to 3 miles wide. This band extends from the line between Ford and Kiowa Counties to the line between Ford and Gray Counties. The association occupies 34,650 acres, or about 5 percent of the county.

Nearly level and undulating Ortello soils make up about 22 percent of the association. Their surface layer and subsoil are fine sandy loam. Nearly all of the acreage is cultivated, and the principal crops are wheat and sorghum.

Hummocky Pratt soils make up about 49 percent of the association. They occur in a complex with the Tivoli soils. The texture throughout their profile is loamy fine sand, and the underlying material is also loamy fine sand. The Pratt soils have a rapid water-intake rate and low water-holding capacity. Nearly all of the acreage is cultivated, except those areas that occur in a complex with the Tivoli soils. In cultivated areas the major problems are wind erosion and the low water-holding capacity of the soils.

Tivoli soils make up 29 percent of the association. They occur in hummocky areas in a complex with the Pratt soils. Their surface layer is loamy fine sand, and their subsoil and underlying material are fine sand. Nearly all of the acreage is in grass and is nonarable.

6. Tivoli Association

This association consists of loose, rapidly permeable, strongly hummocky fine sands. It occupies about 7,690 acres, or about 1 percent of the county.

Tivoli soils make up 97 percent of the association. The single area occurs near the line between Ford and Kiowa Counties, southeast of the Arkansas River. The Tivoli soils also occur in small areas south of the Arkansas River from the town of Ford to the line between Ford and Gray Counties. The surface layer is fine sand that has been darkened slightly by a small amount of organic matter. Beneath the surface layer is fine sand that extends to a depth of more than 4 feet. The underlying material is sandy to clayey old alluvium.

The Tivoli soils have a rapid water-intake rate and rapid permeability, but their water-holding capacity is low. They are suitable only for native grass. Where they are used for range, the major problem is wind erosion.

Active dunes, locally called blowouts, make up about 3 percent of the association. They occur with the Tivoli soils in small spots on the crests of dunes throughout the association. The surface layer is loose fine sand that is constantly shifted by wind. The material beneath the surface layer is also fine sand to a depth of more than 4 feet. The underlying material is old alluvium that ranges from sand to clay.

About 80 percent of the surface of Active dunes is bare. The rest is covered mainly by blowout grass.

Active dunes have low water-holding capacity, a rapid water-intake rate, and rapid permeability. The main problem is wind erosion.

7. Ulysses-Mansic-Mansker Association

This association consists of sloping and strongly sloping, calcareous loamy soils that form the hill breaks below the level of the High Plains. It is in four distinct areas: (1) In the Mulberry Creek watershed; (2) in the southern part of the county near the Clark County line; (3) on breaks along the northern bank of the valley of the Arkansas River, extending westward in a narrow band 1 to 2 miles wide from Bucklin bridge to the Gray County line; and (4) on breaks to Sawlog, Duck, and Elm Creeks in the north-central part of the county along the Hodgeman County line. This association occupies 100,790 acres, or about 14 percent of the county.

Ulysses soils occupy about 41 percent of the association. They are gently sloping and sloping and are deep, granular silt loams that grade to strongly sloping Mansic soils.

Mansic soils make up about 27 percent of the association. They are along all the major drainageways, but the smallest acreage is along Mulberry Creek. The Mansic soils are deep, and their texture is clay loam throughout. Nearly all of the acreage of these soils is cultivated, except the strongly sloping areas, which usually remain in native grass. Winter wheat and sorghum are the crops generally grown. The most common livestock enterprise is the raising of beef cattle.

Mansker soils make up about 12 percent of the association. They occur throughout the association in a discontinuous pattern. Strongly sloping Mansker soils occur with the Potter soils, and these areas are mainly in native grass. Some areas of Mansker soils are gently sloping, and those areas are commonly cultivated. Mansker soils are clay loams that have a layer of strong lime between a depth of about 18 and 26 inches. At that depth the water-holding capacity is low, and roots may be affected by the abundance of lime. Some areas of Mansker soils that adjoin Otero soils have a plow layer of sandy loam.

Alluvial land and the Hobbs soils make up about 7 percent of the association. These bottom-land soils occur throughout the association. Much of the acreage of Hobbs soils occurs with the Mansic soils in the Mansic-Hobbs complex. The Hobbs soils are dark colored and stratified, and they are high in content of organic matter. Some areas are cultivated, but most are in native grass.

Colby soils make up about 5 percent of the association. They occur in a complex with the Ulysses soils. The Colby soils are sloping to strongly sloping. The largest acreage occurs in the Mulberry Creek watershed and along the northern bank of the valley of the Arkansas River.

Harney soils make up about 3 percent of this association. Gently sloping areas of these soils are along the upper parts of the drainageways. They adjoin sloping areas of Ulysses and Mansic soils of the Harney-Spearville-Ulysses association.

Bippus soils make up 3 percent of the association. They occur beneath hill breaks north of the Arkansas River and along Sawlog, Duck, and Elm Creeks. The largest acreage is along Sawlog Creek. The Bippus soils are deep, granular clay loams that have high water-holding capacity. The areas include spots where the surface layer is high in lime that affects the growth of sorghum.

Strongly sloping Potter soils make up 2 percent of the association. They occur in a complex with the Mansker soils. They are also along the edges of outcrops of caliche, and they have some nearly vertical banks near these outcrops. The texture of the Potter soils ranges from clay loam to loam, and these soils are shallow over caliche. In some of the areas, there are outcrops of limestone. The Potter soils are of little value for agriculture. Nearly all the areas are in native grass.

Soil Erosion

Water and wind erosion of soils are active in Ford County. The erosion is mainly accelerated erosion caused by land use that requires tillage. Neither erosion nor runoff was a serious problem as long as the native grasses remained in good condition.

Normal or geologic erosion is a natural process that may result in land building or in soil material being carried away. The major kind of soil material in the county is loess, which resulted from a land-building process. The loess has been deposited in layers throughout a wide area over a long period of time. Wind has carried this material in from various directions (*18*[1]).

Accelerated erosion is now active in the county. The effect of this on soils can be so gradual from year to year that they may not be noticed. The obvious effects of soil erosion in this county are the dust in the air, mud in the streams, and gullies in the land.

Some of the soils mapped in this county were classified as eroded phases. These are soils that have been eroded so that their management should differ from that of similar but uneroded soils. Nearly all the soils in the county have sustained some loss from erosion, especially the cultivated soils. Accelerated erosion will continue to occur wherever the land has little or no vegetation.

Descriptions of the Soils

In this section the soil series in Ford County are described in alphabetic order, and a typical profile is described briefly for each series. Each mapping unit is then discussed, and characteristics that are different from those of the typical profile are pointed out. A more detailed description of a profile that is typical for each series is given in the section "Formation, Classification, and Morphology of Soils." Terms used to describe the soils that may not be familiar to the reader are defined in the Glossary at the back of the report.

The approximate acreage and proportionate extent of the soils are shown in table 1. Their location is shown on the detailed soil map at the back of the report. In the soil descriptions the symbol in parentheses after the name of the soil identifies the soil on the detailed soil map.

[1] Italicized numbers in parentheses refer to Literature Cited, p. 80.

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

Mapping unit	Acres	Percent
Active dunes	233	(1)
Alluvial land	5,692	0.8
Alluvial land and slickspots	2,931	.4
Bippus clay loam, 2 to 5 percent slopes	2,593	.4
Broken alluvial land	3,288	.5
Canadian fine sandy loam	6,248	.9
Dale silt loam	9,303	1.4
Dale and Humbarger clay loams	27,910	4.0
Dalhart-Lubbock complex	4,274	.6
Harney silt loam, 0 to 1 percent slopes	170,809	24.6
Harney silt loam, 1 to 3 percent slopes	151,777	21.9
Holdrege fine sandy loam, 1 to 3 percent slopes	7,898	1.1
Holdrege loam, 0 to 1 percent slopes	4,202	.6
Holdrege silt loam, 0 to 1 percent slopes	11,527	1.7
Holdrege silt loam, 1 to 3 percent slopes	15,799	2.3
Las Animas sandy loam	3,234	.5
Las Animas-Lincoln complex	6,550	.9
Las Animas-Tivoli complex	1,240	.2
Leshara clay loam	4,435	.6
Leshara clay loam, moderately deep	3,159	.5
Lincoln soils	2,202	.3
Mansic clay loam, 0 to 1 percent slopes	2,512	.4
Mansic clay loam, 1 to 3 percent slopes	3,236	.5
Mansic clay loam, 1 to 3 percent slopes, eroded	791	.1
Mansic clay loam, 3 to 6 percent slopes	10,710	1.5
Mansic and Mansker soils, 3 to 6 percent slopes, eroded	3,163	.5
Mansic-Hobbs complex	27,698	4.0
Mansker clay loam, 0 to 3 percent slopes	2,844	.4
Mansker-Potter complex	9,918	1.4
Ortello fine sandy loam, level	983	.1
Ortello fine sandy loam, undulating	6,728	1.0
Ortello-Carwile complex	8,940	1.3
Otero fine sandy loam, hummocky	816	.1
Potter soils	888	.1
Pratt loamy fine sand, hummocky	6,992	1.0
Pratt-Tivoli loamy fine sands	19,912	2.9
Randall clay	5,661	.8
Sandy broken land	1,900	.3
Spearville silty clay loam, 0 to 1 percent slopes	22,230	3.2
Spearville complex, 1 to 3 percent slopes, eroded	13,608	2.0
Tivoli fine sand	7,466	1.1
Ulysses silt loam, 1 to 3 percent slopes	6,932	1.0
Ulysses silt loam, 3 to 6 percent slopes	42,978	6.2
Ulysses-Colby complex, 3 to 6 percent slopes, eroded	17,232	2.5
Ulysses-Harney silt loams, 1 to 3 percent slopes	13,807	2.0
Ulysses-Harney complex, 1 to 3 percent slopes, eroded	1,686	.2
Ulysses-Hobbs complex	5,973	.9
Arkansas River	1,810	.3
Borrow pits	71	(1)
Intermittent lakes	331	(1)
Total	693,120	100.0

1 Less than 0.05 percent.

At the back of the report is given a list of the mapping units in the county and the dryland and irrigated capability units, range sites, and windbreak suitability groups. The page where each of these is described is also given.

Active Dunes

This land type consists of deep, loose, pale-brown, hummocky sand that is constantly shifted about by wind. It consists of small blowouts that are bare until vegetation creeps in and covers them. Blowoutgrass is the only kind of vegetation that will stabilize these areas.

Drought and overgrazing by livestock cause blowouts. The blowouts gradually become larger until more moisture is received and grazing is checked.

Active dunes (Ad).—This land type is associated with the Tivoli soils. It occurs as small blowouts in the Tivoli association and is near the line between Ford and Kiowa Counties, south of the Arkansas River. Small areas are on the crests of dunes or where the vegetation has been destroyed by overgrazing and trampling. Some areas are around the places where livestock obtain water or salt.

In about 80 percent of the acreage, the surface layer is almost bare, light-colored, loose, unstable sand. In about 20 percent, the surface layer is about 4 inches thick and is slightly darker than the material below. The material below is fine sand more than 4 feet deep. The underlying material is old alluvium that ranges from sand to clay.

This land type is steeper and less stable than Tivoli loamy fine sand. The surface layer is also lighter colored and consists of fine sand instead of loamy fine sand.

No runoff occurs on this land type. The areas are highly susceptible to wind erosion and are used only for range. If the blowouts are fenced to separate them from the surrounding areas, grass covers them more rapidly than if they are not protected. (Capability unit VIIe-1, dryland; Choppy Sands range site; not placed in an irrigated capability unit or in a windbreak suitability group)

Alluvial Land

This land type consists of deep, dark, nearly level loamy alluvial sediment in deep, narrow channels of intermittent streams. The areas range from 150 to 400 feet in width. Stream channels 20 to 80 feet wide and 2 to 10 feet deep make up 10 to 20 percent of the acreage. Generally, the channels cannot be crossed by farm machinery.

Small areas around the meandering stream channels are well drained and are highly productive. These areas receive additional water during floods and produce more grass than soils of the adjacent upland.

Alluvial land (An).—This land type is along nearly all the major streams and their tributaries. (Capability unit VIw-1, dryland; not placed in an irrigated capability unit; Loamy Lowland range site; Deep Loamy and Clayey Lowland windbreak suitability group)

Alluvial land and slickspots (As).—This land type is nearly level and is in the valley of the Arkansas River. About three-fourths of the acreage is Alluvial land, and one-fourth is slickspots.

Alluvial land consists of deep, calcareous alluvial material. The surface layer is granular, grayish-brown clay loam or fine sandy loam that is about 8 inches thick. Below the surface layer is highly calcareous, blocky, light brownish-gray clay loam and sandy clay loam that is about 24 inches thick. Lime films and hardened concretions of lime occur throughout the soil material below the surface layer. The results of laboratory tests of samples from a typical area indicate that the material below the surface layer is high in exchangeable sodium. The underlying material is light brownish-gray to pale-brown, mottled, stratified clay to sand that is massive and usually wet.

The slickspots occur as irregular, discontinuous spots that are about 10 to 200 feet wide and 50 to 500 feet long. These areas consist of light-gray to grayish-brown clay to clay loam. They are highly calcareous and are high in exchangeable sodium. The surface crusts and blows easily.

This land type is nearly level to gently undulating and is imperfectly drained. The water table fluctuates and is at a depth of 2 to 15 feet. There is a large amount of runoff, and the water-intake rate is slow. Slickspots dry out more slowly than the areas of fine sandy loam between them (fig. 2).

Where this land type is used for crops, the major problems are wind erosion, imperfect drainage, and the salinity and alkalinity of the water table. The most common cultivated crops are wheat and sorghum, but native grass is better suited. Alkali sacaton, saltgrass, switchgrass, and other native grasses are somewhat tolerant of salt and can use the moisture supplied by the water table. (Capability unit IVs–1, dryland; not placed in an irrigated capability unit; Saline Subirrigated range site; Shallow Sandy and Clayey Lowland windbreak suitability group)

Bippus Series

The Bippus series consists of deep, dark-colored, well-drained, friable, gently sloping soils of the upland. These soils developed in highly calcareous local sediment that accumulated on foot slopes below old alluvial deposits.

The surface layer is dark-colored, friable, calcareous clay loam about 10 inches thick. The underlying material is light-colored, weakly stratified, friable, highly calcareous clay loam. Lime concretions and fragments are common at any depth beneath the surface layer.

The Bippus soils differ from the Holdrege soils in having a clayey surface layer and various stratified layers of lime instead of a lime zone.

***Figure 2.*—Cover of sorghum stubble on a field of Alluvial land and slickspots.**

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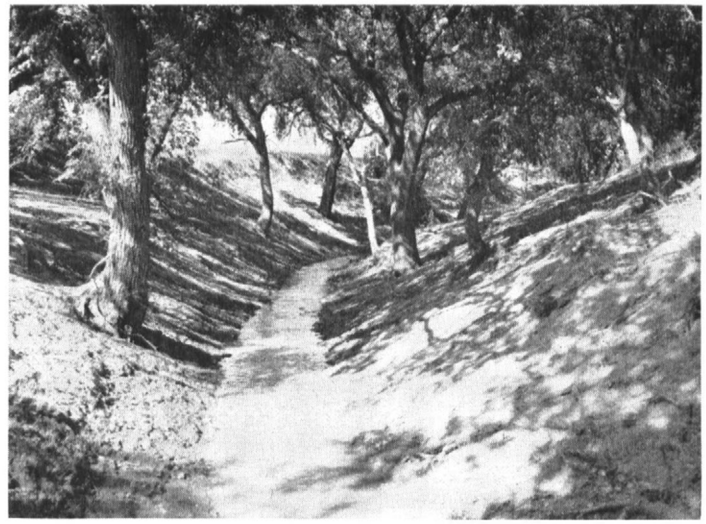

***Figure 3.*—Broken alluvial land on the banks along the deeply incised stream channel of Sawlog Creek. Dale soils are adjacent to the steep streambanks.**

The Bippus soils are permeable and moderately productive. The water-intake rate is moderate, and the water-holding capacity is high.

Bippus clay loam, 2 to 5 percent slopes (Bc).—This soil occupies gently sloping upland that is subject to moderate runoff. It has developed under short grasses and mid grasses.

Winter wheat and sorghum are well suited to this soil, except in small areas that have a large amount of lime at the surface and in the root zone. Sorghum is especially susceptible to chlorosis on the high-lime spots.

This soil is highly susceptible to wind and water erosion. It is easily tilled. Residue management and a minimum of tillage help control wind and water erosion. (Capability unit IIIe–1, dryland and irrigated; Loamy Upland range site; Deep Loamy Upland windbreak suitability group)

Broken Alluvial Land

This land type consists of streambanks and deeply incised stream channels of Sawlog, Duck, Cow, Coon, and Mulberry Creeks and their tributaries. The areas range from 150 to 400 feet in width. The banks are 20 to 60 feet high. Floodwaters seldom top the steep banks to cover the adjacent soils (fig. 3). The bottoms of the channels have a slight slope. The ground water or springs cause many of the areas to be wet much of the time.

Broken alluvial land (Br).—This land type is on the steep banks of the major creeks and their tributaries. The soil material is medium textured and originated in adjacent areas where the soils formed in medium-textured loess and alluvium.

This land type is fertile and friable. It is not suitable for cultivation, however, because of the steep slopes and frequent flooding. Scouring and erosion by floodwaters have dislodged most of the vegetation, except for annual grass, clumps of western wheatgrass, wildrye, and trees. The dominant vegetation is trees, mainly American elm, ash, hackberry, and cottonwood. The trees grow on the steep banks of the narrow flood plains.

This land type has little agricultural use, except for sparse grazing and as a watering place for livestock. Its main function is to carry runoff from the surrounding watersheds. Because of the steep slopes and frequent flooding, the land is best suited to grass and trees used for limited grazing and for protecting the streambank. (Capability unit VIIw–1, dryland; not placed in an irrigated capability unit or a range site; Deep Loamy and Clayey Lowland windbreak suitability group)

Canadian Series

Soils of the Canadian series are deep, dark-colored sandy loams. The soils are young. They lie 6 to 12 feet above the flood plain of the Arkansas River.

The layers in these soils are weakly defined and are somewhat stratified; in most places their texture is fine sandy loam. Below a depth of 3 feet, the texture is dominately loamy, but it ranges from sand to clay. Depth to the water table ranges from 7 to 15 feet.

The Canadian soils resemble the Las Animas soils, except that they are darker, are deeper over sand or clay, and have a deeper water table. They are fine sandy loams, instead of silt loams or clay loams like the Dale soils.

The Canadian soils are well drained and permeable. The water-intake rate is moderately rapid, and the water-holding capacity is medium. There is little runoff. These soils have developed under tall and mid grasses. They contain a moderate amount of organic matter.

These soils are well suited to winter wheat and sorghum. Under good irrigation management, moderate yields of corn and high yields of alfalfa, sorghum, tame grass, and small grain are obtained. Sprinkler and gravity irrigation systems are well suited.

Canadian fine sandy loam (Ca).—Only one soil of the Canadian series is mapped in the county. This soil has slopes of less than 1 percent. The broadest area is in the bend west of the Arkansas River in the east-central part of the county. This area has some channeled topography and grades to the flood plain of the Arkansas River. (Capability unit IIe–2, dryland and irrigated; Sandy range site; Deep Sandy Lowland windbreak suitability group)

Carwile Series

The Carwile series consists of deep, dark soils that are imperfectly drained. The soils are on the upland.

The surface layer is dark grayish brown, granular fine sandy loam about 10 inches thick. The subsoil is about 24 inches thick. The upper part of the subsoil is noncalcareous, granular, grayish-brown to brown sandy loam to sandy clay loam. The lower part is calcareous, blocky, mottled, dark-gray clay that is firm when moist and hard when dry. The underlying material is massive, mottled, gray clay. The thickness of the surface layer ranges from 9 to 20 inches, and that of the subsoil, from 18 to 24 inches. The sediment below a depth of about 4 feet is stratified and ranges from clay to sand.

The soils are poorly drained and mottled, in contrast to the Lubbock soils, which are well drained and lack mottling. The Carwile soils have more clay in the subsoil and underlying layers than the Ortello soils.

Because of the clay in the underlying layers, the Carwile soils are poorly drained. They have a rapid water-intake rate and high water-holding capacity. These soils are fertile and are well suited to wheat and sorghum. They blow if they are not protected.

In Ford County the Carwile soils were mapped only in a complex with the Ortello soils.

Colby Series

The Colby series consists of deep, light-colored, friable, calcareous soils of the upland. These soils are on sloping to rolling landscapes, and in this county they are mainly within the Mulberry Creek watershed.

The surface layer is light-colored, calcareous, granular silt loam about 4 inches thick. There are many white, limy spots. The layers beneath the surface layer range from light-colored silt loam to clay loam (parent) loess.

The Colby soils have a thinner, lighter colored, and more strongly calcareous surface layer than the Ulysses soils. They have a lighter colored surface layer than the Mansic soils, and they contain less clay than those soils.

The Colby soils are moderately permeable. They have a moderate water-intake rate and moderately rapid runoff.

These soils are moderately fertile and are easily tilled, but they are highly susceptible to erosion by wind and water. Sorghum that is grown on some of the strongly calcareous or limy spots is affected by chlorosis.

In this county the Colby soils were mapped only in a complex with the Ulysses soils.

Dale Series

The Dale series consists of deep, nearly level, dark-colored loamy soils in alluvium. The surface layer is dark, noncalcareous, granular silt loam or clay loam about 16 inches thick. The underlying material ranges from silt loam to clay loam. It is granular but is lighter colored than the surface layer. The subsoil grades to stratified, calcareous loamy alluvial parent material derived from the surrounding loess-covered upland. The thickness of the surface layer ranges from 10 to 24 inches. Depth to calcareous material ranges from 12 to 30 inches.

The Dale soils are less deeply leached of lime than the Hobbs soils. Also, they have a slightly thinner darkened surface layer and are flooded less frequently. They are deeper over sand and do not have the shallow, fluctuating water table that is common in the Leshara and Las Animas soils.

The Dale soils are subject to occasional flooding. They are well drained and moderately permeable. The water table is commonly more than 10 feet and less than 30 feet below the surface. The water-holding capacity is high, and the water-intake rate is moderate.

Crops are well suited to these soils under dryland or irrigation farming. Wheat and sorghum are the major crops. These soils will blow if they are not protected.

Dale silt loam (Da).—This soil occurs in nearly level areas along the Arkansas River and the major creeks in

Ford County. Except for a silt loam surface layer, this soil has a profile similar to that described for the Dale series. This surface layer is about 16 inches thick. Depth to calcareous material ranges from about 12 to 30 inches. (Capability unit IIc-2, dryland; capability unit I-1, irrigated; Loamy Lowland range site; Deep Loamy and Clayey Lowland windbreak suitability group)

Dale and Humbarger clay loams (Dh).—These soils occur as nearly level areas along the Arkansas River and the major creeks in the county. They were mapped as an undifferentiated unit.

The Dale soils usually occur on a bench slightly above the Humbarger soils. They have a thicker surface layer than the Humbarger soils and a water table at greater depth.

The water-holding capacity is high in both soils, and the water-intake rate is moderate. In the Dale soils calcareous material is about 24 inches below the surface, but the Humbarger soils are calcareous at the surface. Crops on the Humbarger soils are affected by chlorosis to a greater extent than on the Dale soils.

Nearly all of this unit is used for crops, mainly wheat and sorghum. Both dryland and irrigated crops are well suited.

In cropped areas the main problems are controlling wind erosion, maintaining the content of organic matter, and conserving moisture. (Capability unit IIc-2, dryland; capability unit I-1, irrigated; Loamy Lowland range site; Deep Loamy and Clayey Lowland windbreak suitability group)

Dalhart Series

The Dalhart series is made up of deep soils that are dark colored and friable. These soils are on the upland.

The surface layer is dark grayish-brown, granular fine sandy loam about 7 inches thick. The subsoil is about 36 inches thick. The upper part of the subsoil is brown, granular, noncalcareous sandy clay loam, and the lower part is brown, granular, noncalcareous fine sandy loam. In most places the underlying material is pale-brown, calcareous silty clay loam, but its texture ranges from clay loam to sandy loam. In many places clay or sand is at a depth below 3 feet. The surface layer ranges from 5 to 10 inches in thickness. In most places it is fine sandy loam, but in some places it is loam.

The Dalhart soils contain less clay than the Lubbock. They are less sandy than the Pratt soils.

The Dalhart soils have high water-holding capacity and take water well. They are well suited to wheat and sorghum, but they blow if they are not protected.

Dalhart-Lubbock complex (Dl).—This complex consists mainly of Dalhart, Lubbock, and Randall soils. On the average, Dalhart fine sandy loams make up 67 percent of the complex, Lubbock clay loams 30 percent, and Randall clay 3 percent. This complex occupies nearly level to slightly hummocky areas between the Arkansas River and Coon Creek. The slopes range from less than 1 percent in the Randall soils to more than 5 percent in the Dalhart soils. The Dalhart soils occupy the convex, low hummocks of the complex, and the Randall soils occupy the depressional, concave areas. The Lubbock soils are in the slight depressions or in the slightly convex areas.

Included with the soils of this complex are areas of a Dalhart loamy fine sand that are a result of surface winnowing. Also included are some soils that have characteristics intermediate between those of the Dalhart and Lubbock soils.

The soils of this complex developed in stratified, old sandy and clayey alluvial sediment that has been reworked by wind. The substratum is a persistent layer of limy clay that is within about 6 feet of the surface (fig. 4).

The major problems in managing the soils are the poor drainage of the Randall soil and wind erosion on the Dalhart and Lubbock soils. Farming operations are complicated because some areas remain wet longer than others. The Dalhart soils are sandy and dry out rapidly. They may begin to blow before the Randall soil can be worked. Differences in the length of time it takes for the soils to dry out may also affect harvesting. (Capability unit IIe-3, dryland; capability unit IIe-4, irrigated; Dalhart soil, Sandy range site; Lubbock soil, Loamy Upland range site; Deep Loamy Upland windbreak suitability group)

Harney Series

The Harney series consists of deep, dark-colored, well-drained soils of the upland. These soils developed in calcareous loamy loess.

The surface layer is dark grayish-brown, granular silt loam about 10 inches thick. The subsoil is about 24 inches thick. The upper part is dark grayish-brown, noncalcareous, subangular blocky silty clay loam. The lower part is blocky, calcareous silty clay. The under-

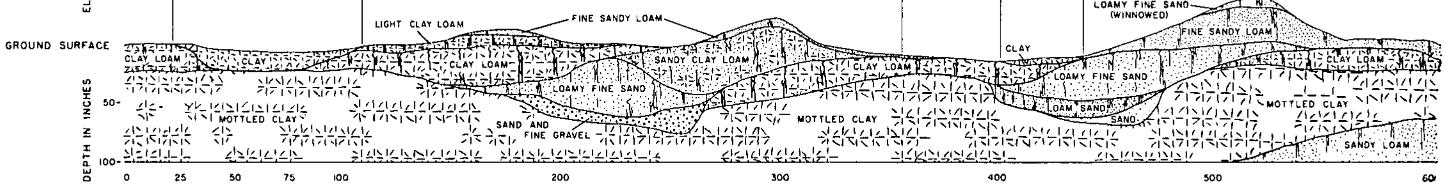

Figure 4.—**A cross section of the Dalhart-Lubbock complex.**

lying material is pale-brown, friable, porous loamy loess that contains less clay than the layers above. The thickness of the surface layer ranges from 4 to 12 inches. Depth to calcareous material ranges from 20 to 30 inches.

The Harney soils have more clay in the lower part of the subsoil than the Holdrege soils. Their subsoil is angular blocky, but that of the Holdrege soils is subangular blocky. They have a thicker surface layer than the Spearville soils and have less clay in the subsoil.

The Harney soils are well drained but have moderately slow permeability. Intake of water is moderately slow. The Harney soils have high fertility and contain a moderately large amount of organic matter.

These soils are easily tilled and highly productive, but they are susceptible to both wind and water erosion. They are well suited to wheat and sorghum under dryland and irrigation farming. Other crops adapted to the climate can be grown under irrigation.

Harney silt loam, 0 to 1 percent slopes (Ha).—This soil is on nearly level, convex upland in broad areas on both sides of the Arkansas River. It occurs throughout the county with the Spearville, Ulysses, and Randall soils. In nearly all areas some patches of Randall and Spearville soils are mapped with this soil. Also included are some small areas that have a surface layer of silt loam, 12 to 16 inches thick, that overlies buried layers of silty clay loam and silty clay.

Dryland and irrigated crops are well suited to Harney silt loam, 0 to 1 percent slopes. Wheat and sorghum are the common crops, but all crops adapted to the climate can be grown. The major problems are wind erosion, maintaining the content of organic matter, and conserving moisture. (Capability unit IIc-1, dryland; capability unit I-1, irrigated; Loamy Upland range site; Deep Loamy Upland windbreak suitability group)

Harney silt loam, 1 to 3 percent slopes (Hb).—This extensive soil has gentle, convex slopes. The surface layer is about 8 inches thick, and the subsoil is about 18 inches thick. Depth to calcareous layers ranges from 15 to 22 inches. This soil occurs throughout the county in association with Harney silt loam, 0 to 1 percent slopes, and Ulysses silt loam, 1 to 3 percent slopes. It has greater susceptibility to erosion and more runoff than the associated Harney soil.

Nearly all of the acreage is used for field crops, mainly wheat and sorghum. Dryland and irrigated crops are well suited. The major problems are controlling wind and water erosion, conserving moisture, and maintaining the content of organic matter. Terracing and contour farming help to control erosion and conserve moisture. (Capability unit IIe-1, dryland and irrigated; Loamy Upland range site; Deep Loamy Upland windbreak suitability group)

Hobbs Series

In the Hobbs series are deep, dark loamy soils that are frequently flooded. The soils are on bottom lands along narrow drainageways in the upland.

The surface layer is dark grayish-brown, granular silt loam about 14 inches thick. The layers beneath the surface layer are loamy, granular, and somewhat stratified. They are noncalcareous to a depth of about 30 inches. The substratum is highly variable in texture and in thickness, but it is mainly medium-textured, calcareous alluvium. Depth to calcareous material ranges from 24 to 48 inches. In places calcareous soil material that was formerly the surface layer of another soil has been washed in.

The Hobbs soils are moderately permeable and are well drained. Floods are frequent, but they do not last long. The water-intake rate is moderate.

These soils are fertile and highly productive. Grasses and field crops grown on them benefit from the extra water from surrounding areas.

In this county the Hobbs soils were mapped only in complexes with the Mansic and Ulysses soils.

Holdrege Series

Deep, dark, well-drained soils of the upland make up the Holdrege series. These soils developed in calcareous loamy loess.

The surface layer is dark grayish-brown, granular loamy material that is about 12 inches thick. It is slightly acid to moderately alkaline. The subsoil is dark grayish-brown, granular silty clay loam that is about 24 inches thick. The underlying material is calcareous and is pale brown and loamy. The surface layer ranges from 6 to 15 inches in thickness. Depth to the calcareous underlying material ranges from 20 to 36 inches.

The Holdrege soils have a less clayey subsoil than the Harney and Spearville soils. They have thicker, darker, noncalcareous upper layers, and they have more clay in their subsoil than the Ulysses soils.

The Holdrege soils are permeable, porous, and well drained. Their water-holding capacity is high, and the water-intake rate is moderate.

These soils are used mostly for winter wheat and sorghum. They are well suited to irrigated crops.

Holdrege fine sandy loam, 1 to 3 percent slopes (Hd).—This soil is on somewhat irregular, gently sloping uplands south of the Arkansas River. Toward the Arkansas River, it grades to the Pratt, Tivoli, and Ortello soils. Toward Mulberry Creek, it grades to the Harney, Spearville, and Ulysses soils.

The surface layer is mainly fine sandy loam about 10 inches thick, but in some places it is loam or loamy fine sand. In areas where the texture is loamy fine sand, the surface layer is less than about 7 inches thick. The subsoil is dark grayish-brown, granular silty clay loam about 20 inches thick. The underlying material is mainly loamy, calcareous loess, but in some places there are layers of loamy fine sand. A very dark grayish-brown, loamy layer that is the surface layer of an old buried soil may occur in the subsoil and in the underlying material.

The water-intake rate is slightly more rapid than that of the Holdrege silt loams. Permeability is also slightly more rapid.

This soil is well suited both to dryland and to irrigation farming. Nearly all of the acreage is in cultivated crops, mainly wheat and sorghum. However, all crops that are adapted to the climate do well. This soil responds well to nitrogen fertilizer when the supply of moisture is adequate. The yields generally can be increased by irrigation. In cultivated areas the primary problems are controlling erosion by wind and water, maintaining the content of organic matter, and conserving moisture.

This soil responds well to good management of crop residue. Terraces, or contour farming with terraces, helps to control erosion and to conserve moisture. (Capability unit IIIe-4, dryland; capability unit IIe-3, irrigated; Sandy range site; Deep Loamy Upland windbreak suitability group)

Holdrege loam, 0 to 1 percent slopes (Hg).—This soil is south of the Arkansas River in a narrow band that is about 1 to 4 miles wide. It is closely associated with Holdrege fine sandy loam, 1 to 3 percent slopes.

The surface layer is loam about 10 inches thick. The subsoil is clay loam or silty clay loam, but it is slightly more sandy throughout than that of the Holdrege silt loams. The underlying material is loamy and calcareous, and it is stratified below a depth of 3 feet in some places. This underlying material rests on stratified, clayey to sandy, old alluvium.

This soil is well drained and permeable. It is well suited to cultivation of both dryland and irrigated crops. Wheat and sorghum are the main crops, but all crops adapted to the climate can be grown.

The major problems in managing this soil are controlling wind erosion, maintaining the content of organic matter, and conserving moisture. (Capability unit IIc-1, dryland; capability unit I-1, irrigated; Loamy Upland range site; Deep Loamy Upland windbreak suitability group)

Holdrege silt loam, 0 to 1 percent slopes (Ho).—This soil is on convex slopes south of the Arkansas River in a band about 1 to 4 miles wide. The largest area is southeast of Ford. Some small areas of Harney silt loam, 0 to 1 percent slopes, are mapped with this soil.

All of the acreage is well suited to the dryland and irrigated crops that are adapted to the climate. The major crops are wheat, other small grain, and sorghum.

The main problems in managing this soil are controlling wind erosion, maintaining the content of organic matter, and conserving moisture. (Capability unit IIc-1, dryland; capability unit I-1, irrigated; Loamy Upland range site; Deep Loamy Upland windbreak suitability group)

Holdrege silt loam, 1 to 3 percent slopes (Hs).—This soil occurs with Holdrege silt loam, 0 to 1 percent slopes. It is on gentle, convex slopes.

The surface layer is dark grayish-brown silt loam about 8 inches thick. The subsoil is granular silty clay loam about 17 inches thick. The upper part of the subsoil is dark grayish brown, and the lower part is grayish brown. The underlying material is pale brown, and is calcareous and loamy. The surface layer ranges from 4 to 10 inches in thickness. Depth to the calcareous underlying material is about 20 to 30 inches.

This soil is permeable and well drained. It has a moderate water-intake rate. It is used mainly for field crops, but all the crops that are adapted to the climate do well. This soil is well suited to dryland and irrigation farming.

The main problems in managing this soil are controlling erosion by water and wind and maintaining the content of organic matter. The soil needs minimum tillage, contour farming with terraces, and good management of crop residue. (Capability unit IIe-1, dryland and irrigated; Loamy Upland range site; Deep Loamy Upland windbreak suitability group)

Humbarger Series

The Humbarger series consists of deep soils in calcareous alluvium. The soils are well drained.

The surface layer is granular, calcareous, dark grayish-brown clay loam about 12 inches thick. The subsoil is granular, calcareous, grayish-brown clay loam. The underlying material is highly calcareous, light brownish-gray clay loam that grades gradually to the lower layers of clay, loamy fine sand, and sand. These lower layers are calcareous, and in places they are mottled. The surface layer ranges from 6 to 20 inches in thickness, and in some places its texture is fine sandy loam. In some places the underlying material is mottled. Depth to the water table ranges from 5 to 10 feet.

The Humbarger soils have a thinner surface layer and are more calcareous than the Dale soils. They lack the shallow water table and the mottling in the subsoil that are common in the Leshara soils.

These soils are suitable for dryland crops and for all the irrigated crops adapted to the climate. The major crops are wheat and sorghum.

In this county the Humbarger soils were mapped only in an undifferentiated unit with the Dale soils.

Las Animas Series

The Las Animas series consists of friable, moderately sandy, calcareous soils on the flood plain of the Arkansas River. These soils are moderately deep to shallow over fine sand or fine gravel. They are nearly level; the slopes are 1 percent or less. Some channeled areas or areas of irregular topography occur near the Arkansas River.

The surface layer is grayish-brown, granular sandy loam about 10 inches thick. The subsoil consists mainly of stratified sandy loam and loamy fine sand, but it contains some clay loam. The substratum is fine sand or fine gravel, and it is 15 to 40 inches beneath the surface. The water table fluctuates between a depth of 2 and 5 feet. In some places the surface layer is clay loam or loamy fine sand.

Unlike the Leshara soils, which are dark colored and have a subsoil of clay loam, the typical Las Animas soils are light colored and have a subsoil of sandy loam. They have less sand throughout the profile and are deeper over sand than the Lincoln soils.

The Las Animas soils are easily tilled. They take water rapidly, but they have low water-holding capacity. Blowing occurs unless these soils are protected. Flooding and the fluctuating water table are limiting factors. In some places the water table is slightly to moderately saline.

Las Animas sandy loam (La).—This soil is on the flood plain of the Arkansas River. The surface layer is calcareous, grayish-brown, granular sandy loam about 10 inches thick. The subsoil is stratified. It is made up of calcareous, light brownish-gray, weakly granular layers of sandy loam or loamy fine sand and thin layers of clay loam. The underlying layers are fine sand or fine gravel and are at a depth of 24 to 40 inches. Depth to mottling ranges from about 30 to 36 inches. The water table fluctuates and is 24 to 60 inches below the surface. In some areas the surface layer is clay loam or loamy fine sand and is less than 7 inches thick.

Nearly all areas are cultivated, and some areas are irrigated. Water for irrigation is usually taken from the Arkansas River or from shallow wells where the water table is high because of the river. The major crops are wheat and sorghum, but alfalfa is grown in some areas.

The main problems in managing this soil are the imperfect subsurface drainage, which is related to the fluctuating water table, the low water-holding capacity, the shallow depth to sand, and the susceptibility to flooding. Wind erosion is also a problem, and in some areas the water table is slightly to moderately saline. (Capability unit IVw–1, dryland; capability unit IIIw–1, irrigated; Saline Subirrigated range site; Shallow Sandy and Clayey Lowland windbreak suitability group)

Las Animas-Lincoln complex (Lc).—This complex oc-occupies somewhat channeled areas along the Arkansas River. Las Animas soils make up about 80 percent of the complex, and Lincoln soils make up about 20 percent. These soils have slopes of less than 1 percent. The Las Animas soils are on small ridges and in some low areas. The Lincoln soils are also on small ridges and are along the channel of the river.

The soils of this complex are commonly shallow over fine sand and fine gravel, but they range from 10 to 40 inches in thickness. The surfare layer is sandy loam, clay loam, or loamy fine sand. The layers beneath the surface layer are mainly stratified sandy loam or loamy fine sand, but in places they contain thin lenses of clay loam. In many places these soils have a surface layer of clay loam that is as much as 10 inches thick. The water table fluctuates between a depth of 1 and 5 feet. In some areas there are slightly to moderately saline spots as a result of the fluctuating water table.

The major problems in managing these soils are caused by the sand near the surface, the shallow, fluctuating water table, and the low content of organic matter. The layers of sandy loam and loamy sand are rapidly permeable, and they have low water-holding capacity. Those of clay loam are moderately permeable, but they are thin and will store less than 2 inches of water.

The soils of this complex are subject to flooding, and they blow if they are not protected. They are used mainly for grass and are best suited to such native grasses as switchgrass, sand dropseed, grama, buffalograss, and some alkali sacaton. Inland saltgrass is common in overgrazed pasture. These soils are seldom used for dryland or irrigated crops. (Capability unit VIs-1, dryland; not placed in an irrigated capability unit; Saline Subirrigated range site; Shallow Sandy and Clayey Lowland windbreak suitability group)

Las Animas-Tivoli complex (Ln).—This complex is in the valley of the Arkansas River. The landscape consists of sandy mounds on a nearly level flood plain. About 50 percent of the acreage consists of Las Animas soils, and about 50 percent, of Tivoli fine sand (fig. 5).

The Las Animas soils are mainly nearly level, but in some places they are gently sloping. Their surface layer is generally sandy loam or clay loam, but in some places it is loamy fine sand. The water table fluctuates between a depth of 1 and 5 feet.

Tivoli fine sand is on mounds or undulating slopes of about 6 percent. The mounds are about 3 to 4 feet high, 50 to 200 feet wide, and 100 to 700 feet long, and they have peaks that are 200 to 400 feet apart. The surface layer is fine sand that is slightly darker than the material below. The layers beneath are mainly fine sand, but they have thin lenses of fine sandy loam throughout. Beneath the surface of the sandy mounds, the water table fluctuates between a depth of about 3 and 10 feet.

Most areas of the soils in this complex are in grass. The major problems in managing the soils are wind erosion, small content of organic matter, and the low water-holding capacity.

Mapped with the Las Animas soils in areas where there is a fluctuating water table are spots of a slightly to moderately saline soil. Also included are some spots of a poorly drained soil that has a surface layer of clay loam.

Nearly all of this complex is underlain by sandy and clayey old alluvium. All of the acreage is subirrigated.

The soils of this complex are well suited to native grass and trees, but they are poorly suited to cultivated crops. The Las Animas soils support switchgrass, western wheatgrass, side-oats grama, buffalograss, inland saltgrass, some alkali sacaton, and cottonwood trees. The sandy

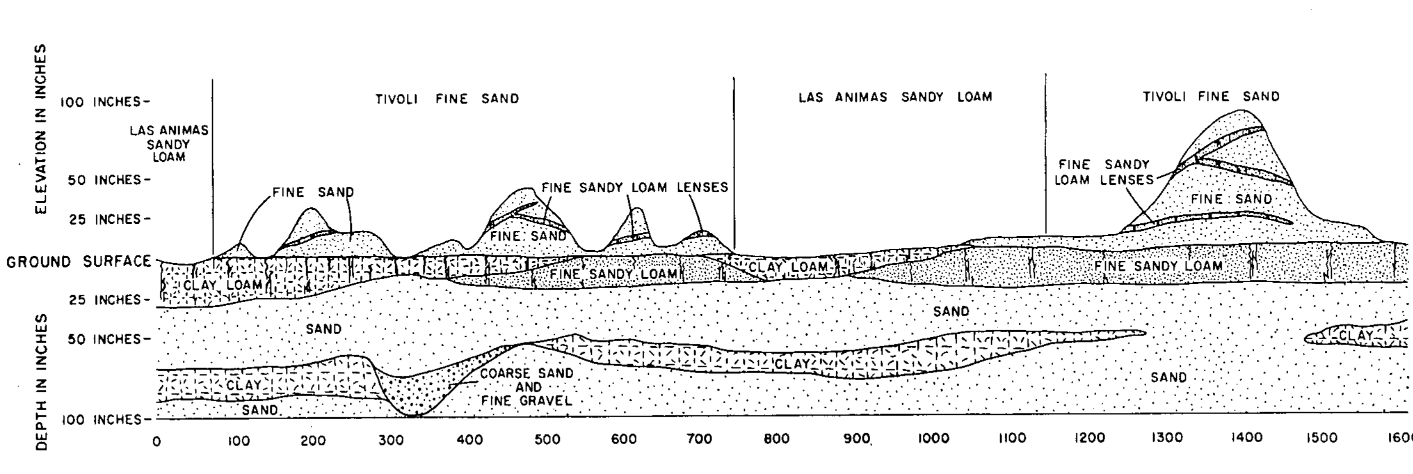

Figure 5.—**Cross section of the soils in the Las Animas-Tivoli complex.**

mounds of Tivoli fine sand support sand bluestem, sand dropseed, Indiangrass, prairie sandreed, and switchgrass. (Capability unit VIe-2, dryland; not placed in an irrigated capability unit; Las Animas soils, Saline Subirrigated range site; Tivoli soil, Sands range site; Shallow Sandy and Clayey Lowland windbreak suitability group)

Leshara Series

In the Leshara series are dark, deep and moderately deep clay loams that are neutral to calcareous. These soils are on the flood plain of the Arkansas River.

The surface layer and the layers beneath are granular clay loam that is underlain by fine sand at a depth of 18 to 60 inches. The water table fluctuates between a depth of 2 and 5 feet. These soils developed mainly in clay loam alluvium interbedded with layers of sandy loam and loamy sand.

The Leshara soils are darker and less sandy than the Las Animas soils. They have a shallower water table than the Dale soils and are flooded more frequently.

The Leshara soils are easily tilled. They are moderately well drained and are productive. The water-intake rate is moderate.

These soils are suitable for crops and are used mainly for winter wheat and sorghum. Alfalfa can be grown without irrigation. In dry periods its roots penetrate to the water table in many places. Alfalfa can be damaged, however, by a shallow water table, by floods, or by drought if the water table drops as low as the sandy substratum.

Leshara clay loam (Ls).—This soil is nearly level and is on the flood plain of the Arkansas River. It is suitable for cultivation, but its use is limited by a moderately low water-holding capacity during dry periods and a fluctuating water table that is near the surface during wet periods. (Capability unit IIIw-1, dryland; capability unit IIw-1, irrigated; Saline Subirrigated range site; Shallow Sandy and Clayey Lowland windbreak suitability group)

Leshara clay loam, moderately deep (Lt).—This nearly level soil is on the flood plain of the Arkansas River. It is similar to the Leshara clay loam not named as moderately deep, except that sandy material is at a depth of 18 to 30 inches. Also, this soil is saline in some places and alkaline in others, as a result of the fluctuating water table.

Because of the sand near the surface, the shallow water table, and the saline or alkaline spots, this soil is not well suited to crops. Crop yields are lower than those on the Leshara clay loam not named as moderately deep. (Capability unit IVw-1, dryland; capability unit IIIw-1, irrigated; Saline Subirrigated range site; Shallow Sandy and Clayey Lowland windbreak suitability group)

Lincoln Series

The Lincoln series consists of light-colored, generally shallow, calcareous sandy soils that have a fluctuating water table near the surface. These soils occur on nearly level to weakly hummocky areas near the Arkansas River channel (fig. 6). They formed in alluvium.

The soil material is generally sandy to a depth of 1 foot, but it contains layers of clay loam in some places.

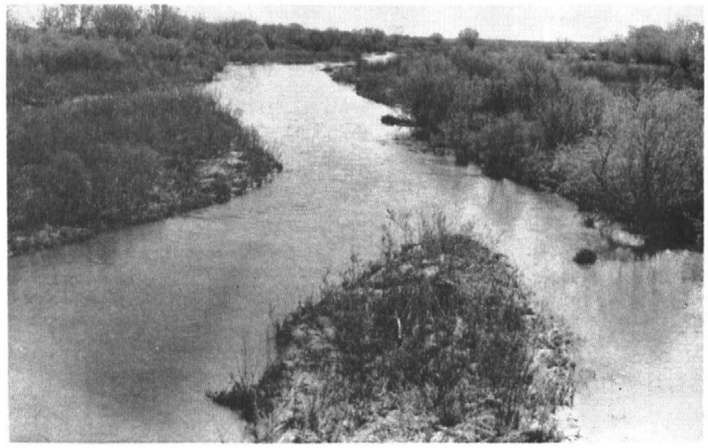

Figure 6.—**Lincoln soils on natural levees and islands of the Arkansas River.**

The material below consists of stratified fine gravel, sand, loamy sand, sandy loam, organic matter, micaceous fine sand, and silt.

The Lincoln soils are more sandy than the Las Animas soils. They are also more shallow over coarse-textured, stratified material.

The Lincoln soils are subject to frequent flooding, sorting, scouring, and redeposition. They are rapidly permeable and have low water-holding capacity and low fertility. They contain only a small amount of organic matter.

These soils are generally not suitable for crops. The vegetation ranges from a cover of deciduous trees and brush to no vegetation on gravel bars. Because the soils are unstable, the annual grasses and weeds that grow among trees and brush provide only a small amount of grazing. Old channel banks and trees furnish some protection to cattle.

Lincoln soils (Lu).—These loose, unstable soils occur along the Arkansas River channel. They are nearly level or are on low hummocks. Some annual grasses, weeds, fast-growing trees, and brush are the only vegetation.

Lincoln soils are not suitable as a woodland site or range site, because of the flooding and shifting of the soil material, the shallow root zone, and the fluctuating water table near the surface. In some places cottonwood trees grow rapidly for a few years. (Capability unit VIIw-1, dryland; not placed in an irrigated capability unit, range site, or windbreak suitability group)

Lubbock Series

The Lubbock series is made up of deep, dark, well-drained soils of the upland. These soils developed in windblown material that overlies old alluvium.

The surface layer is granular clay loam about 6 inches thick. The subsoil is also clay loam, but it has subangular blocky structure and is about 20 inches thick. It is hard when dry, but roots penetrate it easily. The underlying material is calcareous, granular clay loam about 15 inches thick. The substratum, below a depth of 3 feet, consists of thick bands of stratified sandy loam and clay loam. The thickness of the surface layer ranges from 4 to 10 inches, and that of the subsoil, from 15 to 24 inches. Depth to calcareous material ranges from 18 to 40 inches.

The Lubbock soils are darker than the Dalhart soils, and they contain more clay and less sand. They are better drained than the Carwile soils, and they do not have the mottling in the subsoil that is common in the Carwile soils.

The Lubbock soils have high water-holding capacity. They are suited to wheat and sorghum but blow if they are not protected. Other problems in managing them are their slow permeability and slow runoff.

In this county the Lubbock soils are mapped only with the Dalhart soils.

Mansic Series

Soils of the Mansic series are deep, well-drained, dark, calcareous clay loams. They are on the upland and developed in old alluvium.

The surface layer is dark grayish-brown, granular clay loam about 8 inches thick. The layers beneath are only slightly more clayey than the surface layer. The parent material is clay loam that contains slightly more fine and medium sand than the material just above it. Depth to visible lime films ranges from about 7 to 22 inches. The material where the lime films occur grades to a zone of semihard lime accumulations at a depth of 24 to 48 inches. The lime accumulations make up about 5 to 10 percent of the soil mass, and they affect the growth of roots and the water-holding capacity in some areas.

The Mansic soils contain more clay than the Ulysses soils, and they have a slightly stronger zone of lime accumulation. They have a weaker, less continuous zone of lime accumulation, however, than the Mansker soils. They also have a thicker, darker surface layer and higher water-holding capacity.

The Mansic soils have high water-holding capacity, and their moisture-intake rate is moderate. These soils are easily tilled and productive, but they are highly susceptible to erosion by wind and water. Wind erosion takes place partly because the surface layer is calcareous. Areas where the slopes are less than 6 percent are generally cultivated. In nearly all the cultivated fields, sorghum has been affected by chlorosis.

Mansic clay loam, 0 to 1 percent slopes (Ma).—This soil occupies small areas in the north-central and southeastern parts of the county. It is nearly level, but it has convex slopes of 1 percent.

The surface layer is dark grayish-brown, granular clay loam about 10 inches thick. The subsoil is mainly granular clay loam, but in some small areas its structure is subangular blocky. Some small areas that have a surface layer of noncalcareous silt loam are mapped with this soil.

Most of the acreage is used for crops, mainly wheat and sorghum. This soil is suitable for both dryland and irrigation farming.

The major problems in managing this soil are controlling wind erosion, maintaining the content of organic matter, and maintaining good tilth. (Capability unit IIc-1, dryland; capability unit I-1, irrigated; Loamy Upland range site; Deep Loamy Upland windbreak suitability group)

Mansic clay loam, 1 to 3 percent slopes (Mb).—This soil is in the north-central and southeastern parts of the county. It generally occurs with the Harney soils on gentle, convex slopes.

The surface layer is granular, dark grayish-brown clay loam about 5 to 12 inches thick. In most places it is calcareous, but in some places it is noncalcareous to a depth of 15 inches.

This soil is used for both dryland and irrigated crops, but wheat and sorghum are the major crops. All the irrigated crops adapted to the climate can be grown.

The major problems in managing this soil are controlling wind and water erosion, maintaining the content of organic matter, and maintaining good tilth. (Capability unit IIIe-1, dryland; capability unit IIe-1, irrigated; Loamy Upland range site; Deep Loamy Upland windbreak suitability group)

Mansic clay loam, 1 to 3 percent slopes, eroded (Mc).—This soil occurs with Mansic clay loam, 1 to 3 percent slopes, in the east-central and southwestern parts of the county. It is also associated with the Mansker soils.

The surface layer is granular, calcareous clay loam. In most areas it is dark grayish brown, but in some places it is grayish brown. The surface layer generally contains a few to a moderate number of small, water-rounded pebbles and some rounded lime concretions. Many rills or small gullies are apparent after rains. The surface layer is only 3 to 6 inches thick; in tilled fields it has been mixed with deeper soil material to form the plow layer. The layers beneath the surface layer are highly calcareous, pale-brown and grayish-brown clay loam that contains varying amounts of concretions and films of segregated lime. In places lime concretions and films are on the surface, but in some spots they are as deep as 20 inches.

This soil is used or has been used for cultivated crops, and it has been damaged by wind and water erosion. Wheat and sorghum are the major crops grown. This soil is best suited to grass, but it is suited to limited use for dryland and irrigation farming.

In cultivated areas the major problems in managing this soil are controlling water and wind erosion, maintaining the content of organic matter, and conserving moisture. Contour farming with terraces, waterways, stubble-mulch farming, and minimum tillage can do much to solve these problems. (Capability unit IIIe-1, dryland and irrigated; Limy Upland range site; Deep Loamy Upland windbreak suitability group)

Mansic clay loam, 3 to 6 percent slopes (Md).—This soil occurs throughout the county in areas where the landscape is convex and sloping. It is adjacent to the soils of the Mansic-Hobbs complex. The largest acreage is along the Sawlog Creek watershed in the north-central part of the county.

The surface layer is dark grayish-brown, granular clay loam about 4 to 7 inches thick. In most places it is calcareous at the surface, but in places it is noncalcareous to a depth of 7 inches. The layers beneath the surface layer are highly calcareous and are similar to the layers in the other Mansic soils. Depth to visible lime in the form of lime films and concretions ranges from 7 to 20 inches. Depth to layers where there is much segregated lime ranges from 24 to 48 inches. This soil is well drained and has high water-holding capacity, but there is a large amount of runoff.

About half of the acreage is in field crops, and the rest is in grass. This soil is suited to limited use for dryland and irrigation farming but is best suited to grass.

Where this soil is cultivated, the major problems in managing it are controlling water and wind erosion and conserving moisture. This soil is especially difficult to manage if it is irrigated.

In cultivated areas contour farming with terraces, waterways, stubble-mulch farming, and a minimum amount of tillage will do much to control erosion. These practices also help maintain the content of organic matter, improve the soil tilth, and conserve moisture. (Capability unit IVe-2 dryland; capability unit IIIe-1, irrigated; Loamy Upland range site; Deep Loamy Upland windbreak suitability group)

Mansic and Mansker soils, 3 to 6 percent slopes, eroded (Mf).—This undifferentiated unit is on a sloping, eroded landscape, mainly in the northern part of the county. Mansic soils make up about 85 percent of the acreage, and light-colored Mansker soils make up 15 percent.

The surface layer is highly calcareous, granular clay loam. In most places it is grayish brown and pale brown, but in some places it is dark grayish brown. The surface layer contains many spots of lime and exposed layers of carbonates. There are many rills or small gullies after rains. The layers beneath the surface layer are strongly calcareous, pale-brown to white clay loam that contains varying amounts of concretions and films of segregated lime. About 15 percent of the acreage has lime concretions and films on the surface. The effective soil depth and water-holding capacity are limited in these areas.

These soils are used or have been used for cultivated crops and have been damaged by water and wind erosion. The main crops are wheat and sorghum. The soils are suited to very limited use for dryland crops, but they are best suited to grass.

Controlling water and wind erosion, maintaining the content of organic matter, and conserving moisture are the major problems in cultivated areas. Contour farming along with terraces and waterways, stubble-mulch farming, and a minimum amount of tillage can do much to solve these problems. (Capability unit IVe-2, dryland; not placed in an irrigated capability unit; Limy Upland range site; Deep Loamy Upland windbreak suitability group)

Mansic-Hobbs complex (Mh).—This complex is along nearly all the major streams and small drainageways in the county, and it is also on the side slopes of the valley of the Arkansas River. About 60 to 80 percent of the acreage consists of Mansic clay loam, and about 20 to 40 percent, of Hobbs silt loam. The Mansic soil is on the side slopes, and the Hobbs soil is on narrow, nearly level bottom lands that are frequently flooded. The landscape where this complex occurs consists of strongly sloping, erosional upland and of narrow, alluvial drainageways.

In uneroded areas of the Mansic soil, the surface layer is calcareous and is dark grayish brown. In eroded areas it is pale brown. Most of the eroded areas are cultivated or have been cultivated. In those areas are many spots that contain lime concretions and a large amount of lime. The water-intake rate is moderate, and runoff is rapid.

The bottom lands where the Hobbs soil occurs are only about 50 to 150 feet wide and are intersected by a deeply cut stream channel. The Hobbs soil is stratified and is leached of lime to a depth of more than 2 feet. In places, generally near the eroded areas of Mansic clay loam, this soil of the bottom lands is calcareous at the surface.

The soils of this complex are mainly used for grass and are not suitable for field crops.

On the upland the major problems in managing these soils are water erosion and some wind erosion. On the bottom lands the major problem is frequent flooding. (Capability unit VIe-1, dryland; not placed in an irrigated capability unit; Mansic soil, Limy Upland site; Hobbs soil, Loamy Lowland site; Deep Loamy Upland windbreak suitability group)

Mansker Series

The Mansker series consists of highly calcareous, friable, light-colored clay loams that are shallow to moderately deep over caliche. These soils are on the upland and developed in loamy, old alluvium.

The surface layer is grayish-brown granular clay loam about 6 inches thick. The layers beneath the surface layer are dominantly clay loam. Caliche is at a depth of about 22 inches.

The Mansker soils differ from the Mansic and Ulysses soils in having caliche at only a moderate depth. They are deeper over caliche than the Potter soils.

The Mansker soils are well drained and permeable. The development of roots and the water-holding capacity are restricted in the massive layers of caliche. Surface runoff is moderate to rapid. These soils have low water-holding capacity and a low content of organic matter. They have moderate fertility for plants that tolerate lime or that have a shallow or medium rooting system. However, crops, especially sorghum, are commonly affected by chlorosis.

This soil is easily worked, but it is highly susceptible to erosion by both wind and water. The calcareous material in the surface layer, the limited depth to which roots can penetrate, and the limited water-holding capacity restrict its use for crops.

The Mansker soils support a moderate amount of native grass. The vegetation includes side-oats grama, blue grama, and hairy grama, buffalograss, and some broomweed. In improved pastures broomweed decreases, and desirable grasses increase.

Mansker clay loam, 0 to 3 percent slopes (Mn).—This soil is in the east-central part of the county between Coon Creek and the Arkansas River. A small acreage occurs with Potter soils along the major streams in the county.

The surface layer is calcareous, grayish-brown clay loam, and the subsoil is strongly calcareous clay loam. The underlying material consists of layers of pale-brown, strongly calcareous, soft and hard caliche.

Mapped with this soil are small areas of an Ortello fine sandy loam, some areas of an Otero fine sandy loam, and some areas of a Mansic clay loam.

This Mansker soil is suitable for limited dryland and irrigation farming, and nearly all of the acreage is used for crops. The primary problems where crops are grown are erosion by wind and water, the low content of organic matter, and the low water-holding capacity. Contour farming with terraces, waterways, stubble-mulch farming, and a minimum amount of tillage do much to control erosion and to conserve moisture. (Capability unit IIIe-1, dryland and irrigated; Limy Upland range site; Moderately Deep Loamy Upland windbreak suitability group)

Mansker-Potter complex (Mp).—This complex occurs along the slopes north of the valley of the Arkansas River. Locally it is also along all the major streams of the county. Mansker soils make up about 70 percent of the complex, Potter soils about 27 percent, and Mansic soils about 3 percent (fig. 7).

The composition of this complex varies from place to place. The Potter soils make up 15 to 40 percent of the acreage, the Mansker soils make up 58 to 80 percent, and the Mansic soils make up 2 to 5 percent. These soils occur together in strongly sloping to sloping areas that are used mainly for pasture or range.

These deep and moderately deep soils are fertile and permeable, and they have good water-holding capacity. The shallow soils and rock outcrops have little or no intake of water and very low water-holding capacity. There is a large amount of runoff, especially from the shallow soils and rock outcrops. Runoff from flat rocks increases the amount of moisture available locally for deeper soils near the rocks.

Native grasses grow well on the deep and moderately deep soils, but only shallow-rooted plants grow on the soils that are shallow over bedrock. The dominant native grasses are tall and mid grasses. The presence of broom snakeweed, short grasses, and annual grasses indicates that the soils are shallow over bedrock or coarse-textured material or that the area has been overgrazed. (Capability unit VIe-3, dryland; Mansker soil, Limy Upland site; Potter soil, Breaks site; not placed in an irrigated capability unit or in a windbreak suitability group)

Ortello Series

The Ortello series is made up of deep, dark sandy loams. The soils are in nearly level and undulating areas on the upland.

The surface layer is dark grayish-brown, granular fine sandy loam about 10 inches thick. The subsoil is brown,

Figure 7.—**Area of native range. The soils consist mainly of Potter, Mansker, and Mansic soils, but some rock outcrops are included.**

granular fine sandy loam about 22 inches thick. The parent material is brown, noncalcareous, recent, sandy eolian material that in most places is about 4 feet thick. This material grades downward to the substratum of calcareous loess and old alluvium, which ranges from sand to clay in texture. The surface layer ranges from 7 to 14 inches in thickness.

The Ortello soils, unlike the Otero, are noncalcareous to a depth of more than 4 feet. They are less sandy than the Pratt soils, and they have better drainage than the Carwile soils.

The Ortello soils take water rapidly and have little or no runoff. They are well drained and are easily tilled.

These soils are used mostly for crops. Winter wheat and sorghum are the common crops. These soils are well suited to irrigation.

Wind erosion is the major hazard. Good management of crop residue, along with stripcropping (fig. 8), will help to control wind erosion.

Ortello fine sandy loam, level (Of).—This soil is in small, scattered areas south of the Arkansas River. It is in a band about 1 to 4 miles wide. This soil occurs on slopes of about 1 percent, but some small ridges where slopes are 2 percent are included in the areas. The subsoil is like the subsoil of Ortello fine sandy loam, undulating. The underlying layers range from sand to clay at a depth of 4 feet or more.

This soil is well suited to dryland and irrigation farming, and all the crops that are adapted to the climate do well. The major dryland crops are wheat and sorghum. Irrigated crops are mainly wheat and other small grain, sorghum, alfalfa, and some corn.

The main problems in managing this soil are wind erosion and maintaining the content of organic matter. Stubble-mulch farming and minimum tillage help to reduce erosion. (Capability unit IIe-2, dryland and irrigated; Sandy range site; Deep Sandy Upland windbreak suitability group)

Ortello fine sandy loam, undulating (Or).—This soil is south of the valley of the Arkansas River in an area 1 to 4 miles wide. It also occurs with the Carwile soils in an area that extends northward from the Arkansas River to Coon Creek. The soil has irregular slopes that are mostly about 3 percent but range from 2 to 8 percent. The surface layer and subsoil are neutral to slightly acid.

This soil is well suited to dryland and irrigated crops. The dryland crops are mainly wheat and sorghum. The irrigated crops include nearly all the crops adapted to the climate, but they are mainly wheat and other small grain, sorghum, and alfalfa.

The primary problems are controlling erosion by wind and water and maintaining the content of organic matter. Stubble-mulch farming, minimum tillage, and stripcropping help to reduce erosion. (Capability unit IIIe-3, dryland; capability unit IIe-2, irrigated; Sandy range site, Deep Sandy Upland windbreak suitability group)

Ortello-Carwile complex (Os).—This complex occurs in undulating areas that extend northward from the Arkansas River to Coon Creek in the eastern part of the county. About 56 percent of the complex consists of Ortello fine sandy loam, about 26 percent of Carwile fine sandy loam, about 16 percent of Lubbock clay loam, and about 2 percent of Randall clay.

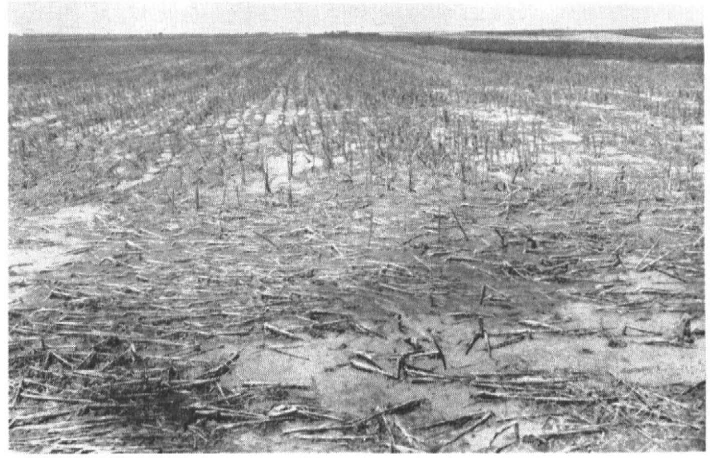

***Figure 8.*—Crop residue in a field of Ortello fine sandy loam where sorghum was grown; the strips in the background are winter wheat.**

The Ortello soil is on mounds about 3 to 10 feet high that resemble waves. The peaks of the mounds are 200 to 900 feet apart. The slopes are about 4 percent. The Carwile and Lubbock soils are nearly level or gently sloping and are between the mounds. The Randall soil is in poorly drained depressions.

The soils of this complex developed in stratified, old alluvial sandy and clayey sediment. The surface layer and much of the subsoil have been reworked by wind. The underlying material ranges from sand to clay, and both textures occur within a depth of about 6 feet. Generally, the clayey and medium-textured material is calcareous and the sandy material is noncalcareous.

Some areas of Ortello loamy fine sand that resulted from surface winnowing are mapped with the soils of this complex. Also included are some soils that have characteristics transitional between those of the Ortello and Carwile soils and between those of the Carwile and Lubbock soils.

Wind erosion and the low content of organic matter are the major problems in managing the Ortello and Lubbock soils. Wind erosion and the imperfect drainage of the subsoil and substratum are the major problems in managing the Carwile soils. The Randall soil is poorly drained and is often ponded after rains. As a result, farming operations are frequently delayed in the depressions.

The soils of this complex are suitable for cultivation under both dryland and irrigation farming. The main crops are winter wheat and sorghum. (Capability unit IIIe-3, dryland; capability unit IIe-2, irrigated; Sandy range site; Deep Sandy Upland windbreak suitability group)

Otero Series

The Otero series consists of deep soils that are light colored, calcareous, and sandy. The soils are on irregular dunes on the upland.

The surface layer is grayish-brown, granular, calcareous fine sandy loam about 10 inches thick. The layers beneath are calcareous, light-colored loamy fine sand about 24 inches thick. The substratum, below a depth of 3 feet, is highly variable. In general its texture ranges from sand to clay, but there are some interbedded layers of caliche.

Unlike the Ortello soils, the Otero soils are calcareous throughout. They are also slightly lighter colored and are more stratified in all layers than the Ortello soils. They are lighter colored and more sandy than the Mansker soils.

The Otero soils are well drained and take water rapidly. They are low in content of organic matter and blow if they are not protected. They are generally used for field crops. Sorghum and winter wheat are the main crops, but sorghum is better suited than wheat. These soils are suitable for irrigation farming.

Otero fine sandy loam, hummocky (Ot).—This soil is in the southwestern corner of the county along the line between Meade and Ford Counties. It also occupies small areas between the Arkansas River and Coon Creek. The landscape where this soil occurs is irregular and has mounds that resemble dunes. The slopes range from 2 to 15 percent, but in most places they are about 6 percent.

The surface layer is generally calcareous fine sandy loam, but some winnowed areas of loamy fine sand are mapped with this soil. The subsoil contains some thin lenses of fine sandy loam.

This soil is used mainly for wheat and sorghum. Where the soil is used for crops, the major problems are controlling wind and water erosion, maintaining the content of organic matter, and conserving moisture. Stripcropping, good management of crop residue, and minimum tillage can do much to control erosion and maintain soil productivity. (Capability unit IIIe–3, dryland; capability unit IIe–2, irrigated; Sandy range site; Deep Sandy Upland windbreak suitability group)

Potter Series

The Potter series is made up of highly calcareous, light-colored, rapidly drained soils that are strongly sloping to steep. The soils are on the upland and are shallow over caliche.

The surface layer is granular clay loam or loam about 8 inches thick. It contains cobbles, fragments of caliche, and stones. The underlying layers are a mass of caliche and gravel or sand pockets that restrict deep penetration of roots and water.

These soils have a shallow root zone and low available water-holding capacity. They are on somewhat broken slopes that range from 15 to 40 percent. The soils are excessively drained because of the large amount of runoff.

The Potter soils have a thinner surface layer than the Mansker soils. They are also steeper and shallower over caliche and gravel.

The Potter soils support a moderate stand of native grass, nearly all of which is used for pasture or range. Common grasses are side-oats grama, blue grama, dropseed, and buffalograss. Management of grazing is needed to keep these soils productive.

Potter soils (Po).—These soils are strongly sloping and are on the upland along the northern side of the valley of the Arkansas River. Locally, they are also along the streams in the northern part of the county. These soils are on the broken shoulders of hills, and the areas include some nearly vertical banks. The slopes range from 15 to 40 percent. The Potter soils commonly occur with the Mansker soils and have been mapped in a complex with those soils.

In most areas the surface layer is clay loam or loam. There are some spots of sand and gravel, outcrops of caliche, mortar beds, and outcrops of limestone, however, as well as areas of cobbly clay loam and cobbly loam.

These soils are used for pasture or range. They are not suitable for crops. (Capability unit VIIs–1, dryland; Breaks range site; not placed in an irrigated capability unit or a windbreak suitability group)

Pratt Series

The Pratt series is made up of deep, brown soils that are noncalcareous and sandy. The soils are on the upland.

The surface layer is grayish-brown, granular loamy fine sand about 9 inches thick. The subsoil is brown, granular loamy fine sand about 20 inches thick. The underlying material is pale-brown loamy fine sand.

The Pratt soils are darker and deeper over sand than the Tivoli soils. They are more sandy throughout than the Ortello soils.

The Pratt soils are rapidly permeable, and they have a rapid water-intake rate. They have low water-holding capacity and are low in content of organic matter.

About half of the acreage is cultivated, and the rest is in grass. The soils are not well suited to cultivation; they are better suited to grass.

Careful management is necessary for irrigation farming. These soils absorb a large amount of water, and they release to plants a large part of the amount that is absorbed.

Pratt loamy fine sand, hummocky (Pr).—This hummocky soil occurs in areas where the landscape is strongly sloping and irregular. It is in a narrow band, 1 to 4 miles wide, south of the valley of the Arkansas River. The slope of the hummocks is dominantly about 5 percent, but it ranges from 3 to 10 percent. This soil is closely associated with the Tivoli soils.

The surface layer is commonly loamy fine sand. However, small areas where the surface layer is of winnowed fine sand are mapped with this soil.

About half of the acreage is cultivated and is used mainly for growing sorghum. Wheat and other small grains are not well suited. The blowing of the surface soil makes it difficult to get a good stand of crops. For that reason, this soil is better suited to native grass than to cultivated crops.

Management problems are related to the low content of organic matter, wind erosion, low fertility, and low water-holding capacity. (Capability unit IVe–1, dryland; capability unit IIIe–2, irrigated; Sands range site; Deep Sandy Upland windbreak suitability group)

Pratt-Tivoli loamy fine sands (Pt).—This complex occurs on irregular, stabilized, low dunes in a narrow strip 1 to 4 miles wide south of the Arkansas River. Some areas also occur in the eastern part of the county in an area between the Arkansas River and Coon Creek. The slope is dominantly about 7 percent, but it ranges from 4 to 15 percent. Pratt loamy fine sand makes up 60 percent of the complex, and Tivoli loamy fine sand makes up 40 percent.

The Pratt and Tivoli loamy fine sands are somewhat similar, except that the Tivoli soil has fine sand between a depth of about 15 inches and a depth of about 5 to 10 feet. Tivoli loamy fine sand is like Tivoli fine sand, except for the texture of the surface layer.

The soils in this complex are rapidly permeable. There is little or no runoff. Water from rainfall penetrates the soils quickly and moves rapidly through the profile. The water-holding capacity is low to very low, but plants can recover a large part of the total amount of water that is stored. (Capability unit VIe-2, dryland; Sands range site; not placed in an irrigated capability unit; Deep Sandy Upland windbreak suitability group)

Randall Series

In the Randall series are deep, poorly drained, nearly level, gray clays that are in depressions. The depressions are on nearly level upland.

These soils are gray clay to a depth of about 40 inches. In places the clay has a weak, blocky structure, and in other places it is massive. It is extremely hard when dry and plastic when wet. The uppermost 30 inches is noncalcareous, and the soil material is weakly calcareous below that depth. The underlying material is brownish-gray, calcareous, granular silty clay loam. These soils range from 3 to 10 feet in depth. At times the depressions hold water. At other times, however, they are dry for 1 to 3 years.

The Randall soils contain more clay and have less well-defined horizons than the Spearville and Harney soils. Unlike those soils, they occur in depressions.

The Randall soils are poorly drained and are sometimes covered by water. In deep depressions that are not drained, these soils are covered by water much of the time. The Randall soils are difficult to till because they are hard when dry and plastic when wet.

Randall clay (Ra).—Only one soil of the Randall series is mapped in this county. This soil is in round or oblong depressions. The areas range from 1 to 640 acres in size, but the size of most areas is about 3 to 20 acres. The depressions may contain standing water after rains (fig. 9). This soil can be used for crops if it is drained, but it is better suited to grass.

Figure 9.—**Wheat stubble that was cultivated with a one-way plow before a 4-inch rainfall. Some of the wheat standing in the background was never harvested.**

Tillage, seeding, and harvesting are commonly delayed on this soil. Rains during the harvest season often cause lodging, and as a result the crop may never be harvested. (Capability unit VIw-2, dryland; not placed in an irrigated capability unit, range site, or windbreak suitability group)

Sandy Broken Land

This land type consists of loamy and sandy soils on the side slopes of drainageways and on the floors of narrow, enclosed valleys. The topography in the areas is rough, steep, and broken.

Sandy broken land (Sb).—About 45 percent of this land type consists of loamy soil material, 35 percent is sandy soil material, and 20 percent is loamy Alluvial land. The sandy material is similar to that in which the Pratt and Tivoli soils developed, and the loamy material is similar to that in which the Ulysses and Mansic soils developed. The areas are on the side slopes of drainageways and on the floors of narrow, enclosed valleys (fig. 10). The areas occupied by Alluvial land are 150 to 400 feet wide and have sandy material within 6 feet of the surface.

Sandy broken land is unsuitable for crops, because of the steep, broken topography and the frequent flooding on the bottom lands. It is excellent, however, for native grass. Runoff is rapid from the side slopes, but in most places enough water is held and stored so that the vegetation is comparable to that on the Sands range site. Because the areas of Alluvial land receive additional water from runoff and overflow, the yields of native grass growing on them are comparable to those on the Loamy Lowland range site. (Capability unit VIe-2, dryland; not placed in an irrigated capability unit; Sands range site; Deep Sandy Upland windbreak suitability group)

Spearville Series

The Spearville series consists of deep, dark, well-drained soils of the upland. These soils have a clayey subsoil. They developed in calcareous, loamy parent material.

The surface layer is dark grayish-brown, granular silty clay loam about 6 inches thick. The subsoil is about 20 inches thick. The upper part is grayish-brown, blocky, noncalcareous silty clay, and the lower part is grayish-brown, blocky, calcareous silty clay loam. The underlying material is pale-brown, blocky, calcareous silty clay loam. The thickness of the surface layer ranges from 4 to 9 inches. That of the subsoil, however, ranges from 12 to 24 inches.

These soils have a thinner surface layer and more clay in the subsoil than the Harney soils. They are also calcareous nearer the surface.

The Spearville soils have high water-holding capacity. The water-intake rate is slow, but the soils are well drained because the underlying material is permeable. The soils are suitable for winter wheat and sorghum, but they are better suited to wheat than sorghum.

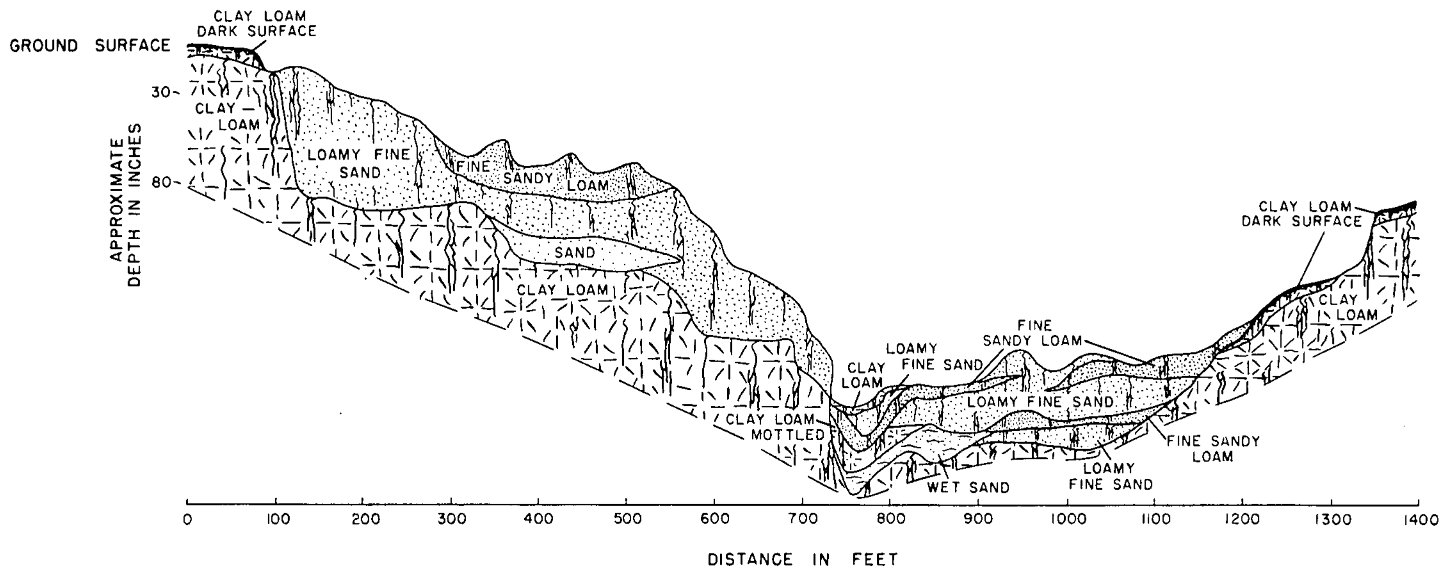

Figure 10.—**A cross section of Sandy broken land in a transitional zone between the sandy upland and the loamy upland.**

Spearville silty clay loam, 0 to 1 percent slopes (Sp).—This soil occurs throughout the county, but large areas are in the northwestern part and in the vicinity of Spearville. The slope is less than 1 percent.

In the northwestern corner of the county, a pale-brown, calcareous soil in irregularly shaped spots and on ridges is mapped with this soil. The included soil has slopes of less than 2 percent, and its surface layer and subsoil are dominantly clay loam. In some places many concretions of calcium carbonate are at the surface.

Also mapped with this Spearville soil is another soil that occurs near depressions occupied by Randall clay. The surface layer of this included soil is silty clay loam about 6 inches thick, and the subsoil is silty clay that extends to a depth of 3 feet or more. This included soil is dark grayish brown to a depth of more than 18 inches, and it is noncalcareous to a depth of more than 2 feet.

Nearly all of the acreage of this Spearville soil is cultivated. This soil is moderately well suited to dryland farming, and wheat and sorghum are the main crops. Wheat is better suited than sorghum, however, because the clayey subsoil is likely to be dry and hard in summer when sorghum needs the most water.

Good crop yields have been obtained where the reserves of moisture are high, but high yields are less consistent on this soil than on soils that have less clay in the subsoil. Some irrigation is practiced, but the slow rate of water intake is a problem. Other problems in managing this soil are wind erosion and the slow permeability of the subsoil, slow runoff, and low content of organic matter. By carefully managing the crop residue and practicing minimum tillage, farmers can do much to conserve moisture and control erosion. (Capability unit IIs-1, dryland and irrigated; Clay Upland range site; Deep Clayey Upland windbreak suitability group)

Spearville complex, 1 to 3 percent slopes, eroded (Sr).—This complex is mainly on gentle slopes along natural drainageways. Small areas occur throughout the county, within broad areas of Spearville silty clay loam, 0 to 1 percent slopes. This soil is also near areas of Harney soils, which are on knobs and ridges a short distance from the drainageways.

About 80 percent of this complex consists of Spearville silty clay loam, and about 20 percent, of irregular spots of a pale-brown, calcareous clay loam. Areas of the Spearville soil that are in grass have a surface layer of silty clay loam about 4 to 6 inches thick. The subsoil is silty clay that ranges from 6 to 16 inches in thickness. In most fields that have been cultivated, the Spearville soil has a surface layer of silty clay loam or heavy silty clay loam. All of the original surface layer is missing in some places, however, and in other places the material in the surface layer is mixed with silty clay that was formerly part of the subsoil. The underlying layers are calcareous silty clay loam.

The irregular spots of a calcareous soil occur both in areas covered by grass and in cultivated fields. The surface layer in such areas is pale-brown, calcareous clay loam that contains a large amount of lime concretions in some places. The subsoil is calcareous clay loam or heavy clay loam, but it is not firm like the typical subsoil of the Spearville soils. In many areas the underlying material is similar to that underlying the Spearville soil, but it includes some calcareous loamy material.

Nearly all of this complex is used for dryland farming, and wheat and sorghum are the main crops. Where the soils are irrigated, yields are lower than on irrigated soils that have a less clayey subsoil.

The major problems in managing these soils are controlling erosion by wind and water, maintaining the content of organic matter, keeping good tilth in the surface layer, and conserving moisture. The practices should include contour farming with terraces, good management of crop residue, and minimum tillage. (Capability unit IIIe-2, dryland; capability unit IIIe-3, irrigated; Clay Upland range site; Deep Clayey Upland windbreak suitability group)

Tivoli Series

The Tivoli series is made up of deep fine sands that are strongly hummocky. The soils are on the upland.

In most places the surface layer is pale-brown, loose fine sand about 6 inches thick, but in some areas it is loamy fine sand that is 4 to 10 inches thick. The fine sand is held together only by plant roots and is darkened by a small amount of organic matter. Beneath the surface layer is pale-brown fine sand that is more than 4 feet thick over sandy to clayey old alluvium.

The Tivoli soils are more sandy than the Pratt soils. They are also lighter colored.

These soils have low water-holding capacity, a rapid water-intake rate, and rapid permeability. There is little or no runoff.

The Tivoli soils are suitable only for native grasses, mainly sand bluestem, big sandreed, sand dropseed, blowoutgrass, and side-oats grama. Rainfall is absorbed quickly and is used efficiently by the grasses.

Tivoli fine sand (Tv).—This soil is hummocky. The slopes range from 4 to 20 percent, but the dominant slope is about 8 percent. On the peaks of some hummocks, the grass has been destroyed, and the raw sand is exposed. In those areas blowouts, described under Active dunes, have formed.

This soil is best suited to native grass. The only way to maintain a good stand of grass is through the control of grazing. (Capability unit VIIe-1; Choppy Sands range site; not placed in an irrigated capability unit or a windbreak suitability group)

Ulysses Series

The Ulysses series is made up of deep, dark-colored soils that are well drained and friable. These soils are on the upland.

The surface layer is dark grayish-brown, granular silt loam about 10 inches thick. Beneath the surface layer is granular, limy silt loam that is lighter colored and slightly higher in content of clay than the surface layer. The parent material is highly calcareous loamy loess.

The surface layer ranges from 5 to 15 inches in thickness. The depth to lime films and concretions is commonly about 5 to 15 inches.

The Ulysses soils contain less clay and have less prominent, limy layers than the Mansic or Mansker soils. They have a thinner dark-colored upper layer, have less clay in the subsoil, and are shallower over lime than the Holdrege soils.

The Ulysses soils are moderately productive. They absorb water well and have moderate permeability. The moisture-holding capacity is high. Runoff is moderate, but these soils are highly susceptible to water erosion and are moderately susceptible to wind erosion.

These soils respond well if crop residue is well managed and terracing and contour farming are practiced. These practices help to control erosion and to conserve moisture. These soils are suitable for both dryland and irrigation farming. Winter wheat and sorghum are the major crops. All crops adapted to the climate can be grown under irrigation in areas where erosion is controlled and the content of organic matter and fertility are maintained.

Ulysses silt loam, 1 to 3 percent slopes (Ua).—This soil occurs throughout the county. It is near areas of Harney silt loam, 1 to 3 percent slopes.

The surface layer is silt loam that ranges from 8 to 15 inches in thickness. The subsoil is calcareous silt loam. Depth to lime films and concretions ranges from about 10 to 20 inches. Generally, the surface layer is not calcareous, except in isolated spots.

This soil is suitable for dryland and irrigation farming. It is less commonly used for irrigated crops, however, than the nearly level Harney and Holdrege soils. Nearly all the acreage is used for dryland farming. Wheat and sorghum are the major crops.

Controlling water and wind erosion and maintaining the content of organic matter are major problems. Practices that include minimum tillage, and contour farming with terraces, can do much to control erosion and maintain the content of organic matter. (Capability unit IIe-1, dryland and irrigated; Loamy Upland range site; Deep Loamy Upland windbreak suitability site)

Ulysses silt loam, 3 to 6 percent slopes (Ub).—This soil is in convex areas, mostly within the Mulberry Creek watershed, but it is also along all the other major creeks in the county. Small spots of a light-colored, eroded soil that has lime concretions at the surface are mapped with this soil.

This Ulysses soil has a surface layer that ranges from 5 to 11 inches in thickness, and its subsoil ranges from silt loam to light silty clay loam. In many cultivated fields and in a few areas that have not been cultivated, the surface layer is calcareous. Depth to lime films and concretions ranges from about 5 to 16 inches.

This soil occurs on the side slopes of drainageways throughout the county in an intricate and consistent pattern with a Hobbs silt loam. It is also associated with soils of the Ulysses-Colby complex, 3 to 6 percent slopes, eroded; however, it is less calcareous than those soils and has fewer concretions of lime at the surface.

More than half of the acreage is cultivated, and the rest is in small areas that are pastured. In cultivated areas only slight erosion is evident. This soil is better suited to grass than to cultivated crops. It can be used, however, for either dryland or irrigation farming.

The major problems in managing this soil are wind and water erosion (fig. 11), maintaining the content of organic matter, and maintaining fertility. Seeding and maintaining a cover of grass, practicing contour farming with terracing, and using minimum tillage can do much to control erosion and to maintain the content of organic matter and fertility. (Capability unit IIIe-1, dryland and irrigated; Loamy Upland range site; Deep Loamy Upland windbreak suitability group)

Ulysses-Colby complex, 3 to 6 percent slopes, eroded (Uc).—The soils of this complex are in convex areas. They are mainly within the Mulberry Creek watershed, but some areas are along other large creeks and along the slopes north of the valley of the Arkansas River. Ulysses silt loam makes up 60 percent of the complex, and Colby silt loam, 40 percent.

The surface layer of the Ulysses soil is noncalcareous and is dark grayish brown in some places. Its thickness varies according to the depth of plowing. The surface layer of the Colby soil is calcareous, grayish-brown and dark grayish-brown silt loam.

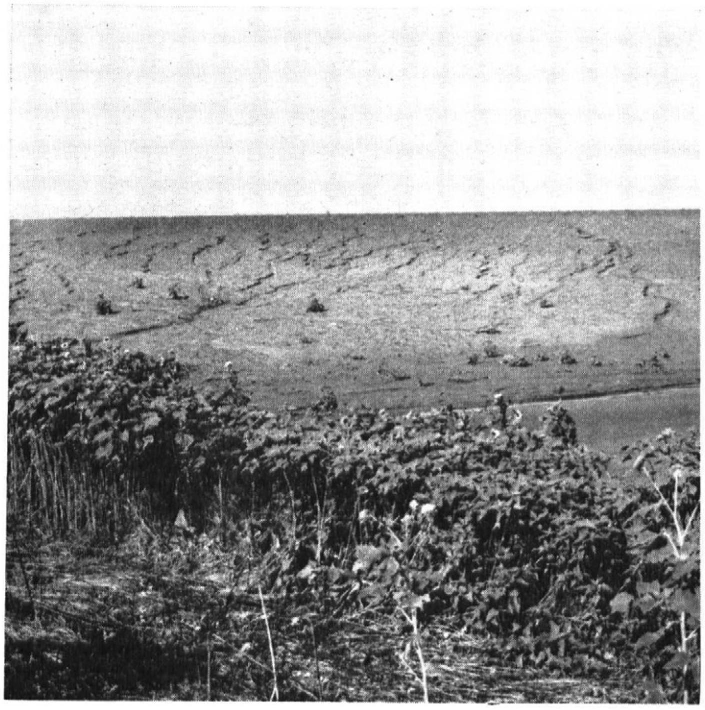

Figure 11.—**Small gullies and rills in a field of Ulysses silt loam, 3 to 6 percent slopes, that was left fallow in summer.**

Throughout the complex are many nearly white, highly calcareous spots that contain lime concretions. Many small gullies and some large ones have been cut by water. The gullies range from 1 to 10 feet in width and from 1 to 5 feet in depth.

All the soils in this complex are cultivated or have been cultivated. The soils are used for both dryland and irrigation farming, but they are best suited to grass. The major problems in managing them are water and wind erosion, the small content of organic matter, and the chlorosis that affects crops grown on the highly calcareous spots. Practices that will control erosion, conserve moisture, and maintain fertility are seeding and maintaining a cover of grass, farming on the contour with terraces, establishing waterways, and using minimum tillage. (Capability unit IVe–2, dryland; capability unit IIIe–1, irrigated; Limy Upland range site; Deep Loamy Upland windbreak suitability group)

Ulysses-Harney silt loams, 1 to 3 percent slopes (Uh).—This complex is in the west-central part of the county. Ulysses silt loam makes up about 60 percent of the complex, and Harney silt loam, about 40 percent. The Ulysses soil is on short, convex slopes, mainly on the higher part of the landscape. The Harney soil is on long, convex slopes.

The profile of the Ulysses soil is like that described for Ulysses silt loam, 1 to 3 percent slopes. The surface layer of the Harney soil is about 8 inches thick, and the subsoil is about 16 inches thick. In some areas the subsoil is thin and clayey and has silty clay loam in the upper part. Depth to calcareous material ranges from 16 to 24 inches. From 5 to 8 percent of the acreage consists of soils that are transitional between Ulysses silt loam and Harney silt loam.

The soils of this complex are well suited to both dryland and irrigation farming. Winter wheat and sorghum are the crops commonly grown under both types of farming, but all the crops adapted to the climate can be grown under irrigation.

The major problems in managing these soils are controlling water and wind erosion, maintaining the content of organic matter, and conserving moisture. Management practices should include minimum tillage, contour farming with terraces, and stubble-mulch farming. (Capability unit IIIe–1, dryland; capability unit IIe–1, irrigated; Loamy Upland range site; Deep Loamy Upland windbreak suitability group)

Ulysses-Harney complex, 1 to 3 percent slopes, eroded (Un).—This complex occupies a small acreage, mainly in the southwestern part of the county. It is on irregular, gentle slopes near a divide in a drainageway between Crooked Creek and Mulberry Creek. Ulysses silt loam, eroded, makes up about 70 percent of the complex, and Harney silt loam, eroded, makes up about 25 percent. The rest of the acreage consists of a soil that has a surface layer of very dark grayish-brown or dark grayish-brown silt loam or silty clay loam.

The eroded Ulysses soil has a highly calcareous surface layer and slopes that range from about 2 to 6 percent. In many places its surface layer has many pale-brown and nearly white spots and lime concretions throughout. The spots are maily in the areas on ridges and knobs, but they also occur in many places in areas of this soil on side slopes. They are closely associated with spots of a dark-colored soil material. As a result, the landscape has a pattern of dark and light colors.

The Harney soil has slopes of 1 to 4 percent. Its surface layer is silt loam about 4 to 6 inches thick, and its subsoil is silty clay loam or silty clay about 12 to 16 inches thick. The underlying material is calcareous and loamy, and it ranges from very dark grayish brown to pale brown in color. Depth to calcareous material ranges from 16 to 30 inches.

The dark-colored soil is on some of the ridges, but it is more common on the side slopes and along short drainageways throughout the complex. It has slopes of 1 to 4 percent and is calcareous.

Some small areas of a grayish-brown to dark grayish-brown, stratified, highly calcareous loamy soil of the bottom lands are mapped with the soils of this complex. The included soil contains many lime concretions that are at various depths.

Runoff is moderate in gently sloping and sloping areas of this complex, but it is slower in the short, narrow drainageways. Erosion is apparent on the ridges and knobs, and as a result, the soils in those areas do not have a dark-colored surface layer; but there are few gullies. The content of organic matter is low in the Ulysses soil and moderate in the Harney soil. It is high in the included soil that has a dark-colored surface layer.

The soils of this complex are used for field crops, but they are better suited to grass. The most common crops are wheat and sorghum.

The major problems in managing the soils are erosion by water and wind, the low content of organic matter in some spots, and the chlorosis that in some areas damages crops. Seeding grass and maintaining a cover of grass will do much to control erosion and to conserve moisture.

Terraces do not work well on the irregular slopes. (Capability unit IVe–2, dryland; capability unit IIIe–1, irrigated; Loamy Upland range site; Deep Loamy Upland windbreak suitability group)

Ulysses-Hobbs complex (Up).—This complex is along some of the drainageways in the uplands. The slopes are mainly between 3 and 6 percent.

Ulysses silt loam, 3 to 6 percent slopes, occupies 35 to 40 percent of the complex. It is on the sloping sides of drainageways, and much of the acreage is in native grass.

Hobbs soils occupy 20 to 30 percent of the complex. These soils are along the floors of drainageways that are 50 to 150 feet wide and are cut by a deep channel in many places.

Eroded areas of Ulysses and Colby soils that have slopes of 3 to 6 percent occupy about 35 to 40 percent of this complex. The soils are on the sloping sides of drainageways.

The Hobbs soils receive runoff from higher lying soils. As a result, there is a greater growth of native grass and crops on those soils than on the other soils of the Ulysses-Hobbs complex. In wet years, however, crops are likely to lodge to some extent.

If the areas are cultivated, the sloping soils of the Ulysses-Colby complex are highly susceptible to water erosion. Small gullies are common, especially in cultivated fields.

Nearly all of the soils of Ulysses-Hobbs complex are used for crops. Winter wheat and sorghum are the most common crops. (Capability unit IVe–2, dryland; capability unit IIIe–1, irrigated; Ulysses soil, Loamy Upland range site; Hobbs soils, Loamy Lowland range site; Deep Loamy Upland windbreak suitability group).

Use and Management of Soils

This section discusses the use and management of the soils of Ford County and explains the system of capability classification used by the Soil Conservation Service. Then, general management and management by capability units for both dryland and irrigated soils are discussed, and yields per acre for the principal dryland crops are given. Finally, the management of soils for range, windbreaks, and wildlife is discussed, and engineering interpretations of the soils are given.

Capability Groups of Soils

The capability classification is a grouping of soils that shows, in a general way, how suitable the soils are for most kinds of farming. It is a practical grouping based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment.

In this system all the kinds of soils are grouped at three levels, the capability class, subclass, and 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 landforms so rough, shallow, or otherwise 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 major limiting factor is risk of erosion. The letter *w* means that water in the soil (water table), or on the soil (flooding), will interfere with the growth of plants or with cultivation. The letter *s* means that the soils are shallow, droughty, or slowly permeable, or that they are saline and alkali soils. The letter *c* indicates that the major limitation is a climate that is 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 have little or no susceptibility to erosion but have other limitations that restrict their use largely to pasture, range, woodland, or wildlife.

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

Soils are classified in capability classes, subclasses, and units in accordance with the degree and kind of their permanent limitations; but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soil; and without consideration of possible but unlikely major reclamation projects.

Management of Dryland Soils

The first part of this section describes general practices needed for dryland farming. In the second part the dryland capability classes, subclasses, and capability units are listed. Then, management by dryland capability units is discussed, and finally, estimated yields of the principal dryland crops are given.

General management of dryland

In dryland farming it is necessary to conserve moisture, to control erosion, and to maintain the fertility of the soils. It is also necessary to maintain the content of organic matter and good tilth. In this county the management practices that will help to do these things consist of choosing a suitable cropping system, fallowing when desirable, managing crop residue properly, keeping tillage to a minimum, tilling at the proper time, tilling at a suitable depth, terracing where needed, farming on the contour, establishing and maintaining waterways, using stripcropping, applying fertilizer, and irrigating where feasible. Most good management practices accomplish more than one purpose, and they can be used on most areas of cropland. In the following paragraphs some of these practices are defined:

A *cropping system* is a sequence of crops grown on a given area of soil over a given period of time. Some cropping systems consist of a rotation of different crops, and the crops follow a definite order of appearance in the field. Other cropping systems consist of only one crop grown year after year on the same field. A flexible cropping system generally consists of different crops, but the crops do not succeed one another in a definite, previously planned order. In this county the cropping system is generally a flexible one. Where a flexible cropping system is used, the selection of the next crop or fallow period depends on the amount of moisture stored in the soil at the time winter wheat or sorghum is to be planted.

A *fallow period* is one in which the soils are kept free of vegetation so that moisture will be stored for the crop that follows. A field may be fallowed for one crop season or for more than one. The most common methods of managing fallow are permitting stubble to stand over winter, tilling in spring before weeds have removed much moisture from the soils, and keeping the soils nearly free of weeds, yet in a condition to absorb rain.

Residue management consists of using crop and livestock residues in a way that will protect the soils from erosion, reduce crusting of the surface soil, and conserve moisture. Moisture is conserved by reducing runoff, by increasing the intake of water, and by reducing the splashing effect of rain.

Tillage is used for managing crop residue, for controlling weeds, and for keeping the soil in good tilth. Through tillage the farmer carries out much of his management program. In using tillage equipment to manage crop residue and to kill weeds, he makes the seedbed suitable for seeding and managing the next crop. The residue left on the surface protects the soils from erosion. It also keeps the soil structure from deteriorating as the result of the splashing effect of raindrops. Equipment that undercuts the vegetation kills the weeds, but it leaves the residue on the surface.

The surface should be roughened by tillage when all the residue or protective vegetation has been used and the soil is left susceptible to wind erosion. Surface roughening minimizes the damage from blowing during the time that the clods are of a size that will resist blowing.

A desirable soil structure is one in which the aggregates are stable. If the aggregates are stable, tillage is needed only to kill weeds and to manage residue. Tillage should be kept to the minimum required to meet these needs. Too much tillage breaks down the clods or aggregates and leaves the soils more susceptible to blowing and crusting. Tillage at the proper time is important in maintaining good soil structure. If the soils are tilled when too wet or are always tilled at the same depth, a compact layer, or tillage pan, may form.

Terracing consists of constructing ridges across the slope to intercept runoff. In sloping areas terraces help to conserve moisture and control erosion. In nearly level areas terracing helps mainly by conserving moisture.

Waterways are natural drainageways or small fields that are used to carry runoff safely away from individual fields or parts of fields and farms. They are shaped, where necessary, to provide a channel that has enough capacity to carry the expected amount of runoff at a nonerosive velocity. The channel is usually kept in grass. Waterways improve terraced fields by helping to eliminate gullies and by using extra water from runoff for producing grass and grass seed.

Stripcropping is a system of growing different adapted crops in narrow strips in the same field. Strips of crops that help to protect the soils from erosion, such as small grains with their residue, are alternated with fallow or with such crops as forage sorghum or grazed grain sorghum that gives less protection from erosion. Stripcropping helps control wind erosion by shortening the distance that the particles of soil material are moved by wind.

Two types of stripcropping are contour stripcropping and wind stripcropping. Contour stripcropping is used on sloping fields to help control erosion by wind and water. The strips are arranged on the contour, and terraces or guidelines are used to establish the pattern.

Wind stripcropping is used on nearly level areas where water erosion is not a problem; on some sloping fields where the slopes are so complex that contour farming is not practical; and on the coarser textured soils where wind erosion is a problem. In wind stripcropping the strips are of uniform width, are usually straight, and are arranged at right angles to the direction of prevailing winds. These prevailing winds are northerly to southerly in winter and early in spring, and southerly to northerly in summer.

Dryland capability classes, subclasses, and units

The following lists the capability classes, subclasses, and capability units for dryland farming in Ford County.

Class I. Soils that have few limitations that restrict their use. (None in this county.)

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, gently sloping, well-drained upland soils that have a surface layer of silt loam.
  - Unit IIe–2. Deep, nearly level fine sandy loams.
  - Unit IIe–3. Deep, well-drained loamy soils and imperfectly drained clay loams; these soils are gently undulating.
- Subclass IIs. Soils that have moderate limitations of moisture capacity or tilth.
  - Unit IIs–1. Deep, nearly level, clayey soils of the upland.
- Subclass IIc. Soils that have climatic limitations of low rainfall, high evaporation, low humidity, high winds, and abrupt changes in temperature.
  - Unit IIc–1. Deep, nearly level, well-drained upland soils that have a surface layer of silt loam to clay loam.
  - Unit IIc–2. Deep, nearly level, medium and moderately fine textured soils that developed in alluvium.

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

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

Unit IIIe–1. Deep and moderately deep, gently sloping, medium and moderately fine textured, calcareous soils of the upland.

Unit IIIe–2. Deep, gently sloping soils that have a surface layer of silty clay loam or clay loam and a slowly permeable subsoil.

Unit IIIe–3. Deep, undulating and hummocky upland soils that have a surface layer and subsoil of fine sandy loam.

Unit IIIe–4. Deep, gently sloping soils that have a surface layer of fine sandy loam.

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

Unit IIIw–1. Nearly level soils in alluvium; they have a surface layer of clay loam and are over deep sand.

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, hummocky sandy soils of the upland.

Unit IVe–2. Deep, sloping, medium and moderately fine textured, calcareous soils of the upland.

Subclass IVw. Soils that have very severe limitations for cultivation, because of excess water.

Unit IVw–1. Nearly level, loamy, calcareous, imperfectly drained soils that are moderately deep over sand and are in alluvium.

Subclass IVs. Soils that have very severe limitations of stoniness, low moisture capacity, or other soil features.

Unit IVs–1. Nearly level, loamy, saline-alkali alluvial land that is moderately deep over sand.

Class V. Soils not likely to erode that have other limitations, impractical to remove, that limit their use largely to pasture or range, woodland, or wildlife food and cover. (None in this county.)

Class VI. Soils that have severe limitations that make them generally unsuitable for cultivation and that 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, strongly sloping loamy soils of the upland.

Unit VIe–2. Deep loamy fine sands and fine sands on hummocks.

Unit VIe–3. Deep, moderately deep, and shallow, strongly sloping, highly calcareous loamy soils that have rock outcrops.

Subclass VIw. Soils severely limited by excess water and generally unsuitable for cultivation.

Unit VIw–1. Deep, frequently flooded, loamy land types cut by deep, meandering stream channels.

Unit VIw–2. Deep clayey soils that are in upland depressions and are frequently ponded.

Subclass VIs. Soils generally unsuitable for cultivation and limited for other uses by their moisture capacity, stones, or other features.

Unit VIs–1. Loamy and sandy, imperfectly drained, calcareous soils that are shallow over sand and that developed in alluvium.

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

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

Unit VIIe–1. Deep, dry sands on steep dunes.

Subclass VIIw. Soils very severely limited by excess water.

Unit VIIw–1. Frequently flooded, unstable, loose sandy to loamy soils of the flood plains.

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

Unit VIIs–1. Shallow soils with steep, broken outcrops of caliche and limestone.

Class VIII. Soils and landforms that have limitations that preclude their use for commercial production of plants; and that restrict their use to recreation, wildlife, water supply, or esthetic purposes.
(None in this county.)

Management of dryland soils by capability units

In this section the soils of this county are grouped in capability units for dryland farming. The significant features of the soils in each capability unit, together with their hazards and limitations, are described. Suggestions for use and management of the soils of each unit are also given.

DRYLAND CAPABILITY UNIT IIe–1

This unit consists of deep, gently sloping, well-drained upland soils that have a silt loam surface layer. These soils are—

Harney silt loam, 1 to 3 percent slopes.
Holdrege silt loam, 1 to 3 percent slopes.
Ulysses silt loam, 1 to 3 percent slopes.

The surface layer is silt loam or loam, and the subsoil a clay loam, silt loam, loam, or silty clay loam. The water-intake rate of these soils ranges from moderately slow to moderate; the moisture-holding capacity is high.

The soils in this unit are well suited to flexible dryland cropping systems, such as fallow-wheat, fallow-wheat-grain sorghum, and fallow-sorghum. Forage sorghum can be substituted for grain sorghum.

These soils are well drained, productive, and easily tilled. The soils are moderately susceptible to both wind and water erosion. Water erosion, however, is the major hazard. Residue management and minimum tillage, and the use of terraces along with contour farming, will do much to control erosion and to conserve moisture. Tillage will bring up clods that help to control wind erosion for short periods.

DRYLAND CAPABILITY UNIT IIe–2

This unit consists of deep, nearly level fine sandy loams. These soils are —

Canadian fine sandy loam.
Ortello fine sandy loam, level.

The surface layer and the subsoil are fine sandy loam. The substratum grades to sand or clay.

The Canadian soils are in the valley of the Arkansas River above the present flood plain. The Ortello soils are on the sandy upland south of the valley of the Arkansas River.

The soils of this unit are well suited to dryland crops that are adapted to the climate. They are well suited to flexible dryland cropping systems, such as fallow-wheat-grain sorghum, and continuous wheat. Whenever the soils are fallowed, wind erosion is a hazard.

The soils in this unit are well drained, productive, and easily tilled, but they are susceptible to wind erosion. Tillage for controlling wind erosion is less effective on these sandy soils than on clayey soils because smaller and fewer clods are left on the surface to resist blowing. Residue management and a minimum of tillage will do much to control erosion and to increase the reserve of moisture. Wind stripcropping is effective when used with good practices for managing residue.

DRYLAND CAPABILITY UNIT IIe-3

Only the Dalhart-Lubbock complex is in this unit. It is made up of deep, well-drained fine sandy loams on knobs or on the tops of low hummocks, dark-colored clay loams in nearly level areas, and imperfectly drained clays in depressions. The soils are nearly level or gently undulating.

The surface layer is fine sandy loam or clay loam, and the subsoil a sandy clay loam or clay loam. The subsoil grades to a clayey substratum.

This complex is mainly between the Arkansas River and Coon Creek in the east-central part of the county. It is suited to dryland cropping systems, such as fallow-wheat and fallow-wheat-grain sorghum. Forage sorghum can be substituted for grain sorghum.

The soils are productive. The soils on knobs and on the tops of the low hummocks are more easily tilled than those in depressions. Tilling, seeding, and harvesting of crops are often delayed when water is ponded in the depressions.

The soils in this complex are susceptible to wind and water erosion, but wind erosion is the major hazard. Residue management and a minimum of tillage can do much to control erosion and to conserve moisture. Some depressions in fields where there are suitable outlets can be drained. Tillage that helps to control wind erosion for short periods is more effective on the clayey soils than on sandy soils.

DRYLAND CAPABILITY UNIT IIs-1

The only soil in this capability unit—Spearville silty clay loam, 0 to 1 percent slopes—is a deep, nearly level, clayey soil of the upland.

This soil has a surface layer of silty clay loam and a subsoil of silty clay. The underlying material is silt loam.

This soil is well drained, but runoff is slow. The subsoil takes up water slowly and releases it slowly to plants. The moisture-holding capacity is high; this soil will store about 2 inches of moisture per foot of depth.

A flexible dryland cropping system, such as fallow-wheat-grain sorghum and fallow-wheat, is used on this soil. High yields of wheat have been obtained when there was a good supply of moisture in the soil.

This soil is productive, but it is difficult to till and is susceptible to erosion by wind. Its clayey subsoil is generally low in moisture during the period when the most water is required by sorghum. The slow permeability of the subsoil is the major limitation to farming. Residue management and a minimum of tillage will do much to control erosion and to conserve moisture. Terraces are used in some places to keep out water or to drain it from depressions that are associated with this soil. Tillage that turns up clods that resist blowing will help to control wind erosion for short periods.

DRYLAND CAPABILITY UNIT IIc-1

In this unit are deep, nearly level, well-drained silt loams to clay loams of the upland. These soils are—

Harney silt loam, 0 to 1 percent slopes.
Holdrege loam, 0 to 1 percent slopes.
Holdrege silt loam, 0 to 1 percent slopes.
Mansic clay loam, 0 to 1 percent slopes.

The surface layer is silt loam, loam, or clay loam, and the subsoil is silt loam, clay loam, or silty clay loam. The water-intake rate of these soils ranges from moderately slow to moderate; the moisture-holding capacity is high. The soils will store about 13 inches of moisture in a depth of 6 feet.

These soils are well suited to flexible dryland cropping systems. Such systems are fallow-wheat-grain sorghum and fallow-sorghum. Forage sorghum can be substituted for grain sorghum in these systems.

These soils are well drained, productive, and easily tilled. If not protected, these soils are moderately susceptible to wind erosion. The major hazards are climatic limitations such as low rainfall, low humidity, and high winds.

Residue management and a minimum of tillage, along with contour farming, can do much to control erosion and to conserve moisture. Tillage that turns up clods that resist blowing will help to control wind erosion for short periods.

DRYLAND CAPABILITY UNIT IIc-2

This unit consists of deep, nearly level, medium-textured and moderately fine textured soils that developed in alluvium. These soils are—

Dale silt loam.
Dale and Humbarger clay loams.

The surface layer of the soils in this unit is clay loam or silt loam. The subsoil and substratum are silt loam and silty clay loam. These soils are subject to occasional flooding, but the water table is at a depth below 10 feet. The water-holding capacity is high.

Dale silt loam is along Sawlog and Mulberry Creeks, and Dale and Humbarger clay loams, along the valley of the Arkansas River, Coon Creek, and Crooked Creek. Locally, the Dale and Humbarger soils are around intermittent lakes.

The soils of this unit are well suited to flexible dryland cropping systems; for example, wheat-fallow, fallow-wheat-sorghum, and fallow-wheat-wheat. Forage sorghum can be substituted for grain sorghum in the cropping system. Alfalfa can be established if there is a good supply of surface moisture. The stand can probably be maintained if the roots have reached the water table, even though surface moisture is low.

The soils in this unit are well drained, productive, and easily tilled, but they are slightly susceptible to wind erosion. Water from adjoining slopes is a problem when it crosses these soils. Residue management with a minimum of tillage, along with contour farming, can do much to control blowing and to conserve moisture. Diversion terraces are used to control runoff from some areas of sloping soils that adjoin these soils.

DRYLAND CAPABILITY UNIT IIIe-1

In this unit are deep and moderately deep, gently sloping, medium and moderately fine textured, calcareous soils of the upland. These soils are—

Bippus clay loam, 2 to 5 percent slopes.
Mansic clay loam, 1 to 3 percent slopes.
Mansic clay loam, 1 to 3 percent slopes, eroded.
Mansker clay loam, 0 to 3 percent slopes.
Ulysses-Harney silt loams, 1 to 3 percent slopes.
Ulysses silt loam, 3 to 6 percent slopes.

These soils generally have a silt loam or clay loam surface layer. Some small areas have a sandy loam surface layer.

The Mansker soils will store about 8 inches of moisture in a depth of about 4 feet. The Bippus, Mansic, Ulysses, and Harney soils will store about 12 inches of moisture in a depth of about 6 feet. The Bippus, Mansic, and Mansker soils are generally calcareous in the surface layer, and chlorosis is sometimes a problem when sorghum is grown.

Soils of this unit are suited to flexible dryland cropping systems, as fallow-wheat and fallow-wheat-sorghum. Forage sorghum can be substituted for grain sorghum.

These soils are well drained, productive, and easily tilled. Wind and water erosion are equal hazards. Residue management and a minimum of tillage, and the use of terraces along with contour farming, will do much to control erosion and to conserve moisture.

DRYLAND CAPABILITY UNIT IIIe-2

Only Spearville complex, 1 to 3 percent slopes, eroded, is in this unit. It consists of deep, gently sloping soils that have a surface layer of silty clay loam or clay loam and a slowly permeable subsoil. In most places the subsoil is clay, but in spots that are highly calcareous it is dominantly clay loam. The substratum is highly calcareous silty clay loam and clay loam.

The soils of this complex have high moisture-holding capacity; they store about 2 inches of moisture per foot of soil depth. The water-intake rate is slow.

The choice of cropping systems is somewhat limited. Fallow-wheat and fallow-wheat-sorghum are the cropping systems most commonly used. The soils are not well suited to sorghum, because the clayey subsoil is generally low in moisture during the period when the most water is required by sorghum. The problems in farming this soil are erosion by water and wind, runoff, and the slow permeability of the clayey subsoil.

The soils of this complex are productive when the moisture reserve is high. Erosion has removed much of the thin surface layer and in some places has exposed the clayey subsoil. These soils are susceptible to wind erosion, especially in spots that are light colored and calcareous.

Contouring and terracing help to conserve water and reduce erosion. Some form of residue management and a minimum of tillage help to control erosion and to increase the reserve of moisture.

DRYLAND CAPABILITY UNIT IIIe-3

Deep, undulating and hummocky soils of the upland make up this unit. These soils are—

Ortello-Carwile complex.
Ortello fine sandy loam, undulating.
Otero fine sandy loam, hummocky.

The surface layer and subsoil of these soils are mainly fine sandy loam. The Carwile soil, however, has a subsoil of sandy clay loam to clay, and it has a clayey substratum. The moisture-holding capacity is high. The Carwile soil will store about 11 inches of moisture, and the other soils about 8 inches of moisture, in a depth of 6 feet.

Flexible dryland cropping systems, such as fallow-wheat-sorghum, fallow-wheat-wheat, and continuous sorghum, are suited to these soils. When these soils are fallowed, the hazard of wind erosion is high. These soils are well drained, easily tilled, and productive. They are highly susceptible to wind erosion and are moderately susceptible to water erosion. Residue management and a minimum of tillage will do much to control erosion and to increase the reserve of moisture. Tillage that roughens the surface will help to control wind erosion for short periods. Continuous wheat or continuous sorghum may be better than other cropping systems, because there is less time between crops when the soils can be damaged by blowing. Wind stripcropping can best be used when wheat and sorghum are cropped continuously.

DRYLAND CAPABILITY UNIT IIIe-4

Only one soil, Holdrege fine sandy loam, 1 to 3 percent slopes, is in this unit. This is a deep, gently sloping soil. Its surface layer is mainly fine sandy loam, but in some small areas it is loam. The subsoil is silty clay loam, and the substratum is loamy.

This soil is well drained, easily tilled, and highly productive. Conserving moisture and controlling erosion by wind and water are the main problems in managing it. Wheat and sorghum can be grown successfully in a flexible cropping system if crop residue is used to protect against blowing. Other good management practices that will conserve moisture and help control erosion are contour farming, contour stripcropping, and terracing with contour farming.

DRYLAND CAPABILITY UNIT IIIw-1

Only one soil, Leshara clay loam, is in this unit. This soil is nearly level, and it formed in alluvium. It is deep over sand.

The surface layer and subsoil are calcareous clay loam, and the substratum is sandy. This soil is on the flood plains along the Arkansas River, and it is subject to occasional flooding.

In some places this soil is slightly to moderately saline. The water-holding capacity is limited because of the sandy substratum. This soil will store about 7 to 9 inches of moisture in a depth of 4 feet. It has a fluctuating water table, generally near the surface. During prolonged droughts, the water table drops so that it is in the sandy substratum. During periods when moisture is favorable, or when the river is high, the water table is in the clay loam near the surface.

This soil is easily tilled and productive. Suitable crops are wheat and sorghum. Alfalfa seldom does well, mainly because the fluctuating water table near the surface makes this soil wet.

The major problems in cultivated areas are susceptibility to flooding, wetness, and limited capacity for storing water. This soil is slightly susceptible to wind erosion. Management practices consist of use of a flexible cropping system, residue management, and a minimum of tillage.

DRYLAND CAPABILITY UNIT IVe-1

Only one soil, Pratt loamy fine sand, hummocky, is in this unit. It is a deep, sandy soil of the upland.

This soil is rapidly permeable and has somewhat excessive drainage. The amount of runoff is small. This soil will store about 6 inches of moisture in a depth of about 6 feet, but the content of organic matter is low. This soil is highly susceptible to wind erosion.

This soil is better suited to native grass than to cultivated crops. If it is cultivated, however, wheat or sorghum may be grown year after year. Tame grasses can be grown in a long rotation with wheat or sorghum, or as an alternate use. Residue managment and a minimum of tillage are needed to keep the soil from blowing. All fields that are now cultivated should be seeded to native grasses if that fits well with farm or ranch planning.

DRYLAND CAPABILITY UNIT IVe-2

This unit consists of deep, sloping, medium and moderately fine textured, calcareous soils of the upland. These soils are—

Mansic clay loam, 3 to 6 percent slopes.
Mansic and Mansker soils, 3 to 6 percent slopes, eroded.
Ulysses-Colby complex, 3 to 6 percent slopes, eroded.
Ulysses-Harney complex, 1 to 3 percent slopes, eroded.
Ulysses-Hobbs complex.

All of these soils have a surface layer and subsoil of silt loam or clay loam, except the Harney soil, which has a subsoil of silty clay loam or silty clay. The Harney and Hobbs soils are less calcareous than the other soils in the unit. The Mansker and Colby soils are more calcareous than the other soils.

These soils are suited to flexible dryland cropping systems, such as fallow-wheat, fallow-sorghum, and fallow-wheat-grain sorghum. Forage sorghum can be substituted for grain sorghum in these cropping systems. Sorghum on the more calcareous soils is commonly affected by chlorosis.

These soils are well drained, easily tilled, and productive. Erosion, both by water and wind, is the major hazard. Calcareous spots in the eroded soils are highly susceptible to wind erosion. Moisture that enters these soils comes mainly from intensive showers. Runoff is high, and the soils are seldom wet to field capacity to a depth of more than 3 feet.

These soils are often used for crops. Nevertheless, if it is feasible in farm or ranch planning, all areas now in grass should be kept in grass. Also, all cultivated fields should be converted to native grass. If these soils are used for crops, residue management that requires a minimum of tillage and terracing along with contour farming will do much to control erosion and to conserve moisture.

DRYLAND CAPABILITY UNIT IVw-1

In this unit are nearly level, loamy, calcareous, imperfectly drained soils in alluvium. These soils are moderately deep over sand. They are—

Las Animas sandy loam.
Leshara clay loam, moderately deep.

These soils have a surface layer and subsoil of calcareous sandy loam or clay loam. Depth to sand ranges from about 18 to 40 inches.

The soils in this unit occur within the flood plain of the Arkansas River valley and have a shallow, fluctuating water table that rises to within 2 feet of the surface. The Las Animas soil will store about 4 inches of moisture to a depth of 3 feet; the Leshara soil will store about 6 inches to a depth of 3 feet. A flexible cropping system, such as fallow-wheat-grain sorghum and fallow-wheat-wheat, is used. Also, sorghum and wheat are continuously grown on the sandy loam.

Susceptibility to flooding, wetness, a shallow water table, a limited root zone, a low moisture-holding capacity, and some salinity are problems.

When the soils are used for crops, residue management and a minimum of tillage will do much to control erosion and conserve moisture. Alfalfa seldom does well because the water table fluctuating near the surface causes poor drainage in the root zone during wet seasons and a droughty condition during dry seasons. A mixture of native grasses can be grown on these soils if this fits well with the farm or ranch plan.

DRYLAND CAPABILITY UNIT IVs-1

Only Alluvial land and slickspots is in this unit. This land type consists of nearly level, loamy, saline-alkali alluvial land that is moderatey deep over sand.

The surface layer is clay loam or fine sandy loam. The underlying material is highly calcareous, saline-alkali clay loam. The substratum ranges from sand to clay but is commonly clayey.

This land type occurs in old alluvium in the valley of the Arkansas River. It has a fluctuating water table at a depth of about 2 to 15 feet, and in many places there is a perched water table. This water table is fed by drainage through old, buried channels in alluvium or by deep percolation through the sandy soils of the adjacent upland.

This land type will store from 7 to 9 inches of moisture in a depth of 4 feet. If it is farmed, wetness, imperfect drainage, the saline-alkali root zone, and flooding are problems.

This land type is not well suited to crops. Cropping systems such as fallow-wheat and fallow-wheat-sorghum have been used, but yields of both wheat and sorghum are among the lowest in the county. When crops are needed, a fallow-small grain cropping system is best suited, since small grain is more tolerant of salt than is sorghum. Mixtures of switchgrass, Indiangrass, western wheatgrass, and other native grasses should be used to seed fields, that are now cultivated, if this is feasible in farm or ranch planning.

DRYLAND CAPABILITY UNIT VIe-1

Only the Mansic-Hobbs complex is in this unit. This complex is composed of strongly sloping Mansic soils on side slopes and nearly level Hobbs soils on flood plains.

It occurs throughout Ford County. The Hobbs soils make up about 20 to 40 percent of the mapping unit. The areas are generally less than 100 feet wide. The Mansic soils make up about 60 to 80 percent of the unit. About 5 percent is Mansker soils.

The surface layer ranges from clay loam to silt loam. Below it are layers of calcareous clay loam and silt loam.

The soils of this complex are moderately permeable. The moisture-holding capacity is high, but much of the rainfall runs off. The Hobbs soils receive runoff from side slopes and overflow from stream channels.

The soils of this complex are generally nonarable. They are highly productive when used for range and pasture. The areas that are now used for crops should be seeded to native grass mixtures and kept in good condition. Proper range use and deferred grazing are needed to maintain and improve native range or seeded range. Contour furrowing helps hold moisture on side slopes if suitable for the specific pasture or range. Diversion ditches may be needed on the side slopes to protect adjoining soils.

DRYLAND CAPABILITY UNIT VIe-2

This unit consists of deep soils that in most places have a surface layer of deep loamy fine sand or fine sand. The soils are on hummocks. These soils are—

Las Animas-Tivoli complex.
Pratt-Tivoli loamy fine sands.
Sandy broken land.

The surface layer of these soils is mainly loamy fine sand or fine sand, but in some small areas it is fine sandy loam. The subsoil is generally loamy fine sand or fine sand, but in some places it contains lenses of fine sandy loam.

Moisture is absorbed rapidly and penetrates to a great depth in these soils. There is only a small amount of runoff. The moisture-holding capacity is low. Nevertheless, plant roots can recover a large part of the moisture that is stored.

The soils of this unit are suitable only for production of native grass, and most of the acreage is used for range or pasture. The problems that limit the use of these soils are wind erosion, low moisture-holding capacity, and low content of organic matter.

Proper range use and deferred grazing are needed to maintain and improve the native and seeded range on these soils. All cultivated fields should be seeded to native grass, and a good stand of native grass should be maintained.

DRYLAND CAPABILITY UNIT VIe-3

Only the Mansker-Potter complex is in this unit. This complex consists of deep, moderately deep, and shallow, strongly sloping, highly calcareous loamy soils that have rock outcrops.

In most places the surface layer is clay loam, but in some places it is fine sandy loam or loam. Outcrops of caliche and scattered fragments of caliche are common, and some outcrops of limestone and pockets of gravel occur in local areas. The layers beneath the surface layer are rock, gravel, or caliche that limits the penetration of roots and the water-holding capacity in many areas.

Mansker soils make up about 70 percent of this complex, Potter soils about 27 percent, and Mansic soils about 3 percent.

The major hazards in using these soils are the excessive runoff, the susceptibility to water erosion, the shallow root zone, and the low moisture-storing capacity. In spots where deeper soils occur between the rocks, the moisture- storing capacity is high.

The soils of this complex are not suitable for cultivated crops and are commonly used for range. Proper range use and deferred grazing are needed to maintain or improve native or seeded range.

DRYLAND CAPABILITY UNIT VIw-1

Only Alluvial land is in this capability unit. It is a deep, frequently flooded loamy land type and is cut by deep, meandering stream channels.

The surface layer and the layers beneath consist mainly of stratified clay loam, silt loam, and loam, but there are some local spots of fine sandy loam. The steep, meandering stream channels cut this land type into small areas. Many of these areas that could be cultivated cannot be reached with farm machinery, because of the steep-sided stream channels.

This land type is well drained, but it is frequently flooded. Flooding increases the amount of water available for plants. Permeability is moderate to moderately slow, and the water-holding capacity is high. This land type is generally stable, except for cuts and fills in the stream channel and local deposition from side streams.

This land is generally not used for crops. It is generally used for range or pasture. Proper range use and deferred grazing are needed to maintain or improve the native or seeded range.

Detention dams, ponds for watering livestock, and other water developments are constructed on this land type. Examination of the site is necessary before construction is begun, however, to see if the site is suitable for the intended structure. In some places springs can be used for watering livestock.

DRYLAND CAPABILITY UNIT VIw-2

Only one soil, Randall clay, is in this unit. It is a deep, frequently ponded clayey soil in upland depressions.

This soil has a clayey surface layer and subsoil. It occurs in small areas throughout the county with the Harney, Spearville, and Lubbock soils.

This soil is ponded intermittently. At times it is wet and ponded; at other times it is dry for 1 to 3 years. Seldom can crops be grown in 2 consecutive years without damage from wetness or ponding. The ponded water in the depressions dries up slowly. In many areas wetness delays tillage, seeding, and harvesting. The clayey surface layer is difficult to till. The subsoil is very slowly permeable.

This soil is not well suited to field crops or grass, but some areas have been used for field crops. In places good crops of winter wheat are grown. In many places the feasibility of drainage depends on whether outlets are available and on other related site factors. After the soil is drained, wetness and slow permeability continue to be problems.

In the areas used for crops, residue management and a minimum amount of tillage help improve and maintain the structure of this soil. Terracing can be used in places to keep water out of the depressions if terraces are feasible for the specific field. Where surface drainage is adequate, or the soil is less severely ponded, native grass can be maintained.

DRYLAND CAPABILITY UNIT VIs-1

Only the Las Animas-Lincoln complex is in this unit. It consists of loamy and sandy, imperfectly drained, calcareous soils that are shallow over sand and that developed in alluvium.

The surface layer ranges from clay loam to sand, and the layers beneath are sand, fine sandy loam, and loamy fine sand. In some places the soils contain thin lenses of clay loam. There is an abrupt boundary at a depth of 10 to 24 inches between the sandy substratum and the material above. A small acreage of moderately deep and deep soils is mapped with the soils of this complex. In the included soils sand is at a depth of 24 to 40 inches.

The soils of this complex are imperfectly drained, because of a fluctuating water table that is generally about 2 to 5 feet below the surface. Imperfect drainage, flooding, limited moisture-holding capacity, and slight to moderate salinity in some spots are hazards when these soils are used for crops. Water penetration is rapid where the surface layer is sandy loam, but it is slow where the surface layer is clay loam.

These soils are near the channel of the Arkansas River. In places along the banks of the river, dikes are used to protect them from flooding.

These soils are nonarable and have little potential for use for crops. Proper range use and deferred grazing are needed to maintain and improve the areas in native or seeded grass.

The substratum of these soils is a source of sand and gravel. In most places only a small amount of spoil needs to be removed before the sand or gravel is reached.

DRYLAND CAPABILITY UNIT VIIe-1

In this unit are deep, dry sands on steep dunes. These soils are—

Active dunes.
Tivoli fine sand.

These soils are loose fine sands on a sharply hummocky landscape. They occur in the eastern part of the county, southeast of the Arkansas River along the line between Ford and Kiowa Counties.

The surface layer is slightly darkened, loose fine sand about 6 inches thick, and it is held together by roots. The layers beneath the surface layer are also fine sand. Old alluvium is at a depth of about 4 feet to many feet.

Most areas of these soils, except a small acreage of Active dunes, are stabilized. The content of organic matter and the moisture-holding capacity are low. The water-intake rate is very rapid; much of the rainfall is absorbed quickly, and there is little or no runoff. Moisture moves rapidly into the soils, and it penetrates deeply. Plants can use a large part of the moisture that is stored. Wind erosion and limited moisture-holding capacity are problems in managing these soils.

These soils are suitable only for range. If overgrazed, they are highly susceptible to wind erosion. Proper range use and deferred grazing are needed to maintain or improve the native or seeded range. Range seeding may be needed on Active dunes to prevent damage to adjoining areas.

DRYLAND CAPABILITY UNIT VIIw-1

This unit consists of frequently flooded, unstable, loose sandy to loamy soils of the flood plains. These soils are—

Broken alluvial land.
Lincoln soils.

The soils are regularly flooded or are subject to intermittent flooding, scouring, and deposition. Broken alluvial land is on streambanks that are somewhat unstable. It consists of medium-textured to clayey alluvium that is highly stratified. The Lincoln soils are on unstable sandbars or on natural levees along streams, and they consist of loose, coarse-textured material.

Little or no vegetation can become established on these unstable areas. Trees, brushy plants, and annuals are the most common kinds of vegetation. The soils are not suited to cultivated crops and have little value for grazing.

DRYLAND CAPABILITY UNIT VIIs-1

This unit consist only of the Potter soils. These soils are shallow over caliche and limestone, and the areas include steep, broken outcrops of caliche and limestone.

The surface layer is generally clay loam, but in some places it is loam, silt loam, or fine sandy loam. There are irregular fragments of caliche on the surface and in the surface layer. Rock outcrops, mainly of caliche, cover about half the surface, and there are pockets of gravel. The layers beneath are bedrock that allows little penetration by roots or water.

These soils are used only for grass, but excessive runoff is a hazard in areas under grass. The growth of plants is also limited by the shallow root zone and low moisture-holding capacity. Between the rocks, however, where the soil material is deeper, enough moisture to support deep-rooted plants is caught and stored.

Range seeding and cultivation are impractical, because of the rough, rocky, and steep topography. Proper range use and deferred grazing are needed to maintain or improve the native range, but yields of forage will normally be low.

Predicted yields of crops (dryland)

Table 2 gives expected average yields per seeded acre of winter wheat, grain sorghum, and forage sorghum for each soil in the county, based on common and on improved management. Information on which to base precise estimates is inadequate, however, because no longtime, accurate records of yields are available. Also, yields fluctuate greatly during the recurring and alternating periods of drought and high precipitation.

Some of the best information on which to base estimates was taken from records kept at the Southwest Experimental Field near Minneola, Kans. Estimates were also based on farm records, on unpublished papers and reports, on rod-row sampling of yields obtained on Harney silt loam, on some records kept by 4-H Clubs, and on observations of farmers and technicians who are acquainted with the soils and crops. Most of the data obtained were for winter wheat and grain sorghum on Harney silt loam.

TABLE 2.—*Expected average acre yields of the principal dryland crops*

[Yields in columns A are to be expected under management most farmers in the county are practicing; those in columns B are yields to be expected under improved management. Absence of yield data indicates that the soil is not suited to cultivation. Wheat yields reflect the general use of summer fallow]

Soil	Wheat		Grain sorghum		Forage sorghum	
	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*
Active dunes						
Alluvial land						
Alluvial land and slickspots	9	14	10	14	1.2	1.7
Bippus clay loam, 2 to 5 percent slopes	13	17	15	20	1.4	2.2
Broken alluvial land						
Canadian fine sandy loam	12	15	27	30	3.1	4.6
Dale silt loam	17	22	18	23	2.4	3.4
Dale and Humbarger clay loams	17	22	18	23	2.4	3.4
Dalhart-Lubbock complex	11	15	15	17	1.6	2.3
Harney silt loam, 0 to 1 percent slopes	17	21	18	21	1.8	2.7
Harney silt loam, 1 to 3 percent slopes	15	19	16	20	1.4	2.2
Holdrege fine sandy loam, 1 to 3 percent slopes	13	17	19	22	1.7	3.1
Holdrege loam, 0 to 1 percent slopes	19	23	21	25	2.6	3.9
Holdrege silt loam, 0 to 1 percent slopes	18	22	19	23	2.1	3.6
Holdrege silt loam, 1 to 3 percent slopes	17	20	17	20	1.8	2.7
Las Animas sandy loam	9	12	15	18	1.7	3.1
Las Animas-Lincoln complex						
Las Animas-Tivoli complex						
Leshara clay loam	14	17	14	17	1. 4	2. 2
Leshara clay loam, moderately deep	10	14	10	14	1. 2	1. 7
Lincoln soils						
Mansic clay loam, 0 to 1 percent slopes	14	17	16	20	1. 3	2. 0
Mansic clay loam, 1 to 3 percent slopes	11	15	14	17	1. 0	1. 8
Mansic clay loam, 1 to 3 percent slopes, eroded	10	14	13	16	1. 0	1. 8
Mansic clay loam, 3 to 6 percent slopes	8	12	7	10	. 9	1. 4
Mansic and Mansker soils, 3 to 6 percent slopes, eroded	6	10	6	9	. 7	1. 2
Mansic-Hobbs complex						
Mansker clay loam, 0 to 3 percent slopes	8	11	10	13	. 9	1. 3
Mansker-Potter complex						
Ortello fine sandy loam, level	12	15	22	25	2. 6	3. 6
Ortello fine sandy loam, undulating	10	13	20	23	2. 1	3. 3
Ortello-Carwile complex	13	16	18	21	2. 0	3. 2
Otero fine sandy loam, hummocky	10	13	17	21	1. 6	3. 0
Potter soils						
Pratt loamy fine sand, hummocky	5	10	14	16	1. 2	2. 6
Pratt-Tivoli loamy fine sands						
Randall clay						
Sandy broken land						
Spearville silty clay loam, 0 to 1 percent slopes	15	19	12	15	1. 1	1. 6
Spearville complex, 1 to 3 percent slopes, eroded	11	14	9	11	. 9	1. 4
Tivoli fine sand						
Ulysses silt loam, 1 to 3 percent slopes	14	17	17	20	1. 3	2. 3
Ulysses silt loam, 3 to 6 percent slopes	12	15	12	15	1. 3	2. 3
Ulysses-Colby complex, 3 to 6 percent slopes, eroded	10	14	10	13	. 9	1. 9
Ulysses-Harney silt loams, 1 to 3 percent slopes	16	19	13	19	1. 3	2. 3
Ulysses-Harney complex, 1 to 3 percent slopes, eroded	11	16	8	12	1. 0	2. 1
Ulysses-Hobbs complex	13	16	12	16	1. 3	2. 3

No estimates are given of yields of barley and alfalfa, because those crops were scarce during the period covered by these records. Barley is commonly grown in this county; however, alfalfa is generally grown only on soils in alluvium.

Estimated average yields of wheat and sorghum to be expected over a long period under the management commonly practiced in the county are shown in columns A of table 2. Yields that may be obtained by using an improved system of management are shown in columns B.

Common management.—Under the prevailing, or most common, system of management, the following practices are used in producing wheat:

1. Tillage is done in straight lines, generally parallel to the boundaries of fields.
2. Terraces generally are not used.
3. A disk-type implement is generally used for tillage.
4. The cropping system used is wheat and fallow. Winter wheat is seeded early in fall on soils kept free of weeds during the growing season. If a satisfactory stand of wheat is not obtained, or if the wheat blows out, the soil is planted to sorghum.
5. Crop residue is grazed if it is available. Usually, the winter wheat, both seeded and volunteer, is grazed during fall and winter.

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Under the common system of management used in the production of sorghum on all arable soils, except the Canadian, Carwile, Ortello, Otero, and Pratt, the following practices are used:

1. The cropping system consists of wheat-sorghum-fallow. The soil is cultivated after the wheat has been harvested and is clean-tilled until about June 1, when the sorghum is planted.
2. Sorghum is seeded with a drill or planter and is seldom cultivated while the crop is growing. If the growing crop is cultivated, a rotary hoe or harrow is used.

On Canadian, Carwile, Ortello, Otero, and Pratt soils, the cropping system consists of wheat and sorghum grown continuously in alternating strips.

Improved management.—Under improved management for wheat and grain sorghum, the needed soil and water conservation practices are used and the cropping system is one of those given in the description of the capability unit that includes the soil. The needed conservation practices include the following:

1. Tillage is done on the contour between terraces.
2. Tillage is held to a minimum and is done in a way that will protect the crop residue.
3. When crop residues are grazed, sufficient residue is left in the field to help protect the soil from wind and water erosion and to increase infiltration of water.

Other practices necessary to conserve soil and water are given in the description of management for each dryland capability unit in the section "Management of Dryland Soils."

Management of Irrigated Soils

The first part of this section describes general practices for irrigation farming. Then, the irrigated capability classes, subclasses, and capability units are listed. Finally, management by irrigated capability units is discussed.

General management of irrigated soils

Ford County has about 13,000 to 15,000 acres under irrigation. Nearly all of the areas that are irrigated are large and are used mainly for wheat and sorghum. Some general management of these irrigated areas is described in the following paragraphs. More detailed management practices for the soils suited to irrigation are described in the section "Management of Irrigated Soils by Capability Units."

The two general methods of applying irrigation water are the gravity and the sprinkler systems. In the gravity system furrows, graded borders, basins or level borders, borders on contour benches, contour furrows, and corrugations are used. Land leveling is usually necessary for gravity irrigation, except where the contour ditch type of irrigation is used. The contour ditch type of irrigation is used only for grass or other close-growing crops. If a drainage system is established with the land leveling, irrigation water is used more efficiently, salinity is controlled, and tailwater is disposed of without causing erosion.

About 112 wells in the upland produce the water for irrigation. About 14 pumps are located along the Arkansas River and other large streams, and nearly all of these are used to provide water for sprinkler irrigation. Only three farms irrigate by diverting water from the channel of the Arkansas River. All three are near Wilroads Garden.

Sources of irrigation water.—The major sources of water in this county are deposits of alluvial sand and gravel in stream valleys, and sand and gravel in alluvium of the Ogallala formation (*18*).

The water table in the sandy and gravelly alluvium of the valley of the Arkansas River is less than 25 feet below the surface. The water table in the sandy and gravelly alluvium of the Ogallala formation is about 100 to 200 feet below the surface. It is the principal source of high-quality water in the uplands, which includes the Bloom-Kingsdown area and the west-central part of the county.

The water table is at a depth of less than 50 feet in the southwestern part of the county west of the Fowler fault line. Artesian water flows from livestock wells over a limited part of that area at a rate of less than 3 gallons per minute (*18*).

Water quality and soil factors.—Water from all sources in this county needs to be tested before it is used for irrigation. Though much of the water is good, some is not. All of the water, except that from rainfall, contains some dissolved substances that may accumulate in the soils. The effect on the soils when these dissolved substances (salts) from irrigation water accumulate depends mainly on the kind and amount of the substances and on their reaction in the soil.

Drainage is the most important factor in determining whether the soil and water are compatible. Drainage from the surface and through the substratum below the root zone, plus permeability, should be considered for all irrigation systems. Many areas of the county need drainage. When using water for irrigation, the degree of safety depends on the characteristics of the soils and the quality of irrigation water. Water of good quality must be used to wash salts below the root zone. If drainage is too slow, salts may accumulate and ruin the soils. If it is too fast, water is wasted and plant nutrients are washed downward from the root zone. Water used on well-drained soils can contain a greater amount of dissolved salts than water used on imperfectly drained soils. In imperfectly drained soils, lack of drainage is likely to cause salts to accumulate naturally before irrigation is begun.

Irrigated capability classes, subclasses, and units

The soils of Ford County have been grouped in the following capability classes, subclasses, and capability units for irrigation farming:

Class I. Soils that have few limitations that restrict their use.

Unit I–1. Deep, nearly level, well-drained, moderately permeable loamy soils developed in alluvium and loess.

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, gently sloping, well-drained loamy soils of the upland.
Unit IIe-2. Deep, nearly level and undulating sandy soils that have a surface layer and subsoil of fine sandy loam.
Unit IIe-3. Deep, gently sloping soils that have a surface layer of fine sandy loam over a subsoil of silty clay loam.
Unit IIe-4. Deep, well-drained fine sandy loams and imperfectly drained clay loams that are gently undulating.
Subclass IIw. Soils that have moderate limitations because of excess water.
Unit IIw-1. Nearly level, imperfectly drained alluvial clay loams that are deep over sand.
Subclass IIs. Soils that have moderate limitations because of very slow permeability in the subsoil.
Unit IIs-1. Deep, nearly level upland soils that have a surface layer of silty clay loam over a slowly permeable clayey subsoil.
Class III. Soils that have severe limitations that reduce the choice of plants, or that require special conservation practices, or both.
Subclass IIIe. Soils subject to severe erosion if they are cultivated and not protected.
Unit IIIe-1. Deep and moderately deep, gently sloping and sloping, calcareous soils of the upland.
Unit IIIe-2. Deep, hummocky soils that consist of loamy fine sand throughout.
Unit IIIe-3. Deep, gently sloping soils that have a surface layer of silty clay loam and clay loam underlain by a subsoil of slowly permeable clay and clay loam.
Subclass IIIw. Soils that have severe limitations because of excess water.
Unit IIIw-1. Moderately deep, nearly level, imperfectly drained, loamy alluvial soils that are slightly to moderately saline.

Management of irrigated soils by capability units

In this section the irrigable soils of Ford County have been placed in capability units. In each capability unit are soils that have about the same limitations and risks of damage when used for irrigation. Management practices suitable for the soils in each unit are discussed.

IRRIGATED CAPABILITY UNIT I-1

This unit consists of deep, nearly level, well drained, moderately permeable loamy soils developed in alluvium and loess. These soils are—

Dale silt loam.
Dale and Humbarger clay loams.
Harney silt loam, 0 to 1 percent slopes.
Holdrege loam, 0 to 1 percent slopes.
Holdrege silt loam, 0 to 1 percent slopes.
Mansic clay loam, 0 to 1 percent slopes.

These soils, to a depth of 6 feet, will store about 12 to 14 inches of moisture. They have a moderate water-intake rate, are productive and easily worked, and have few limitations when used for irrigation. They are susceptible to wind erosion.

These soils are well suited to irrigation. They recover productivity rapidly after leveling if crop residue and fertilizer are properly used. Crops adapted to the climate can be farmed intensively. Normally, these soils are well supplied with plant nutrients, which must be maintained by use of fertilizer and crop residue.

IRRIGATED CAPABILITY UNIT IIe-1

In this unit are deep, gently sloping, well-drained loamy soils of the upland. These soils are—

Harney silt loam, 1 to 3 percent slopes.
Holdrege silt loam, 1 to 3 percent slopes.
Mansic clay loam, 1 to 3 percent slopes.
Ulysses silt loam, 1 to 3 percent slopes.
Ulysses-Harney silt loams, 1 to 3 percent slopes.

These soils will store about 13 inches of moisture in a depth of 6 feet. The water-intake rate is moderate.

The soils of this unit can be leveled. They recover productivity rapidly after leveling if crop residue and fertilizer are properly used. The soils can be farmed intensively. Normally, they are well supplied with plant nutrients, which must be maintained by use of fertilizer and crop residue. They must be protected by terracing or other suitable water-management practices that help control erosion caused by intensive rains or irrigation water.

IRRIGATED CAPABILITY UNIT IIe-2

This unit consists of deep, nearly level and undulating sandy soils that have a sandy loam surface layer and subsoil. These soils are—

Canadian fine sandy loam.
Ortello fine sandy loam, level.
Ortello fine sandy loam, undulating.
Ortello-Carwile complex.
Otero fine sandy loam, hummocky.

These soils will store about 7 to 9 inches of available moisture in a depth of 6 feet. The water-intake rate is moderate to rapid. Susceptibility to wind erosion and moderately low water-holding capacity are problems.

These soils can be leveled. Soils in undulating areas are more difficult to level into large fields than those in nearly level areas. The undulating areas require deeper cuts and possibly, special irrigation surveys to determine the nature of the substratum.

These soils are well suited to irrigation. Because of their favorable water-intake rate and permeability, they can produce good crops under sprinkler irrigation. Erosion can be controlled by the proper use of crop residue. Locally, the soils in nearly level areas may be underlain by clay; therefore, a special irrigation survey may be needed to determine the degree of subsurface drainage.

IRRIGATED CAPABILITY UNIT IIe-3

The only soil in this unit is Holdrege fine sandy loam, 1 to 3 percent slopes. It is a deep, gently sloping soil that has a surface layer of sandy loam and a subsoil of silty clay loam. The substratum is loamy.

This soil will store about 12 inches of available moisture in a depth of 6 feet. The water-intake rate is moderate.

This soil can be leveled, but deep cuts are required in some areas. The major hazard is susceptibility to wind erosion.

This soil is well suited to irrigation. Irrigated areas can be farmed intensively because of the favorable depth of the soil and the favorable water-intake rate. Also, this soil has high water-holding capacity and responds well to fertilizer.

IRRIGATED CAPABILITY UNIT IIe-4

Only the Dalhart-Lubbock complex is in this unit. It consists of deep, well-drained fine sandy loams and of imperfectly drained clay loams or poorly drained clays that are gently undulating. Dalhart soils make up about 67 percent of the complex, Lubbock soils, about 30 percent, and Randall soils, about 3 percent.

The soils of this complex will store about 13 inches of moisture in a depth of 6 feet. The water-intake rate is slow to moderate. The soils can be leveled, but because of the irregular topography, it will be necessary to make many cuts in the ridges and knobs and many fills in the low areas.

If depressions are filled where the poorly drained Randall soil occurs, an imperfectly drained substratum may result in an irrigated area. Also, in some places the soils are underlain by clay. In other places they are underlain by sand, which makes them poorly suited to irrigation. Therefore, it may be necessary to investigate the substratum throughout an entire area if an irrigation system is planned.

If these soils are irrigated, the major problems are wind erosion, the slow rate of water intake in some areas, and the slow drainage of the substratum throughout the complex.

IRRIGATED CAPABILITY UNIT IIw-1

Leshara clay loam is the only soil in this unit. It is a nearly level, imperfectly drained alluvial clay loam that is deep over sand.

This soil is on the flood plain of the Arkansas River. It is underlain by sand that is at a depth of 32 to 60 inches.

This soil will store about 6 to 8 inches of moisture in a depth of 4 feet. Permeability is moderate. Imperfect drainage in the substratum is a problem because of the fluctuating water table near the surface and susceptibility to flooding. Some saline spots are also problems if this soil is to be used for irrigation farming.

The texture of this soil is relatively uniform clay loam throughout, but there are some thin strata of sandy loam to loamy sand. This soil can be leveled and mixed without greatly lowering its productivity. A special irrigation survey may be necessary, however, to find the actual depth of the cut when leveling this soil. Generally, the depth of the cut should not exceed 18 inches. A cut of 18 inches or deeper will seriously lower the water-holding capacity and allow greater loss of water through the sandy substratum.

If it is irrigated, this soil may be moderately productive.

IRRIGATED CAPABILITY UNIT IIs-1

Spearville silty clay loam, 0 to 1 percent slopes, is the only soil in this unit. It is a deep, nearly level upland soil that has a surface layer of silty clay loam over a subsoil of slowly permeable clay.

This soil has high available moisture-holding capacity; it stores about 13 inches of moisture in a depth of 6 feet. The water-intake rate is slow.

This soil is less well suited to irrigation than more permeable soils. The clayey subsoil holds moisture tightly, but it is slow to take moisture and it releases it slowly to plants. Roots and water have difficulty in penetrating the subsoil.

Water of good quality is required for irrigating this soil because salts accumulate and do not leach downward through the clay in the subsoil.

This soil is deep enough for leveling, but cuts deeper than 10 inches penetrate the subsoil. Productivity is recovered rapidly after leveling if crop residue is turned under and fertilizer is applied.

This soil is well supplied with plant nutrients. If it is irrigated, the main problem is the slow permeability of the subsoil.

IRRIGATED CAPABILITY UNIT IIIe-1

This unit is made up of deep and moderately deep, gently sloping and sloping, calcareous soils of the upland. These soils are—

Bippus clay loam, 2 to 5 percent slopes.
Mansic clay loam, 1 to 3 percent slopes, eroded.
Mansic clay loam, 3 to 6 percent slopes.
Mansker clay loam, 0 to 3 percent slopes.
Ulysses silt loam, 3 to 6 percent slopes.
Ulysses-Colby complex, 3 to 6 percent slopes, eroded.
Ulysses-Harney complex, 1 to 3 percent slopes, eroded.
Ulysses-Hobbs complex.

Only a small acreage of these soils is irrigated. The water that is available for irrigation is generally used on soils that have slopes of 1 percent or less.

These soils have a surface layer of silt loam and clay loam and a subsoil of silt loam, clay loam, or silty clay loam. They are fertile, well drained, and moderately permeable. Most of them have good water-holding capacity and will store about 13 inches of moisture in a depth of 6 feet. The Mansker soils, however, have limited water-holding capacity and will store only about 8 inches of moisture in a depth of 4 feet.

Water erosion and the efficient use of irrigation water are problems. Where the soils are irrigated, management practices should be used that provide for control of erosion, efficient use of water, and maintenance of organic matter and fertility.

These soils can be leveled. Productivity is recovered slowly, however, in some calcareous spots after those areas are leveled. Crop residue and commercial fertilizer are needed. Contour farming is needed also in many areas to control water erosion. Alfalfa, sweetclover, tame grasses, wheat, and sorghum are among the crops that are grown.

IRRIGATED CAPABILITY UNIT IIIe-2

Pratt loamy fine sand, hummocky, is the only soil in this unit. It is a deep, hummocky soil that consists of loamy fine sand throughout.

This soil will store about 6 or 7 inches of moisture in a depth of 6 feet. It has rapid permeability. The low water-holding capacity, low content of organic matter, and high susceptibility to wind erosion are problems that limit the use of this soil for irrigated crops.

This soil is easily worked and responds well if crop residue is fully utilized and fertilizer is applied. Good management should provide for controlling wind erosion and maintaining fertility and good tilth. Sprinkler systems are used more commonly than gravity systems on this soil because of the irregular topography and rapid permeability. The common crops grown under irrigation are pasture grasses, sorghum, and wheat.

IRRIGATED CAPABILITY UNIT IIIe-3

This unit consists only of Spearville complex, 1 to 3 percent slopes, eroded. The soils in this complex are deep and gently sloping. Their surface layer is silty clay loam or clay loam, and their subsoil is slowly permeable clay and clay loam. The substratum is loamy.

The soils in this complex have high available moisture-holding capacity. They will store about 13 inches of moisture in a depth of 6 feet. The water-intake rate is slow.

These soils are not well suited to irrigation, because of their slow permeability, susceptibility to erosion, and the large amount of runoff. Cuts below a depth of 10 inches penetrate the clayey subsoil or highly calcareous material.

Some spots contain accumulations of salts; others are highly calcareous. Irrigation water must therefore be carefully applied. Good management is needed to control runoff and erosion, prevent further accumulations of salts, and supply nutrients in the limy spots. Also, the tilth needs to be improved and good tilth maintained. Fertilizer should be added also, and the fertility needs to be maintained. Contour farming is needed, along with terraces and waterways, to control erosion and runoff.

Not much of the acreage of these soils can be irrigated, because the available water is generally used on more productive soils that have slopes of 1 percent or less.

IRRIGATED CAPABILITY UNIT IIIw-1

This unit consists of moderately deep, nearly level, imperfectly drained soils that are loamy and are slightly to moderately saline. The soils formed in alluvium. These soils are—

Las Animas sandy loam.
Leshara clay loam, moderately deep.

These soils occur close together on the flood plain of the Arkansas River. They are underlain by sand at a depth of 18 to 40 inches. In the Las Animas soil the sand lies at a depth of 24 to 40 inches, and the soil material that is above is sandy loam. The Leshara soil consists of 18 to 30 inches of clay loam over sand.

These soils will store about 3 to 6 inches of available moisture in a depth of 4 feet, even in areas where sandy material is near the surface. The water-intake rate is moderate. Imperfect drainage of the substratum, the water table near the surface, susceptibility to flooding, slight to moderate salinity, and the shallow root zone are hazards if the soils are used for irrigated crops.

Few of the areas can be leveled. If an area is to be leveled, a special survey may be necessary to determine the actual depth of the cut, because these soils vary in depth over sand. Graded borders, basins, and furrows can be used where the depth allows for leveling. A sprinkler irrigation system is better suited than a gravity system in fields where the Las Animas soil is predominant, because that soil has a faster water-intake rate and more rapid permeability than the Leshara soil.

Only low to moderate yields can be expected, even though fertilizer and crop residue are properly used. Greater losses of plant nutrients from leaching occur in the Las Animas soil than in the Leshara.

Predicted yields of irrigated crops

Methods of irrigation management are variable and have changed rapidly, so that yield predictions of irrigated crops were difficult to establish during the time of the survey. Generally, irrigation farming insures more dependable and higher yields than dryland farming. This increase ranges from 50 to 300 percent above yields obtained under dryland farming. Yield depends mainly upon the varieties of crops grown, the management practices used, the severity of damage by insects, and the climate.

Range Management [2]

Rangeland makes up about 22 percent of the total acreage in Ford County. It is scattered throughout the county, but some areas are concentrated in the northern half. Generally, this rangeland is not suitable for cultivation.

The raising of livestock is the second largest agricultural enterprise in this county. Its success depends upon the way ranchers and farmers manage their range and other sources of feed. The livestock are mainly feeder-stocker cattle, but there are a few breeding herds in the county.

Range sites and condition classes

Different kinds of range produce different kinds and amounts of forage. If the operator of a range is to manage his rangeland properly, he needs to know the different kinds of land, or range sites in his holdings and the plants each site is capable of producing. He is then able to determine what his range can be expected to produce in different seasons and under different degrees of grazing use.

Range sites are areas of rangeland that differ from each other in their ability to produce a distinct kind or amount of climax, or original, vegetation. A significant difference is one great enough to require different grazing practices or other management practices that will maintain or improve the present vegetation.

Climax vegetation is the combination of plants that originally grew on a given site. The most productive combination of forage plants on a range site is generally the climax type of vegetation.

Range condition is the present state of the vegetation in relation to the highest stage of plant growth the site can support. It is determined by computing the percentage of the present vegetation in relation to the climax vegetation for the site. Changes in range condition are caused primarily by the degree of use or the kind of use of the rangeland. The effects of grazing become more apparent during periods of drought. Four range condition classes are defined. A range in excellent condition has from 76 to 100 percent of the vegetation that is characteristic of the climax vegetation on the same site;

[2] PETER N. JENSEN, range conservationist, Soil Conservation Service, assisted in preparing this section.

one in good condition, 51 to 75 percent; one in fair condition, 26 to 50 percent; and one in poor condition, less than 26 percent.

In the descriptions of range sites, native vegetation is referred to in terms of *decreasers*, *increasers*, and *invaders*. Decreasers and increasers are climax plants. Decreasers are the most heavily grazed and are consequently the first to be injured by overgrazing. Increasers withstand grazing better or are less palatable to the livestock; they increase under grazing and replace the decreasers. Invaders are weeds that become established after the climax vegetation has been reduced by grazing.

Descriptions of range sites

The range sites in Ford County are Loamy Lowland, Saline Subirrigated, Loamy Upland, Limy Upland, Sandy, Sands, Choppy Sands, Clay Upland, and Breaks. The most extensive of these is Loamy Upland, which makes up nearly 50 percent of the range in the county.

Because of differences in the soils, the range sites vary greatly in the amount of forage produced. The total yield of herbage varies also from year to year because of differences in the amount of precipitation, in the amount of grazing in past years, and in relief. In addition, trampling or the activities of rodents and insects may damage the forage plants or cause them to disappear. The following listing gives estimates of the top growth of herbage for the range sites in excellent condition where there has been an average amount of rainfall:

Range site:	*Air-dry weight (lb. per acre)*
Loamy Lowland	3,000–4,000
Saline Subirrigated	4,000–6,000
Loamy Upland	1,250–2,000
Limy Upland	1,500–2,500
Sandy	2,000–3,000
Sands	2,500–3,500
Choppy Sands	1,500–2,500
Clay Upland	1,000–2,500
Breaks	1,500–2,000

The range sites in this county are described in the following pages. The description of each site includes the names and map symbols of the soils in the site and the dominant vegetation when the site is in excellent condition.

LOAMY LOWLAND SITE

This range site is made up of nearly level soils that are deep and moderately permeable. The soils have a surface layer of sandy loam to clay loam. Their water-holding capacity is high. All of them receive extra moisture from flooding and the water table. Following are the soils in this range site and the map symbol of each:

Alluvial land (An).
Dale silt loam (Da).
Dale and Humbarger clay loams (Dh).
Hobbs soil in Mansic-Hobbs complex (Mh).
Hobbs soil in Ulysses-Hobbs complex (Up).

The climax plant cover is a mixture of switchgrass, big bluestem, Indiangrass, Canada wildrye, little bluestem, and other decreasers. These grasses make up at least 60 percent of the total cover, and perennial forbs and grasses make up the rest. In places increasers make up as much as 40 percent of the climax vegetation. The dominant increasers are western wheatgrass, side-oats grama, blue grama, and buffalograss. A common invader is silver bluestem.

SALINE SUBIRRIGATED SITE

This range site is made up of nearly level, somewhat poorly drained, saline and saline-alkali soils on the bottom lands of the Arkansas River. The texture of these soils ranges from clay to loamy sand. The soils receive additional moisture from flooding or from a water table near the surface. Following are the soils in this range site and the map symbol of each:

Alluvial land and slickspots (As).
Las Animas sandy loam (La).
Las Animas-Lincoln complex (Lc).
Las Animas soil in Las Animas-Tivoli complex (Ln).
Leshara clay loam (Ls).
Leshara clay loam, moderately deep (Lt).

The climax plant cover is a mixture of decreasers, such as alkali sacaton, switchgrass, Indiangrass, western wheatgrass, and side-oats grama. These grasses make up at least 75 percent of the total cover, and perennial forbs and grasses make up the rest. Dominant decreasers are alkali sacaton and switchgrass. In places increasers make up 25 percent of the climax vegetation. They are mainly saltgrass, blue grama, and buffalograss. Common invaders are alkali muhly and tamarisk.

LOAMY UPLAND SITE

This range site consists of deep, nearly level to steep soils of the upland. These soils have a surface layer and subsoil of loam to clay loam. They are well drained and moderately permeable, and they have high water-holding capacity. Following are the soils in this range site and the map symbol of each:

Bippus clay loam, 2 to 5 percent slopes (Bc).
Lubbock soil in Dalhart-Lubbock complex (Dl).
Harney silt loam, 0 to 1 percent slopes (Ha).
Harney silt loam, 1 to 3 percent slopes (Hb).
Holdrege loam, 0 to 1 percent slopes (Hg).
Holdrege silt loam, 0 to 1 percent slopes (Ho).
Holdrege silt loam, 1 to 3 percent slopes (Hs).
Mansic clay loam, 0 to 1 percent slopes (Ma).
Mansic clay loam, 1 to 3 percent slopes (Mb).
Mansic clay loam, 3 to 6 percent slopes (Md).
Ulysses silt loam, 1 to 3 percent slopes (Ua).
Ulysses silt loam, 3 to 6 percent slopes (Ub).
Ulysses-Harney silt loams, 1 to 3 percent slopes (Uh).
Ulysses-Harney complex, 1 to 3 percent slopes, eroded (Un).
Ulysses soil in Ulysses-Hobbs complex (Up).

The climax plant cover is a mixture of decreasers, such as little bluestem, side-oats grama, blue grama, and buffalograss. In a few places there is a small amount of big bluestem and switchgrass. Under present grazing, blue grama and buffalograss are the dominant grasses. Annuals are the principal invaders. Pricklypear is the common invader in droughty years, but in favorable years little barley and cheatgrass brome are common invaders.

LIMY UPLAND SITE

This range site consists of nearly level to steep soils of the upland. The soils have a surface layer and subsoil of loam to clay loam. They are moderately to strongly calcareous, moderately permeable, and well drained. The water-holding capacity is high. Following are the soils in this site and the map symbol of each:

Mansic clay loam, 1 to 3 percent slopes, eroded (Mc).
Mansic and Mansker soils, 3 to 6 percent slopes, eroded (Mf).
Mansic soil in Mansic-Hobbs complex (Mh).
Mansker clay loam, 0 to 3 percent slopes (Mn).
Mansker soil in Mansker-Potter complex (Mp).
Ulysses-Colby complex, 3 to 6 percent slopes, eroded (Uc).

The climax plant cover is a mixture of grasses, such as little bluestem, side-oats grama, blue grama, hairy grama, and buffalograss. The dominant decreasers are little bluestem and side-oats grama. The dominant increasers are buffalograss, broom snakeweed, and grasses that form a mat.

SANDY SITE

This range site is made up of deep, nearly level to steep upland soils that have a surface layer of sandy loam and a subsoil of sandy loam to sandy clay loam. The soils are well drained and are moderately to rapidly permeable. The moisture-holding capacity is moderate. Following are the soils in this site and the map symbol of each:

Canadian fine sandy loam (Co).
Dalhart soil in Dalhart-Lubbock complex (Dl).
Holdrege fine sandy loam, 1 to 3 percent slopes (Hd).
Ortello fine sandy loam, level (Of).
Ortello fine sandy loam, undulating (Or).
Ortello-Carwile complex (Os).
Otero fine sandy loam, hummocky (Ot).

The climax plant cover is a mixture of decreasers, such as sand bluestem, big bluestem, little bluestem, and switchgrass. In places climax grasses make up 55 percent of the composition of the plant cover, and perennial forbs and grasses make up the rest. The dominant increaser grasses are side-oats grama, blue grama, hairy grama, buffalograss, and sand dropseed. The principal woody increasers are chickasaw plum, small soapweed, and pricklypear. Common invaders are windmillgrass, perennial three-awns, and annuals.

SANDS SITE

This range site is made up of deep hummocky soils that have a surface layer of loamy fine sand and a subsoil of loamy sand to sandy loam. The soils are well drained, are rapidly permeable, and have moderate to low moisture-holding capacity. Following are the soils in this site and the map symbol of each:

Pratt loamy fine sand, hummocky (Pr).
Pratt-Tivoli loamy fine sands (Pt).
Sandy broken land (Sb).
Tivoli soil in Las Animas-Tivoli complex (Ln).

The climax plant cover is a mixture of decreasers, such as sand bluestem, little bluestem, switchgrass, and side-oats grama. In some areas the climax grasses make up 65 percent of the composition of the plant cover, and perennial forbs and grasses make up the rest. The dominant increasers are blue grama, sand dropseed, and sand paspalum. The principal invaders are annuals.

CHOPPY SANDS SITE

This range site consists of deep fine sands in hummocky to dune areas in the sandy upland. Blowouts are associated with the soils in this site. These soils are rapidly permeable, are somewhat excessively drained, and have low water-holding capacity. The following are the soils in this site and the map symbol of each:

Active dunes (Ad).
Tivoli fine sand (Tv).

The climax plant cover is a mixture of decreasers, such as sand bluestem, switchgrass, and little bluestem. These climax grasses make up about 60 percent of the plant cover; other perennial forbs and grasses make up the rest. The dominant increasers are sand dropseed and sand paspalum. Blowoutgrass is the first perennial that stabilizes blowouts or dunes. Annuals are the principal invaders.

CLAY UPLAND SITE

This range site is made up of deep, nearly level or gently sloping soils of the upland. These soils have a surface layer of silty clay loam and a subsoil of silty clay. They are slowly permeable and are droughty. The following are the soils in this site and the map symbol of each:

Spearville silty clay loam, 0 to 1 percent slopes (Sp).
Spearville complex, 1 to 3 percent slopes, eroded (Sr).

The climax plant cover is a mixture of decreasers, such as western wheatgrass, side-oats grama, big bluestem, and switchgrass. The dominant increasers are blue grama and buffalograss. Annuals are the principal invaders.

BREAKS SITE

This range site is made up of soils on steep to very steep, broken slopes. These soils are shallow over caliche and limestone. Their texture ranges from loam to clay loam. The soils are permeable and well drained, but they have low water-holding capacity. Depth to which roots can penetrate is limited by fragmental caliche. The following are the soils in this site and the map symbol of each:

Potter soil in Mansker-Potter complex (Mp).
Potter soils (Po).

The climax plant cover is a mixture of such decreasers as little bluestem, big bluestem, Indiangrass, switchgrass, and Canada wildrye. In places these grasses make up at least 65 percent of the plant cover, and other perennial forbs and grasses make up the rest. Dominant increasers are side-oats grama and hairy grama.

UNSTABLE SITES

Because of the instability of the soils and the vegetation, the following mapping units are not true range sites:

Broken alluvial land (Br).
Lincoln soils (Lu).
Randall clay (Ra).

Broken alluvial land consists of stratified layers of loam, silt loam, and clay loam. It is along the major creeks of the county. The areas are frequently covered by floodwaters that quickly recede. Scouring and cutting cause them to have an unstable cover of plants. The vegetation consists primarily of annuals and trees, such as American elm, green ash, and hackberry.

The Lincoln soils are shallow and are sandy or gravelly. They occur in nearly level to weakly hummocky and channeled areas along the Arkansas River. Flooding, deposition, and shifting of the stream channel are common. The cover of plants is sparse and consists primarily of cottonwood trees, tamarisk, sand willow, and annual grasses.

Randall clay is in upland depressions throughout the county. It is commonly covered by water during rainy seasons. The composition of the plant cover is different in wet seasons than in dry, but it consists mainly of Pennsylvania smartweed, cocklebur, sedges, and rushes.

Management principles and practices

High forage production and the conservation of soil, water, and plants on rangeland are obtained by maintaining range that is already in good or excellent condition, and by improving range that is depleted. The vegetation is improved by managing the grazing so as to encourage the growth of the best native forage plants.

The development of leaves, the growth of roots, the formation of flowers and stalks, the production of seed, the regrowth of forage, and the storage of food in the roots are all essential stages in the development and growth of grass. Grazing must be regulated to permit these natural processes of growth to take place if maximum yields of forage and peak production of livestock are to be maintained.

Livestock are selective in grazing and constantly seek the more palatable plants. If grazing is not carefully controlled, the better plants are eventually eliminated. If heavy grazing is continued, even the second-choice plants will be thinned out or eliminated, and undesirable weeds or invaders will take their place.

Research and the experience of ranchers have shown that when only about half the yearly volume of grass is grazed, damage to the desirable plants is minimized and the range is improved. The grass that is left to grow has the following effects on the range:

1. It permits the better range plants to maintain or improve their vigor and thus crowd out or prevent weeds.
2. It enables plants to store food for quick and vigorous growth after droughts and in spring.
3. It causes the roots to increase in number and length so that they can reach additional moisture and plant nutrients. (Roots of overgrazed grass cannot reach deep moisture, because not enough green shoots are left to provide food needed for good root growth.)
4. It protects the soils from erosion by wind and water. Grass is the best kind of cover to control erosion.
5. It serves as a mulch that allows rapid intake of water. The more moisture stored in the ground, the better the growth of grass for grazing.
6. It stops snow where it falls so that it can melt and soak into the soil for later use.
7. It provides a greater reserve of feed for the dry years and thus removes the need for forced sale of livestock.

Sound range management requires adjustment in the stocking rates from season to season, according to the amount of forage produced. It should provide for reserve pastures or other feed during droughts or other periods when production of forage has been low. Thus, the range forage can be grazed moderately at all times. It is often desirable to keep part of the livestock, such as stocker steers, readily salable. Such flexibility allows the rancher to adjust the number of livestock to the amount of forage available without selling breeding animals.

Proper range use and deferred grazing or rotation-deferred grazing are practices that are applicable on all rangeland, regardless of other practices used. They cost little and improve the range. Other practices that improve the range are range seeding, developing suitable watering places, constructing fences, placing salt in areas where it encourages uniform grazing, and controlling undesirable plants.

1. *Proper range use* consists of grazing rangeland at a rate that will maintain the vigor of the plants, a reserve of forage, and enough residue to conserve soil and water. At the same time, proper range use keeps the most desirable vegetation on the site or improves the quality of the vegetation that has deteriorated.
2. *Deferred grazing* is resting a pasture during any growth period of the year. All livestock are kept off the range while it is rested. This practice increases the vigor of the forage plants and permits the desirable plants to reproduce naturally by seed. It also allows a reserve of forage to be built up for fall and winter grazing or for emergency use.
3. *Rotation-deferred grazing* is a practice in which one or more pastures are rested at planned intervals throughout the growing season. Each pasture is rested during a different period each successive year so that desirable forage plants can develop and produce seed.
4. *Range seeding* consists of establishing native or improved grasses and forbs, by seeding or reseeding, on land suitable for range. The area to be seeded should have a climate and soils that will support range. Also the plants need to be adapted to the climate and soils. This insures that the supply of forage can be maintained with no care other than the proper management of grazing.

   A mixture of species that are dominant in the climax vegetation on the particular site should be seeded. The seed of the native grasses or forbs to be planted ought to have originated from an area as near as feasible to the area to be seeded. Generally, the origin of the seed should be no farther away than 250 to 400 miles south or 100 to 150 miles north of the area to be seeded.

   Grasses should be seeded in forage stubble or in the stubble of grain sorghum because this type of cover protects the soils from erosion, provides a firm seedbed, and helps control weeds. The mulch also helps to retain moisture in the surface layer. The newly seeded areas should not be grazed for at least 2 years so that the plants have time to become firmly established.
5. *Water developments* need to be distributed over the entire range, if feasible, so that livestock do not have to travel far for water. Good distribution of watering places helps achieve uniform use of the range. Generally, wells, ponds, and dugouts supply water for livestock, but in some places water must be hauled. The characteristics of each range site determine which type of water development is most practical.
6. *Fences* need to be constructed to provide for good management of livestock and range. This can mean separating different areas of range on the basis of seasonal use. In some places different

range sites are fenced separately. This is done when the areas differ greatly and are large enough for fencing to be practical.

7. *Salting* is necessary on rangeland to supplement the native range forage. Proper distribution of salt is used to improve the distribution of grazing.
8. *Control of undesirable plants* through chemical or mechanical means may be needed in some areas. It permits improvement in the forage on the range and also makes livestock easier to handle.

To summarize, livestock management that achieves high production and conserves the resources of the range includes—

1. A feed and forage program that provides available range forage and also concentrates, tame and native hay, tame pasture, or harvested roughage to keep livestock in good condition throughout the year. During emergencies, the use of roughage reserved for feed and the deferred grazing of native pastures will indirectly conserve the plant cover, soils, and water. Shortages of feed can be avoided by storing for future use the surplus produced in years of high yields. Reserves of feed may be stored in stacks, pits, or silos.
2. A breeding program that provides for the type of livestock most suitable for the range and for the ranching system, for a supply of calves in seasons when forage is most nutritious, and for continued improvement of the herd, consistent with the type of range and climate.
3. Culling nonproductive animals from the herd.

Windbreak Management

Ford County has no large areas of woodland. It is primarily an area of grassland. The native woodland consists of narrow bands and patches of trees along streams and drainageways. The dominant species in the native woodland are cottonwood, ash, elm, and hackberry, but few of these trees have commercial value. Trees are planted in some areas, but they are affected by the hazards of extreme climate—a high degree of evaporation, low humidity, high winds, extreme changes in temperature, and droughts. Only hardy species of trees do well, and their growth depends largely on the relationship between water and soil. The amount of moisture and air in the soils greatly influences the vigor, growth, and life of the trees.

Trees are generally planted in this county to reduce soil blowing; to protect field crops, orchards, gardens, farmsteads, and livestock; to hold blowing snow; and to provide habitats for wildlife. Their main purpose is to provide shelter from wind.

About 250 separate plantings of trees were made throughout the county in the years 1937 through 1942 through the Prairie States Forestry Project. About 80 percent of the trees were planted in 1938 and 1939, 16 percent in 1942, and the rest in 1937, 1940, and 1941. About 50 percent were planted on or near lowland areas along Coon Creek and Crooked Creek and in the valley of the Arkansas River. In those areas the high water table is a factor in the survival of trees. About 40 to 50 percent of the trees were planted on the sandy upland, and 5 to 10 percent were planted on the soils of the High Plains.

In 1935 shelterbelt projects similar to the forestry project were initiated in the Great Plains. Since 1942 about 130 farmstead windbreaks have been planted and maintained in Ford County, mainly on Deep Loamy Upland sites.

Windbreak suitability groups

The soils of the county suitable for trees have been placed in seven windbreak suitability groups. This grouping helps landowners plan the use of their soils for windbreaks. The soils in a particular group have essentially the same productivity and respond to similar management. Each windbreak suitability group is discussed separately as follows:

1. Deep Loamy and Clayey Lowland.—This group consists of deep, nearly level to steep silt loams and clay loams. These are dark-colored, well-drained soils that were formed in alluvium. Moisture and roots can penetrate to a uniform depth of 10 feet or more. These soils are highly fertile. They are subject to flooding, and the water from flooding is a source of extra moisture for trees. Depth to the water table ranges from 10 to 30 feet. Movement of water through the subsoil is moderate to moderately slow. The soils in this group are—

Alluvial land.
Broken alluvial land.
Dale silt loam.
Dale and Humbarger clay loams.

The soils are well suited to plantings for shelterbelts and windbreaks. Alluvial land and Broken alluvial land are natural sites for trees where extra water is available from the water table and from overflow. Dale silt loam and Dale and Humbarger clay loams are not frequently flooded, but trees on those soils obtain extra water from the water table. Some water is also available from runoff that flows into drainageways that cross these soils.

2. Deep Sandy Lowland.—The only soil in this group is Canadian fine sandy loam. This is a deep, nearly level, dark-colored, well-drained soil that formed in alluvium. Moisture and roots can penetrate it to a uniform depth of 10 feet or more. This soil is highly fertile, but it is subject to occasional flooding. Depth to the water table ranges from 10 to 30 feet. Movement of water through the subsoil is moderate to moderately rapid.

This soil is well suited to plantings for shelterbelts and windbreaks. Extra moisture is available from the water table.

3. Deep Loamy Upland.—This group consists of deep, nearly level to steep, dark-colored, well-drained, medium to fine-textured soils. Roots and water penetrate these soils to a depth of as much as 6 feet. The surface layer ranges from loam to silty clay loam. The subsoil, or layers beneath the surface layer, ranges from silt loam to light silty clay.

The soils in this group are highly fertile. Movement of water through the material beneath the surface layer is moderate to slow. The water table is at a depth of more than 30 feet. No extra water is available for trees, except that stored from rain or snow. The clayey subsoil slows

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the growth and development of roots. Erosion is a hazard. (Climatic hazards, such as low rainfall, low humidity, high evaporation, high winds, and abrupt changes in temperature, influence the growth and development of trees. The soils in this group are—

Bippus clay loam, 2 to 5 percent slopes.
Dalhart-Lubbock complex.
Harney silt loam, 0 to 1 percent slopes.
Harney silt loam, 1 to 3 percent slopes.
Holdrege fine sandy loam, 1 to 3 percent slopes.
Holdrege loam, 0 to 1 percent slopes.
Holdrege silt loam, 0 to 1 percent slopes.
Holdrege silt loam, 1 to 3 percent slopes.
Mansic clay loam, 0 to 1 percent slopes.
Mansic clay loam, 1 to 3 percent slopes.
Mansic clay loam, 1 to 3 percent slopes, eroded.
Mansic clay loam, 3 to 6 percent slopes.
Mansic and Mansker soils, 3 to 6 percent slopes, eroded.
Mansic-Hobbs complex.
Ulysses silt loam, 1 to 3 percent slopes.
Ulysses silt loam, 3 to 6 percent slopes.
Ulysses-Colby complex, 3 to 6 percent slopes, eroded.
Ulysses-Harney silt loams, 1 to 3 percent slopes.
Ulysses-Harney complex, 1 to 3 percent slopes, eroded.
Ulysses-Hobbs complex.

The growth of trees on soils of this group depends on the supply of moisture from rainfall and snow.

4. **Deep Sandy Upland.**—In this group are deep, nearly level to steep, well-drained, medium- to coarse-textured soils. Roots and water penetrate these soils to a uniform depth of as much as 7 feet. The surface layer ranges from fine sandy loam to loamy fine sand. The layers beneath range from silt loam to fine sand.

Movement of water through these soils ranges from moderate to rapid. The water table is at a depth of more than 30 feet. The only extra water available for trees is that stored from rain or snow. Erosion is a hazard. The climatic hazards of low rainfall, low humidity, high evaporation, high winds, and abrupt changes in temperature affect the growth and development of trees. The soils in this group are—

Ortello fine sandy loam, level.
Ortello fine sandy loam, undulating.
Ortello-Carwile complex.
Otero fine sandy loam, hummocky.
Pratt loamy fine sand, hummocky.
Pratt-Tivoli loamy fine sands.
Sandy broken land.

5. **Moderately Deep Loamy Upland.**—The only soil in this group is Mansker clay loam, 0 to 3 percent slopes. This is a moderately deep, highly calcareous, well-drained soil that has a surface layer of loam or clay loam. The depth to which roots and moisture can penetrate are limited by caliche at a depth of about 4 feet.

This soil is moderately fertile. Movement of water through the material beneath the surface layer is moderate to slow. The water table is at a depth of more than 30 feet. The growth of trees depends upon the amount of moisture from rainfall or snow that is stored above the layer of caliche. Erosion is the major hazard. The shallow root zone and climatic hazards limit the growth and development of trees.

6. **Shallow Sandy and Clayey Lowland.**—In this group are somewhat poorly drained soils on the flood plain of the Arkansas River. The soils are shallow to moderately deep over coarse-textured material. The surface layer and subsoil range from loamy sand to clay loam. Sand limits the penetration of tree roots below a depth of 5 feet.

These soils are subject to flooding. The water table fluctuates and is about 2 to 5 feet below the surface. It carries dissolved salts and deposits them in the soils. As a result, all of these soils are slightly to moderately saline or alkaline. Except during dry seasons, the water table has much extra water available for trees. In dry seasons, however, it drops until it is in the sand. The sandy soils have a rapid water-intake rate, but the water-intake rate of the clay loams is moderately slow. The soils in this group are—

Alluvial land and slickspots.
Las Animas sandy loam.
Las Animas-Lincoln complex.
Las Animas-Tivoli complex.
Leshara clay loam.
Leshara clay loam, moderately deep.

7. **Deep Clayey Upland.**—This group consists of deep, nearly level and gently sloping, well-drained clayey soils. Water moves slowly through the profile, and the growth of roots is restricted, to some extent, by the clayey subsoil. The surface layer is silty clay loam. The substratum is calcareous clay loam and silty clay loam.

These soils are fertile. The water table is at a depth of more than 30 feet, however, and no extra water is available for trees, except that stored from rain and snow. Growth of trees on these soils is controlled by the slow permeability of the subsoil and by erosion and the climatic hazards. The soils in this group are—

Spearville silty clay loam, 0 to 1 percent slopes.
Spearville complex, 1 to 3 percent slopes, eroded.

General management of trees

Persons who wish to plant trees in Ford County or who are interested in the general management of trees need to know which soils are suitable for different species. Table 3 shows the windbreak suitability groups in this county and indicates the suitability of the soils in each for specified conifers, shrubs, and deciduous trees in dryland areas. The relative terms used in the ratings are "excellent," "good," "fair," and "poor."

As shown in table 3, black walnut and American elm can be grown only on lowland sites. They need a deep soil.

Osage-orange and Siberian elm are generally not suitable for field windbreaks, because they use moisture that is needed by other trees or by crops in the adjacent fields. They have long runners that extend into the fields and into other rows of trees. In areas where extra moisture can be applied, however, they are satisfactory for windbreaks around farmsteads.

Bur oak has a large taproot. Therefore, using a mechanical planter is difficult for planting bur oak.

Eastern redcedar is well suited to all the woodland sites in this county. It has a high rate of survival, and a study of eastern redcedar, planted in 19 rows and used for shelterbelts and windbreaks, showed that the trees had good to excellent vigor. The average age of the trees examined was 16 years, and their average height was 13.7 feet. The trees grew at a rate of 0.3 foot to 1 foot per year.

TABLE 3.—*Suitability of trees and shrubs for planting (dryland)*

Common trees and shrubs	Windbreak suitability groups						
	1. Deep Loamy and Clayey Lowland	2. Deep Sandy Lowland	3. Deep Loamy Upland	4. Deep Sandy Upland	5. Moderately Deep Loamy Upland	6. Shallow Sandy and Clayey Lowland	7. Deep Clayey Upland
Conifers:							
Austrian pine	Excellent	Excellent	Excellent	Excellent	Good	Excellent	Excellent.
Eastern redcedar [1]	Excellent	Excellent	Excellent	Excellent	Good	Excellent	Excellent.
Ponderosa pine [1]	Excellent	Excellent	Excellent	Excellent	Good	Excellent	Excellent.
Shrubs:							
American wild plum	Good	Good	Poor	Fair	Poor	Good	Poor.
Skunkbush	Good	Good	Fair	Fair	Poor	Good	Poor.
Tamarisk	Good	Good	Good	Fair	Fair	Excellent	Good.
Western chokecherry	Good	Good	Poor	Fair	Poor	Good	Poor.
Deciduous trees:							
American elm	Good	Good	Poor	Poor	Poor	Poor	Poor.
Black walnut	Good	Good	Poor	Poor	Poor	Poor	Poor.
Bur oak	Excellent	Excellent	Good	Poor	Poor	Fair	Poor.
Cottonwood	Excellent	Excellent	Poor	Poor	Poor	Fair	Poor.
Green ash	Good	Good	Poor	Poor	Poor	Poor	Poor.
Hackberry [1]	Excellent	Good	Fair	Fair	Poor	Fair	Poor.
Honeylocust (thornless)[1]	Good	Good	Good	Good	Poor	Fair	Poor.
Osage-orange	Excellent	Excellent	Good	Excellent	Fair	Good	Fair.
Russian-olive [1]	Good	Good	Poor	Poor	Poor	Fair	Poor.
Russian-mulberry [1]	Fair	Fair	Fair	Poor	Poor	Poor	Poor.
Siberian elm [1]	Good	Good	Good	Good	Fair	Fair	Good.

[1] Trees most commonly used in Ford County.

Following are some practices to be applied in planting trees:

1. Select tree and shrub species best suited to the kinds of soil on the planting site.
2. If the site is one where crops have been grown, fallow the site so moisture will be conserved, and cultivate before planting to prepare a good seedbed.
3. Plant sorghum to check wind erosion if the soils have a sandy surface layer.
4. Spacing between the rows may vary from 16 to 30 feet but should be adjusted to fit the width of the cultivating equipment used.
5. Cultivate windbreaks and shelterbelts at least 3 years to keep down competing weed growth. At the wider spacings, cultivation for the life of the trees is desirable.
6. At planting time and over an extended period, protect the trees from livestock, fire, and small animals, especially rabbits.

Good management for shelterbelts and windbreaks consists mainly of controlling erosion by wind and water and using tillage methods that help to store moisture.

Any way that moisture can be conserved within the windbreaks or shelterbelts and in nearby areas will help produce better, longer lived trees. During droughts, trees often die if moisture has not been provided through the accumulation of snow in the previous winter or through cultivation, straw mulching, and irrigation.

Sandy soils are the best for trees planted for shelterbelts and windbreaks. Clayey soils are less desirable. The moisture in sandy soils is more evenly distributed and penetrates to a greater depth than that in clayey soils. Trees on sandy soils develop a more extensive root system than those on clayey soils, and their roots penetrate to a greater depth. In contrast, the clayey soils have a slow water-intake rate. As a result, during rainstorms there is a greater amount of runoff from those soils than from sandy soils. Clayey soils seldom reach field capacity to a depth of more than 3 feet. Roots of trees growing on clayey soils develop more slowly than those of trees growing on sandy soils, and they do not penetrate to so great a depth. Also, the root system is less extensive, and the trees are damaged more severely by drought.

Farmstead windbreaks [3]

Where feasible, farmstead windbreaks should be planted on the north and west sides of the farmstead. This gives protection in winter from the prevailing north and west winds. Plantings on the south side give protection from winds in summer. A 5-row planting provides an effective windbreak. A windbreak of less than five rows does not provide the maximum protection; one of more than five adds little extra protection.

Experience has shown that a dense shrub or conifer is desirable in the first two rows on the north and west sides of a windbreak. A common arrangement is one row of tamarisk and one row of eastern redcedar, or two rows of eastern redcedar. This arrangement causes the snow to

[3] ROGER C. ARENSDORF, soil conservationist, assisted in preparing this section.

start drifting immediately to the south or east of these rows, and puts much of the drifted snow in the tree belt. A typical 5-row windbreak consists of the following trees: In the first row, on the north, tamarisk or redcedar; in the second row, eastern redcedar; in the third row, honeylocust; in the fourth row, honeylocust or bur oak; and in the fifth row, Russian-olive. The sixth row, on the south or east, could have Austrian pine to add to the beauty of the belt.

Common species of shrubs that are suitable for windbreaks and that are adapted to the soils and climate of the county are American plum, which grows well on the Deep Sandy Upland site, and tamarisk, which grows well on the Deep Sandy Upland and Deep Loamy Upland sites. These shrubs require a spacing of 3 to 4 feet in the rows.

Common species of adapted deciduous trees that are suitable for windbreaks are bur oak, Siberian elm, cottonwood, honeylocust, osage-orange, Russian-olive, and Russian mulberry. These should be planted in rows 16 to 30 feet apart. All of these trees but the Russian-olive and Russian mulberry are tall, and the Russian-olive and Russian mulberry are of medium height. Siberian elm grows fast but is short lived. Cottonwood and honeylocust also grow fast. Cottonwood grows best on soils that have a water table within reach of the root system. Honeylocust and osage-orange are hardy.

Common adapted evergreens are Austrian pine, ponderosa pine, and redcedar. These trees should be planted 6 to 10 feet apart in rows. Redcedar is the best species for planting in the county. Austrian pine is especially good on the Deep Clayey Upland site, and ponderosa pine does well on the Deep Sandy Upland and Deep Sandy Lowland sites.

Tree survival apparently is directly related to the preparation of the soil before planting. A good summer-fallow period that will help give good survival includes one subsoiling operation to a depth of about 18 inches. Some hand replanting is generally necessary during the first and second years following the original planting. The original plantings are usually made with a tree planter.

Weed control is necessary to give the trees maximum available moisture. For control of weeds, the trees require cultivation between the rows. Usually, the trees can be cultivated mechanically for 3 years. After the trees are 3 years old, their size may prevent cultivation between the rows, particularly where the narrower spacing between rows is used.

If not controlled, tall weeds may shade new plantings of eastern redcedar. Where this occurs, it is probably best not to remove them. Removing the weeds and the shade they provide apparently causes the death of the trees as a result of the sudden exposure to the midsummer sun. Local observations show a greater loss from this type of exposure than from loss of moisture used by the tall weeds.

Five to ten years of growing time is generally required for a windbreak to reach an effective height. Establishing windbreaks are of great value to their owners.

Table 4 consists of data derived from samples taken from a few shelterbelts growing on four soil types—it is a compilation of limited studies on the relationship of soil to tree growth and vigor. The data are scant, but they show the height and vigor that are expected of the species sampled when planted on soils similar to those named in the table.

Hardwood trees reach their maximum height in about 20 years. They may live longer, but they lose vigor. Pines and eastern redcedar reach their maximum height in about 40 years.

TABLE 4.—*Growth and vigor of some trees and shrubs on three windbreak suitability sites*

[Dashes indicate that no measurement was taken]

Trees and shrubs	Deep Loamy Upland (Harney and Holdrege silt loams)				Deep Clayey Upland (Spearville silty clay loams)				Deep Sandy Upland (Pratt loamy fine sands)			
	Average height	Average age	Relative vigor	Samples	Average height	Average age	Relative vigor	Samples	Average height	Average age	Relative vigor	Samples
	Feet	*Years*		*Number*	*Feet*	*Years*		*Number*	*Feet*	*Years*		*Number*
American plum	------	------	------	------	------	------	------	------	7	20	Fair	1
Blacklocust	16	18	Poor	2	19	11	Fair	1	17	19	Fair	2
Black walnut	------	------	------	------	------	------	------	------	12	21	Poor	1
Boxelder	------	------	------	------	------	------	------	------	9	21	Poor	1
Chokecherry	4	18	Good	1	------	------	------	------	------	------	------	------
Cottonwood	------	------	------	------	------	------	------	------	23	21	Poor	2
Eastern redcedar	11	11	Excellent	6	13	17	Good	4	17	20	Excellent	9
Green ash	------	------	------	------	------	------	------	------	14	21	Fair	3
Honeylocust	20	15	Good	3	13	13	Good	5	20	20	Fair	7
Kentucky coffeetree	------	------	------	------	------	------	------	------	5	20	Poor	1
Osage-orange	------	------	------	------	------	------	------	------	19	21	Good	5
Ponderosa pine	4	6	Excellent	1	------	------	------	------	------	------	------	------
Russian mulberry	15	18	Good	1	10	22	Fair	1	16	19	Fair	3
Russian-olive	9	9	Fair	3	------	------	------	------	------	------	------	------
Siberian elm	25	9	Excellent	3	14	9	Poor	2	25	20	Fair	3
Sumac	------	------	------	------	------	------	------	------	6	18	Excellent	1
Tamarisk	------	------	------	------	8	9	Excellent	1	------	------	------	------

Wildlife Management[4]

The kind and amount of wildlife that can be produced and maintained in the county are largely determined by the kind and amount of vegetation the soils can produce, and by the manner in which this vegetation is distributed. Wildlife is influenced by topography, and by such soil characteristics as fertility. Fertile soils are capable of greater wildlife production than less fertile soils, and waters that drain from fertile soils generally will produce more fish than waters that drain from infertile soils.

Topography affects wildlife through its influence on land use. Rough, irregular areas may present hazards to livestock, and the undisturbed vegetation in many such areas is valuable to wildlife. If suitable vegetation is lacking in such areas, it often can be developed to improve conditions for desirable species of birds and animals.

Wetness and the water-holding capacity of the soils are important in selecting sites for constructing ponds for fish and in developing and maintaining habitats for waterfowl. Rough areas are difficult to fence or farm, and some cannot be grazed by livestock. The areas where vegetation is undisturbed are valuable to wildlife.

Factors of the kind mentioned in the foregoing paragraphs were considered in preparing table 5, which shows the potential of the soil associations in the county for producing habitats for the more important species of wildlife. The column titled "Food" shows, by means of ratings, the capacity of the soil association to provide the kinds of food plants needed by the kind of wildlife specified. More detailed information about the soil associations is given in the section "General Soil Map."

The ring-necked pheasant is probably the most important game bird in the county. Bobwhite quail inhabit the areas along streams, where the habitat is suitable. Deer have been seen in the valley of the Arkansas River west of Dodge City. Beaver are common along the Arkansas River.

Mourning doves are an important migrant species in the county. Other important migrant species include a number of different kinds of waterfowl. The Arkansas River and other streams, and natural and manmade ponds and lakes are used primarily during semiannual migrations.

Channel catfish are probably the most important species of game fish in the Arkansas River. A number of different species of other fish are also in that river and in other streams. The ponds and lakes are suitable for stocking largemouthed black bass, bluegill, and channel catfish.

The wildlife resources of Ford County are important primarily for the opportunities for recreation they provide. Hunting and fishing are the most common forms of recreation provided by wildlife. Wildlife also contribute

[4] By CHARLES V. BOHART, biologist, Soil Conservation Service.

TABLE 5.—*Potential of soil associations for producing habitats for the more important kinds of wildlife*

Soil association	Wildlife	Potential for producing, for species of wildlife named—			
		Woody cover	Herbaceous cover	Aquatic environment	Food
Harney-Spearville-Ulysses and Holdrege	Pheasant	Fair	Good		Good.
	Waterfowl			Fair	Fair.
	Cottontail rabbit	Fair	Good		Fair.
	Dove	Fair	Good		Good.
Ulysses-Mansic-Mansker	Fish			Good	
	Deer	Fair	Good		Fair.
	Pheasant	Fair	Good		Fair.
	Cottontail rabbit	Fair	Good		Fair.
	Dove	Fair	Good		Fair.
Dale-Leshara-Las Animas	Squirrel	Good			Fair.
	Quail	Good	Very good		Good.
	Fur bearers	Good	Good	Good	Good.
	Cottontail rabbit	Good	Very good		Good.
	Deer	Good	Very good		Good.
	Waterfowl			Fair	
	Fish			Fair	
	Dove	Good	Very good		Good.
	Pheasant	Fair	Very good		Fair.
Pratt-Tivoli-Ortello and Tivoli	Prairie chicken	Fair	Very good		Fair.
	Dove	Fair	Good		Fair.
	Deer	Fair	Good		Fair.
Ortello-Dalhart-Lubbock-Carwile	Pheasant	Good	Very good		Very good.
	Cottontail rabbit	Good	Good		Good.
	Dove	Good	Good		Good.

to the enjoyment of other forms of outdoor recreation, such as picnicking, camping, hiking, and outdoor photography. Many species of wildlife also help in the control of undesirable insects and rodents. Most hawks are especially valuable in that respect.

Some areas are expecially suitable for developing facilities for outdoor recreation, as picnicking and camping. Wooded areas along streams near heavily traveled highways can often be developed for camping. Such areas provide a real convenience to travelers and an additional source of income to landowners. Areas suitable for farm fish ponds can also be used for camping. Fishing and boating are added attractions.

Farm ponds provide a habitat for some species of wildlife, and the area around the pond can be developed so that it will provide woody and herbaceous cover. If the pond is properly designed and is stocked and well managed, sustained yields of fish can be produced.

Use of the soils for agriculture, as determined by the soils and climate, has many effects on wildlife resources. Where grassland is converted to cropland, some kinds of wildlife lose their protective cover. In turn, an improved supply of food is made available for ring-necked pheasant and some other kinds of wildlife.

Proper grazing on soils that are best suited to pasture and range produces the greatest amount of beef per acre and permits good use of these soils for wildlife. Trees and shrubs planted for field windbreaks and for farmstead windbreaks provide habitats for many kinds of wildlife.

Developing a specific habitat for wildlife requires that the kind of vegetation the soils will produce be located and distributed properly. Technical assistance in planning wildlife developments and in determining which species of vegetation to plant can be obtained at the district office of the Soil Conservation Service. Additional information and assistance can be obtained from the Extension Service and from the Kansas Forestry, Fish and Game Commission, Bureau of Sports, Fisheries, and Wildlife. The Soil Conservation Service also provides technical assistance in planning developments for outdoor recreation.

Engineering Interpretations of the Soils[5]

In this section the outstanding engineering properties of the soils are given, particularly in relation to highway construction and agricultural engineering. A brief description of the engineering soil classification systems, and definitions of engineering terms used in the tables, are also given.

Soil properties frequently influence design, construction, and maintenance of engineering structures. The properties most important to engineers are permeability to water, shear strength, compaction characteristics, soil drainage, shrink-swell characteristics, texture, plasticity, and reaction. However, depth to bedrock, depth to the water table, and the topography are also important.

[5] FRED MEYER, JR., civil engineer, Soil Conservation Service, assisted in the preparation of this section.

The information in this report can be used to—

1. Make soil and land use studies that will aid in selecting and developing industrial, business, residential, and recreational sites.
2. Make preliminary estimates of the engineering properties of soils that will help in planning agricultural drainage systems, farm ponds, terraces, waterways, dikes, diversion terraces, irrigation canals, and irrigation systems.
3. Make preliminary evaluations of soil and ground conditions that will aid in selecting locations for highways and airports and in planning detailed investigations of the selected locations.
4. Locate probable sources of gravel, sand, and other construction materials.
5. Correlate performance of engineering structures with soil mapping units and thus develop information that will be useful in maintaining the structures. The information may also prove useful as a guide in future planning.
6. Determine the suitability of the soils for cross-country movement of vehicles and construction equipment.
7. Supplement information obtained from other published maps, reports, and aerial photographs for the purpose of making maps and reports that will be more useful to engineers.
8. Develop other preliminary estimates for construction purposes pertinent to the particular area.

This report will not eliminate the need for, or take the place of, on-site sampling and testing of soils for design and construction of specific engineering works. It may be useful in planning more detailed field surveys to determine the in-place condition of the soil at the site of the proposed construction.

Some terms used in soil science may have a different meaning than that used in engineering. Many of these terms are defined in the Glossary. Some of the terms used by engineers are defined in this section.

Engineering classification systems

Agricultural scientists of the U.S. Department of Agriculture (USDA) classify soils according to texture. Their system is the textural classification used by the Soil Conservation Service in soil surveys. In some ways this system of naming textural classes is comparable to the two systems used by engineers for classifying soils; that is, the system of the American Association of State Highway Officials (AASHO) and the Unified system. Following is a description of the classification systems used by engineers.

AASHO Classification System.—The AASHO system of classifying soils is based on field performance of highways (*2*, *11*). It is most widely used in highway construction. In this system, soil materials are classified in seven groups according to general load-carrying capacity and service. These groups range from A–1 for the best soils for road subgrade to A–7 for the poorest. These basic groups have been divided into subgroups; for example, A–2–4, with a group index number that approximates within-group evaluations, for example, A–2–4(0).

Group indexes range from 0 for the best soils for subgrade to 20 for the poorest. For the soils tested, the group index is shown in parentheses in the next to last column of table 9, following the soil group or subgroup symbol. Only the group and subgroup classifications are estimated in table 7 for the soils in this county.

The basic groups make up two major groups: (1) *Granular materials* (35 percent or less passing a No. 200 sieve) and (2) *silt-clay materials* (more than 35 percent passing a No. 200 sieve).

A–1, A–2, and A–3 soils are classified as granular materials.

A–1 soils generally consist of a mixture of coarse to fine, well-graded sands and gravels that are nonplastic or weakly plastic. In well-graded material there are no sizes lacking and no excess material in any size range. A–1–b soils are dominantly coarse sand.

A–2 soils consist of a wide range of granular materials that cannot be classified as A–1 or A–3, because of the content of fines, the plasticity, or both. A–2–4 soils are made up of these granular materials that have plasticity characteristics of the A–4 group.

A–3 soils consist primarily of fine sands and are deficient in material passing the No. 200 sieve.

A–4, A–6, and A–7 soils are classified as silt-clay materials.

A–4 soils are composed predominantly of silt. They contain only a moderate to small amount of coarse material and only a small amount of sticky colloidal clay.

A–6 soils are composed mainly of clay and contain only a moderate to negligible amount of coarse material.

A–7 soils are also composed mainly of clay, but they are elastic because the particles of silt are all of one size, or the soils contain a large amount of organic matter, mica flakes, or lime carbonate. Soils of the A–7–6 group have a high plasticity index in relation to liquid limit.

Unified Classification System.—Some engineers prefer to use the Unified soil classification system (*19*), which was adopted jointly by the Bureau of Reclamation and the Corps of Engineers (*17*). In this system soil material is divided into 15 classes. Eight classes (GW, GP, GM, GC, SW, SP, SM, and SC) are for coarse-grained material, six classes (ML, CL, OL, MH, CH, and OH) are for fine-grained material, and one class (Pt) is for highly organic material. Mechanical analyses are used to determine the GW, GP, SW, and SP classes of material. Mechanical analyses and data that show the liquid limit and plasticity index are used to determine the GM, GC, SM, and SC classes and the ML, CL, OL, MH, CH, and OH classes applicable to fine-grained soils. The soils of Ford County have been classified only in the SP, SM, ML, CL, and CH classes.

The following gives a brief definition of the major divisions and the soil group symbols of the Unified classification system used in this survey:

Coarse-grained soils (more than half of the material is retained on a No. 200 sieve):
- *Sands* (more than half of the coarse fraction passes a No. 4 sieve):
  - *Clean sands* (little or no fines):
    - SP Poorly graded sands, gravelly sands.
  - *Sands with fines* (appreciable amount of fines):
    - SM Silty sands, sand-silt mixtures.

Fine-grained soils (more than half of material passes a No. 200 sieve):
- *Silts and clays* (liquid limit less than 50):
  - ML Inorganic silts and very fine sands, rock flour, silty or clayey fine sands and clayey silts than have slight plasticity.
  - CL Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, and lean clays.
- *Silts and clays* (liquid limit greater than 50):
  - CH Inorganic clays of high plasticity, and fat clays.

Soil properties significant to engineering

Two tables are given in this section. In the first (table 6) the soils are briefly described and their physical properties important to engineering are estimated. In the second (table 7) some engineering interpretations are given.

The estimated physical properties described in table 6 are for a typical profile, generally of each soil series. They are based on the results of laboratory tests of soils from Ford, Logan, and Morton Counties, on tests made by the State Highway Commission of Kansas at construction sites, on experience with the same kinds of soils in other counties, and on information in other parts of this report.

The estimated physical properties are those of the average soil profile; hence, some variation from these values should be anticipated.

In the column that gives a description of the soil and site, the significant layers in each kind of soil are described. A more complete description of a profile that is typical for each series is given in the section "Formation, Classification, and Morphology of Soils." For some soils, depth to the water table is given in table 6. Additional information about the water resources and depth to the water table is given in the sections "Natural Resources" and "General Management of Irrigated Soils." Briefly, depth to the water table in the sandy areas of the upland ranges from 25 to about 70 feet; in the areas of the upland that are not sandy, it ranges from 25 to about 200 feet; in the High Plains, it ranges from 50 to 200 feet. Depth to the water table and the amount of water in an area vary as a result of differences in the geologic formations and in the position of the soils. Throughout the valley of the Arkansas River, there is a fluctuating water table near the surface.

The column that shows depth from surface gives the approximate depth of the bedrock or other underlying material, but it does not indicate the kind of underlying material. The only kinds of rock within 10 feet of the surface are local outcrops of caliche sand and gravel of the Ogallala formation and outcrops of rock of the Cretaceous period. About 90 percent of the acreage where outcrops occur is within areas of Potter soils and the Mansker-Potter complex, mainly along Sawlog, Duck, and Elm Creeks. The rest of this acreage is in the Mansic-Hobbs complex and in areas of Mansker clay loam, 0 to 3 percent slopes, mainly along drainages of Mulberry Creek and the Arkansas River. Additional

TABLE 6—*Brief descriptions and*

Map symbol	Soil	Description of soil and site	Depth from surface
			Inches
Ad	Active dunes.	Loose, unstable, deep fine sand on steep dunes; no definite profile.	0–60+
An	Alluvial land.	Deep, stratified loamy soil of the upland; cut by meandering stream channels; subject to flooding and deposition.	([1])
As	Alluvial land and slickspots.	Nearly level, stratified, saline-alkali alluvium; the surface layer is about 4 to 10 inches of clay loam and sandy loam over a subsoil of clay loam that extends to a depth of about 50 inches; underlain by sand; the layers of clay loam are high in exchangeable sodium; has a fluctuating water table and is subject to flooding.	([1])
Bc	Bippus clay loam, 2 to 5 percent slopes.	About 4 to 10 feet of calcareous, stratified clay loam on gently sloping and sloping fans and colluvial slopes.	0–60+
Br	Broken alluvial land.	Steep streambanks of silt loam, loam, and clay loam that are frequently flooded; subject to channel cutting, scouring, and deposition.	([1])
Ca	Canadian fine sandy loam.	Nearly level soil formed in alluvium; consists of about 2 to 3 feet of fine sandy loam over about 2 feet of loamy fine sand; locally there are layers of clay loam in the subsoil and substratum; this soil is seldom flooded; depth to the water table ranges from 7 to 15 feet.	0–38 38–50 50–60+
Da	Dale silt loam.	Nearly level, well-drained soil formed in alluvium; it consists of about 2 feet of silt loam over 2 feet of silty clay loam; the substratum is generally clay loam, but in local areas it is sand or clay; this soil is seldom flooded; depth to the water table ranges from more than 10 to less than 30 feet.	0–24 24–52 52–60+
Dh	Dale and Humbarger clay loams.	Nearly level, deep, well-drained soils formed in alluvium; the surface layer and the subsoil are clay loam or silty clay loam; the substratum is generally clay loam, but in local areas it is sand or clay; these soils are seldom flooded; depth to the water table ranges from 10 to 15 feet. The estimated physical properties are the same for both soils.	0–60
Dl	Dalhart-Lubbock complex.	Nearly level and gently undulating soils of the upland; the complex is about 70 percent Dalhart soils and 30 percent Lubbock and Randall soils. The Dalhart soils have a surface layer of fine sandy loam that is about 7 inches thick over a subsoil that extends to a depth of about 2 feet; the substratum is clay loam. The Lubbock soils are deep clay loams. For estimated physical properties of the Randall soils, see Randall clay.	Dalhart soils: 0–7 7–23 23–70 Lubbock soils: 0–60
Ha Hb	Harney silt loam, 0 to 1 percent slopes. Harney silt loam, 1 to 3 percent slopes.	Deep, well-drained soils of the upland; they consist of about 4 to 10 inches of silt loam over about 8 to 15 inches of silty clay loam; below is about 10 to 20 inches of silty clay underlain by a substratum of clay loam and loam that extends to a depth of 5 to 12 feet.	0–8 8–18 18–30 30–50
Hd	Holdrege fine sandy loam, 1 to 3 percent slopes.	Deep, well-drained soil of the upland; it consists of 7 to 15 inches of fine sandy loam over a subsoil that is about 10 to 20 inches of loam, silt loam, and fine sandy loam; underlain by loamy loess that extends to a depth of 6 to 15 feet.	0–10 10–18 18–60
Hg Ho Hs	Holdrege loam, 0 to 1 percent slopes. Holdrege silt loam, 0 to 1 percent slopes. Holdrege silt loam, 1 to 3 percent slopes.	Deep, well-drained soils of the upland; they consist of about 6 to 12 inches of silt loam over a subsoil of silty clay loam that extends to a depth of about 36 inches; underlain by silt loam loess that extends to a depth of 6 to 15 feet.	0–12 12–36 36–72+
La	Las Animas sandy loam.	Nearly level, stratified soil formed in alluvium of sandy loam; it consists of about 36 inches of sandy loam underlain by fine sand and gravel; the soil is somewhat poorly drained, and there is a fluctuating water table near the surface; subject to flooding.	0–36 36–60+

See footnotes at end of table.

estimated physical properties of the soils

Classification			Percentage passing sieve—			Permeability	Available water capacity	Salinity	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				
						Inches per hour	*Inches per inch of soil*		
Fine sand	SP–SM	A–2 or A–3	100	100	5–20	2.0–5.0	0.05	None	Low.
([1])	([1])	([1])	([1])	([1])	([1])	([1])	([1])	None	([1]).
([1])	([1])	([1])	([1])	([1])	([1])	([1])	([1])	([1])	([1]).
Clay loam	CL	A–6	100	100	85–95	0.2–0.5	.19	None	Moderate.
([1])	([1])	([1])	([1])	([1])	([1])	([1])	([1])	None	([1]).
Fine sandy loam	SM	A–2 or A–4	100	100	30–50	0.5–1.0	.15	None	Low.
Loamy fine sand	SM	A–2 or A–4	100	100	20–40	1.0–2.0	.10	None	Low.
Fine sand	SP	A–3	100	95–100	5–10	5.0+	.05	None	Low.
Silt loam	ML–CL	A–4	100	100	85–100	0.2–0.5	.18	None	Low to moderate.
Silty clay loam	CL	A–7	100	100	85–100	0.2–0.5	.19	None	High.
Clay loam	CL	A–7	100	100	85–100	0.2–0.5	.19	None	High.
Clay loam	CL	A–7	100	100	85–100	0.2–0.5	.19	None	High.
Fine sandy loam	SM	A–2 or A–4	100	100	30–50	0.5–1.0	.15	None	Low.
Sandy clay loam	CL	A–6	100	100	85–100	0.2–0.5	.18	None	Moderate.
Clay loam	CL	A–6	100	100	85–100	0.2–0.5	.18	None	Moderate.
Clay loam	CL	A–7	100	100	85–100	0.2–0.5	.19	None	High.
Silt loam	ML–CL	A–4	100	100	95–100	0.2–0.5	.18	None	Low to moderate.
Silty clay loam	CL	A–7	100	100	95–100	0.2–0.5	.19	None	High.
Silty clay	CL or CH	A–6	100	100	95–100	0.2–0.5	.20	None	Moderate.
Silty clay loam	CL	A–6	100	100	95–100	0.2–0.5	.19	None	Moderate.
Fine sandy loam	SM	A–2 or A–4	100	100	30–50	0.5–1.0	.15	None	Low.
Silt loam	ML	A–4	100	100	95–100	0.2–0.5	.18	None	Low.
Silt loam	ML	A–4	100	100	95–100	0.2–0.5	.18	None	Low.
Silt loam	ML–CL	A–4	100	100	95–100	0.2–0.5	.18	None	Low.
Silty clay loam	CL	A–7	100	100	95–100	0.2–0.5	.18	None	High.
Silt loam	CL	A–6	100	100	95–100	0.2–0.5	.18	None	Moderate.
Sandy loam	SM	A–2 or A–4	95–100	95–100	30–50	0.5–1.0	.15	Slight to moderate.	Low.
Fine sand and gravel.	SP–SM	A–3	100	95–100	5–10	5.0+	.05	Slight to moderate.	Low.

TABLE 6.—*Brief descriptions and estimated*

Map symbol	Soil	Description of soil and site	Depth from surface
			Inches
Lc	Las Animas-Lincoln complex.	Consists of about 50 percent Las Animas soils and 50 percent Lincoln soils. For estimated physical properties of the Las Animas soils, see Las Animas sandy loam; for those of the Lincoln soils, see Lincoln soils.	------------
Ln	Las Animas-Tivoli complex.	Consists of about 50 percent Las Animas soils and 50 percent Tivoli soils. For estimated physical properties of the Las Animas soils, see Las Animas sandy loam; for those of the Tivoli soils, see Tivoli fine sand.	------------
Ls	Leshara clay loam.	Nearly level, stratified clay loam alluvium that is about 40 inches thick over fine sand and gravel; the water table is near the surface; subject to flooding.	0–40 40–60+
Lt	Leshara clay loam, moderately deep.	Nearly level, stratified clay loam alluvium that is about 20 inches thick over fine sand and gravel; the water table is near the surface; subject to flooding.	0–20 20–60+
Lu	Lincoln soils.	Nearly level, stratified soils formed in alluvium; the surface layer is mixed loamy sand, fine sand, and fine sandy loam to a depth of about 15 inches; it is underlain by fine sand and gravel to a depth of about 6 feet; subject to damaging floods; has a fluctuating water table near the surface.	0–15 15–72
Ma Mb Mc Md	Mansic clay loam, 0 to 1 percent slopes. Mansic clay loam, 1 to 3 percent slopes. Mansic clay loam, 1 to 3 percent slopes, eroded. Mansic clay loam, 3 to 6 percent slopes.	Deep, well-drained, calcareous soils of the upland; the soils are clay loam to a depth of 6 feet or more; developed from old clay loam alluvium.	0–74+
Mf	Mansic and Mansker soils, 3 to 6 percent slopes, eroded.	Consists of about 85 percent Mansic soils and 15 percent Mansker soils that occur in scattered spots. For estimated physical properties of the Mansic soils, see the Mansic clay loams; for those of the Mansker soils, see Mansker clay loam, 0 to 3 percent slopes.	------------
Mh	Mansic-Hobbs complex.	Strongly sloping Mansic clay loams of the upland and nearly level loamy Hobbs soils of the bottom land; Mansic soils make up about 60 to 80 percent of the complex, and Hobbs soils, about 20 to 40 percent. The estimated properties given in the column to the right are those of Hobbs soils. The Hobbs soils consist of 4 to 10 feet of deep, well-drained, stratified alluvium of silt loam, loam, and silty clay loam; the areas are cut by narrow, deep, meandering stream channels and are frequently flooded; scouring and deposition are common. For estimated physical properties of the Mansic soils, see the Mansic clay loams.	0–60+
Mn	Mansker clay loam, 0 to 3 percent slopes.	About 18 to 26 inches of moderately deep, highly calcareous clay loam of the upland over fragmental clay loam caliche that is more than 3 feet thick and makes up from 10 to 50 percent of the soil mass, by volume.	0–24 24–60
Mp	Mansker-Potter complex.	Consists of about 70 percent Mansker soils and about 30 percent Potter soils. For estimated physical properties of the Mansker soils, see Mansker clay loam, 0 to 3 percent slopes. For estimated physical properties of the Potter soils, see Potter soils.	------------
Of Or	Ortello fine sandy loam, level. Ortello fine sandy loam, undulating.	Deep, well-drained soils of the upland; they consist of about 4 to 6 feet of fine sandy loam underlain by a substratum of clay loam and silty clay loam.	0–60 60–70+

See footnotes at end of table.

physical properties of the soils—Continued

Classification			Percentage passing sieve—			Permeability	Available water capacity	Salinity	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				
						Inches per hour	*Inches per inch of soil*		
Clay loam	CL	A-7	100	100	80-95	0. 2-0. 5	0. 19	Slight to moderate.	High.
Fine sand and gravel	SP-SM	A-3	100	95-100	5-10	5. 0+	. 05	Slight to moderate.	Low.
Clay loam	CL	A-7	100	100	80-95	0. 2-0. 5	. 19	Slight to moderate.	High.
Fine sand and gravel.	SP-SM	A-3	100	95-100	5-10	5. 0+	. 05	Slight to moderate.	Low.
(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1).
Fine sand and gravel.	SP-SM	A-3	100	95-100	5-10	5. 0+	. 05	Moderate	Low.
Clay loam	CL	A-6	100	100	85-95	0. 2-0. 5	. 19	None	Moderate.
Silt loam	ML-CL	A-4	100	100	90-100	0. 2-0. 5	. 18	None	Low to moderate.
Clay loam	CL	A-6	95-100	85-95	50-70	0. 2-0. 5	. 18	None	Moderate.
Clay loam (caliche).	SC or CL	A-6	95-100	85-95	40-60	0. 2-0. 5	. 10	None	Moderate.
Fine sandy loam	SM	A-2-4	100	100	20-30	0.5-1.0	.15	None	Low.
Clay loam	CL	A-6	100	100	55-75	0.2-0.5	.19	None	Moderate.

TABLE 6.—*Brief descriptions and estimated*

Map symbol	Soil	Description of soil and site	Depth from surface
			Inches
Os	Ortello-Carwile complex.	Well-drained fine sandy loams and somewhat poorly drained soils that occur together on an undulating landscape; Ortello fine sandy loams make up about 45 percent of the complex; Carwile fine sandy loams, about 15 percent; and Randall clay, in depressions, and soils that are transitional from one series to another, about 40 percent. The estimated physical properties given in the columns to the right are those of the Carwile soils. The Carwile soils are deep, nearly level, and somewhat poorly drained; they are on the upland and consist of about 2 feet of sandy loam over stratified, clayey, old alluvium that extends to a depth of 5 feet or more. For estimated physical properties of the Ortello soils, see the Ortello fine sandy loams.	0–11 11–30 30–60+
Ot	Otero fine sandy loam, hummocky.	Deep, hummocky, calcareous soils of the upland; consists of about 12 inches of fine sandy loam over 24 inches of loamy fine sand; underlain by highly variable strata, ranging from fine sand to clay, and local, interbedded caliche.	0–12 12–36 36–60 60+
Po	Potter soils.	Soils consisting of only about 3 to 12 inches of cobbly clay loam over hard caliche; the soils are on steep, rough, broken slopes; included in the areas are outcrops of caliche, limestone, and shale.	0–5 5–12
Pr	Pratt loamy fine sand, hummocky.	About 4 to 6 feet of loamy fine sand on a hummocky landscape---	0–54+
Pt	Pratt-Tivoli loamy fine sands.	Deep, rapidly permeable, hummocky soils of the upland; about 60 percent of the complex is Pratt loamy fine sand, and 40 percent is Tivoli loamy fine sand. The estimated physical properties given in the columns to the right are those of the Tivoli soils. The Tivoli soil is a deep, rapidly permeable, hummocky soil of the upland; it consists of about 9 to 15 inches of loamy fine sand over sand that extends to a depth of about 4 to 10 feet. For estimated physical properties of the Pratt soil, see Pratt loamy fine sand, hummocky.	0–14 14–60+
Ra	Randall clay.	Clay to a depth of 5 feet or more; poorly drained; very slowly permeable; in frequently ponded depressions.	0–60+
Sb	Sandy broken land.	Steep sandy and loamy soils of the upland; the areas are cut by a meandering stream channel; subject to flooding and deposition.	(1)
Sp	Spearville silty clay loam, 0 to 1 percent slopes.	Deep soil of the upland; consists of about 3 to 7 inches of silty clay loam over silty clay that extends to a depth of about 24 inches; underlain by silty clay loam, clay loam, and loam to a depth of 5 feet or more; developed over calcareous loamy loess that ranges from about 7 to 30 feet in thickness.	0–7 7–24 24–60+
Sr	Spearville complex, 1 to 3 percent slopes, eroded.	Consists of about 80 percent Spearville silty clay loam and 20 percent pale-brown, eroded, calcareous heavy clay loam. For estimated physical properties of the Spearville soils, see Spearville silty clay loam, 0 to 1 percent slopes.	0–16 16–60+
Tv	Tivoli fine sand.	Hummocky fine sand of the upland; the fine sand extends to a depth of 6 feet or more.	0–60+
Ua Ub	Ulysses silt loam, 1 to 3 percent slopes. Ulysses silt loam, 3 to 6 percent slopes.	Deep, well-drained, calcareous soils of the upland; they consist of about 5 to 25 inches of silt loam underlain by loamy loess to a depth of 5 feet or more.	0–9 9–38 38–71
Uc	Ulysses-Colby complex, 3 to 6 percent slopes, eroded.	Consists of 60 percent Ulysses silt loam and 40 percent Colby silt loam. The estimated physical properties given in the columns to the right are those of the Colby soil. The Colby soil is deep and calcareous, and it occurs on the upland; it consists of about 38 inches of silt loam over loamy loess that extends to a depth of 5 feet or more. For estimated physical properties of the Ulysses soil, see the Ulysses soils.	0–38 38–66+

See footnotes at end of table.

physical properties of the soils—Continued

Classification			Percentage passing sieve—			Perme-ability	Avail-able water capacity	Salinity	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				
						Inches per hour	*Inches per inch of soil*		
Sandy loam	SM	A-2	100	100	20-30	0.5-1.0	0.15	None	Low.
Sandy clay loam	CL	A-7	100	100	60-80	0.2-0.5	.18	None	High.
Clay	CH	A-7	100	100	85-95	0.05-0.2	.21	None	High.
Fine sandy loam	SM	A-2 or A-4	100	100	30-50	0.5-1.0	.15	None	Low.
Loamy fine sand	SM	A-2 or A-4	100	100	20-40	1.0-2.0	.10	None	Low.
Clay loam	CL	A-6	100	100	80-90	0.2-0.5	.18	None	Moderate.
Fine sand	SP or SM	A-1, A-2, or A-3.	95-100	85-95	5-20	2.0-5.0	.05	None	Low.
Clay loam	CL	A-4	95-100	95-100	50-70	0.5-1.0	.18	None	Low.
Clay loam (caliche).	SC or CL	A-4	90-100	85-95	40-60	0.2-0.5	.15	None	Low.
Loamy fine sand	SM	A-2 or A-4	100	100	20-40	1.0-2.0	.10	None	Low.
Loamy fine sand	SM	A-2 or A-4	100	100	20-40	1.0-2.0	.10	None	Low.
Fine sand	SP-SM	A-1, A-2, or A-3.	95-100	85-95	5-20	2.0-5.0	.05	None	Low.
Clay	CH	A-7	100	100	90-100	[2]	.21	None	High.
[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	----------	
Silty clay loam	CL	A-6	100	100	95-100	0. 2-0. 5	. 19	None	Moderate.
Silty clay	CH	A-7	100	100	95-100	0. 05-0. 2	. 21	None	High.
Silty clay loam	CL	A-7	100	100	95-100	0. 2-0. 5	. 19	None	High.
Clay loam	CH	A-7	100	100	95-100	0. 05-0. 2	. 21	None	High.
Silty clay loam	CL	A-7	100	100	95-100	0. 2-0. 5	. 19	None	Moderate.
Fine sand	SP-SM	A-2 or A-3	95-100	85-95	0-10	2. 0-5. 0	. 05	None	Low.
Silt loam	CL	A-6	100	100	75-95	0. 2-0. 5	. 18	None	Moderate.
Silty clay loam	CL	A-6	100	100	75-95	0. 2-0. 5	. 19	None	Moderate.
Clay loam	CL	A-6	100	100	80-100	0. 2-0. 5	. 19	None	Moderate.
Silt loam	ML	A-4	100	100	75-95	0. 2-0. 5	. 18	None	Low.
Clay loam	CL	A-6	100	100	80-100	0. 2-0. 5	. 19	None	Moderate.

TABLE 6.—*Brief descriptions and estimated*

Map symbol	Soil	Description of soil and site	Depth from surface
			Inches
Uh Un	Ulysses-Harney silt loams, 1 to 3 percent slopes. Ulysses-Harney complex, 1 to 3 percent slopes, eroded.	Deep, well-drained soils; the Ulysses soil makes up about 60 percent of these complexes and the Harney soil about 40 percent. For estimated physical properties of the Ulysses soils, see the Ulysses soils. For estimated physical properties of the Harney soils, see the Harney soils.	------------
Up	Ulysses-Hobbs complex	Sloping silt loams of the upland and nearly level, narrow loamy soils of the bottom land; the Ulysses soil, on side slopes, makes up about 70 to 80 percent of the complex; the Hobbs soil makes up about 20 to 30 percent. For estimated physical properties of the Ulysses soil, see the Ulysses soils. For estimated physical properties of the Hobbs soil, see the Mansic-Hobbs complex.	------------

[1] Classification and properties not estimated, because of the variable characteristics of this mapping unit.

information about the kinds of bedrock and the kinds of rock outcrops in the county is given with other facts about parent material in the section "Formation, Classification, and Morphology of Soils."

Table 6 gives the textural classes of the U.S. Department of Agriculture. It also gives estimated classifications according to the Unified and AASHO systems.

The columns that show the amount of material passing sieves of various sizes show the percentages of soil material that is smaller in diameter than the openings in a given screen. The results of the grain-size analyses are based on tests made by a combination of the sieve and hydrometer methods.

The column that shows permeability gives the estimated rate, expressed in inches per hour, at which water moves through a soil that is not compacted.

In the column that shows available water capacity are estimates, in inches per inch of soil, of the capillary water in the soil when it is wet to field capacity. When the soil is air dry, this amount of water will wet the soil material to a depth of 1 inch without deeper percolation.

The column headed salinity refers to the amount of harmful salts in the soil. These salts are so distributed in the profile that the growth of most crop plants is less than normal. Estimates of salinity are based on the electrical conductivity of the saturated soil extract and are expressed in millimhos per centimeter at 25° C. The following defines the relative terms used in table 6 for each arbitrarily selected range of conductivity: None—less than 2 millimhos per centimeter, the effects of salinity are negligible; slight—2 to 4 millimhos per centimeter, yields of very sensitive crops may be restricted; and moderate—4 to 8 millimhos per centimeter, yields of many crops are restricted.

Salinity tests have been run on only a few of the soils in this county. These tests and tests on those soils in adjoining counties indicate that all the soils in the valley of the Arkansas River, for example, the Las Animas, Leshara, and Lincoln, have slight to moderate salinity. The subsoil and substratum of Alluvial land and slickspots contain salts or alkali. Saline-alkali soils are those that contain more than 15 percent exchangeable sodium. The electrical conductivity of the saturation extract of such soils is greater than 4 millimhos per centimeter.

The column that shows shrink-swell potential indicates the volume change in a soil when the content of water changes. It gives estimates of how much a soil shrinks and swells under extremes of dryness and wetness. Examples of soils that have high shrink-swell potential are those of the Randall and Spearville series. The Randall soils shrink greatly when they are dry and swell when they are wet. The Tivoli soils are examples of soils that have low to very low shrink-swell potential. A knowledge of this potential is important in planning the use of a soil for building roads and other engineering structures.

Estimates of shrink-swell are applicable only to plastic material and are based on the liquid limit of the soil. The shrink-swell potential of the soils of the county is indicated by the relative terms "low," "moderate," and "high." The soils that have a liquid limit of 25 or less are given a rating of "low;" those that have a liquid limit of 25 to 40 are given a rating of "moderate;" and those that have a liquid limit of 40 to 60 are given a rating of "high."

The reaction of the soil of this county is not given in table 6, but the reaction of most of the soils is neutral to moderately alkaline. The Tivoli soils, Active dunes, and Alluvial land and slickspots are the only exceptions. The Tivoli soils and Active dunes have a slightly acid surface layer but have slightly alkaline material below the surface layer. Slickspots, in the mapping unit Alluvial land and slickspots, are strongly alkaline at a depth of about 10 to 30 inches. The relative terms used to describe reaction, that is, the degree of acidity or alkalinity of a soil, are defined in the Glossary.

Dispersion is not a problem on most of the soils in Ford County, and it is not shown in table 6. The only material that shows any dispersion is that below the surface layer in Alluvial land and slickspots. Dispersion is caused in those places by the high content of exchangeable sodium. No soils were analyzed for dispersion by laboratory procedures for measuring concentrations of suspensions.

physical properties of the soils—Continued

Classification			Percentage passing sieve—			Perme-ability	Avail-able water capacity	Salinity	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				
						Inches per hour	*Inches per inch of soil*		

[2] Less than 0.05.

Only the field observations of the breakdown of soil structure in Alluvial land and slickspots, and the high level of exchangeable sodium, indicate dispersion and the presence of salts and alkali.

The suitability of the soils of this county for various engineering uses is indicated in table 7. In that table are also given soil features that affect the use of the soils for highway construction and for agricultural engineering. Several land types, soil complexes, and undifferentiated units of soils are not listed in table 7, since the materials are variable and each site needs to be examined before engineering work is done.

The suitability of the soils as a source of topsoil is indicated by the terms "good," "fair," or "poor," or if the soils are not suitable, that fact is indicated. This information is important because topsoil is needed for growing vegetation that will control erosion on embankments, on the shoulders of roads, and on cut slopes. The rating gives the estimated suitability of the surface layer as a possible source of topsoil. Whether it is still in place or has been moved, some part of the soil material can be used as topsoil in many areas, as on embankments or cut slopes.

The silty soils on cut slopes can usually be seeded without adding a layer of topsoil. The Tivoli and other sandy soils are not suitable as a source of topsoil. If vegetation is to be grown on cut slopes of the Tivoli and similar soils, a layer of suitable topsoil must be added.

Also in table 7 is shown the suitability of the soils as a source of sand and gravel. Sand and gravel in commercial amounts occur in localized pockets in the Canadian, Leshara, Mansic, Potter, and Pratt soils. The Canadian, Leshara, Las Animas, and Lincoln soils are underlain at a depth below 15 to 50 inches by mixed and stratified sand and gravel. Many pockets of sand and gravel are at or near the surface along the old stream channels that meander throughout the valley of the Arkansas River. They are also along the channels of intermittent streams in the upland. The Tivoli soils are a dependable source of fine (quartz) sand.

The columns that show the suitability of the soils as a source of material for road fill and road subgrade give ratings of the reworked soil material. Potential frost action, shrink-swell potential, and compaction characteristics are among the factors considered in estimating the ratings.

Some soils have impounded surface water, have a fluctuating water table, or are subject to frequent flooding. All are factors that affect the location of highways. Roads across these soils must be constructed on embankment sections, or a good system of underdrains and surface drains must be provided. Examples of soils that are frequently ponded when runoff accumulates are the Randall soils. The Randall soils occur in depressions and have very slow permeability and poor surface drainage. There are also problems in locating highways on the Las Animas, Leshara, and Lincoln soils in the valley of the Arkansas River. These soils have a fluctuating water table near the surface and are subject to frequent flooding. The Hobbs soils of the Mansic-Hobbs complex are also frequently flooded. The Tivoli, Ortello, Otero, Canadian, Carwile, and Pratt soils are subject to severe wind erosion when the plant cover is removed.

Dikes or levees may be constructed on some soils, such as the Las Animas and Leshara. These soils have fair to good compaction characteristics, and they can be used as construction material for dikes or levees. The Lincoln soils have a fluctuating water table near the surface and are pervious. The soil material is variable, however, so that a detailed investigation at the site may be necessary. The Canadian and Dale soils and the soils of the Mansic-Hobbs complex are well drained, have good compaction characteristics, and can be used for construction material.

The Canadian, Dale, Las Animas, Leshara, and Otero soils are generally not used for reservoir areas or embankments. These soils are in valleys or on uplands, and they have undeveloped drainage. They occur where the topography is generally not suitable for farm ponds.

The Bippus, Mansic, and Ulysses soils, and the soils of the Ulysses-Colby and Ulysses-Harney complexes gener-

TABLE 7.—*Interpretation of*

Soil series and map symbol	Suitability as source of—					Soil features affecting—
	Topsoil	Sand	Gravel	Road fill [1]	Road subgrade [1]	Highway location
Bippus (Bc)	Good	Not suitable	Not suitable	Fair	Fair	(2)
Canadian (Ca)	Good	Poor (localized pockets).	Poor (localized pockets).	Good	Good	Highly erodible
Carwile (Os)	Fair	Not suitable	Not suitable	Fair	Surface layer is good; subsoil is poor.	Imperfectly drained.
Colby (Uc)	Good	Not suitable	Not suitable	Fair	Fair to good	(2)
Dale (Da)	Good	Not suitable	Not suitable	Fair	Poor	(2)
Dalhart (Dl)	Fair	Not suitable	Not suitable	Good	Good in uppermost 2 feet; fair in clay loam substratum.	(2)
Harney (Ha, Hb, Uh, Un).	Good	Not suitable	Not suitable	Fair	Poor	(2)
Hobbs (Mh)	Good	Not suitable	Not suitable	Good	Fair	Frequently flooded
Holdrege (Hd, Hg, Ho, Hs).	Good	Not suitable	Not suitable	Good	Fair	(2)
Humbarger (Dh)	Good	Not suitable	Not suitable	Good	Fair	(2)
Las Animas (La)	Fair	Poor to good; shallow water table.	Poor (localized pockets).	Good	Poor to good	Fluctuating water table near the surface; slight flooding hazard.

See footnotes at end of table.

engineering properties of the soils

Soil features affecting—Continued						
Dikes or levees	Farm ponds		Agricultural drainage	Irrigation	Field terraces and diversion terraces	Waterways
	Reservoir area	Embankment				
(3)	Moderately slow permeability.	Impervious when compacted; good core material.	Well drained; moderately slow permeability.	Deep; high water-holding capacity; well drained; slow intake rate.	Deep; moderately slow permeability.	Deep; fertile; highly calcareous in local areas; moderate erodibility.
Well drained	(3)	(3)	Well drained; moderately rapid permeability.	Deep; nearly level; low water-holding capacity; moderate intake rate.	High erodibility; good compaction; impervious when compacted.	High erodibility; fertile.
Imperfectly drained.	Slow permeability; substratum may have high seepage rate.	Imperfect drainage; temporary high water table.	Undulating topography; temporary high water table; slowly permeable subsoil.	Moderate intake rate; slow permeability in subsoil.	(3)	(3).
(3)	Moderate permeability.	Fair to good compaction.	Well drained	Deep; high water-holding capacity; moderate permeability.	Deep; moderate erodibility; good compaction.	Deep; moderate erodibility.
Deep water table; well drained.	(3)	(3)	Well drained; moderate permeability.	Deep; nearly level; high water-holding capacity; slow intake rate.	Low to moderate erodibility.	Deep; fertile; low to moderate erodibility.
(3)	Moderate permeability.	Impervious when compacted.	Well drained	Deep; moderate permeability; high water-holding capacity.	Moderate to high erodibility.	Deep; fertile; moderate to high erodibility.
(3)	Moderately slow permeability.	Impervious when compacted.	Well drained; moderately slow permeability.	Deep; nearly level to gently sloping; high water-holding capacity; moderately slow permeability.	Deep; moderately slow permeability; low to moderate erodibility.	Deep; fertile; low to moderate erodibility.
Deep water table; well drained.	Moderate permeability.	Impervious when compacted.	Well drained; moderate permeability.	Deep; high water-holding capacity; moderate permeability; frequently flooded.	Moderate erodibility.	Deep; fertile; moderate erodibility.
(3)	Moderate permeability.	Impervious when compacted.	Well drained	Deep; nearly level to gently sloping; high water-holding capacity; moderate permeability.	Deep; moderate permeability; moderate erodibility; surface layer is fine sandy loam that has high erodibility.	Deep; moderate erodibility.
Deep water table; well drained.	Moderate erodibility.	Impervious when compacted.	Well drained; moderate permeability.	Deep; high water-holding capacity; moderate permeability.	Low to moderate erodibility.	Deep; fertile; low to moderate erodibility.
Moderately deep; fluctuating water table near the surface; moderate permeability.	(3)	(3)	Fluctuating water table near the surface.	Somewhat poorly drained; fluctuating water table near the surface; moderate permeability; sand pockets.	(3)	(3).

TABLE 7.—*Interpretation of engineering*

Soil series and map symbol	Suitability as source of—					Soil features affecting—
	Topsoil	Sand	Gravel	Road fill [1]	Road subgrade [1]	Highway location
Leshara (Ls, Lt)	Good	Substratum is good.	Poor (localized pockets); substratum is good.	Good below 2 to 4 feet; poor above.	Fair below 2 to 4 feet; poor above.	Fluctuating water table near the surface; moderate stability; slight flooding hazard.
Lincoln (Lu)	Poor	Good.	Poor (localized pockets).	Good	Poor to good	Fluctuating water table near the surface; subject to flooding.
Lubbock (Dl)	Good	Not suitable	Not suitable	Good	Fair	Subsoil has moderate to high shrink-swell potential; sometimes flooded.
Mansic (Ma, Mb, Mc, Md, Mf, Mh).	Good	Poor (localized pockets).	Not suitable	Fair	Fair	(2)
Mansker (Mn, Mp)	Surface layer is fair; substratum is poor.	Poor (localized pockets).	Not suitable	Fair	Poor	Moderately stable; high compressibility; shallow to caliche.
Ortello (Of, Or)	Fair	Not suitable	Not suitable	Good	Good	(2)
Otero (Ot)	Poor	Not suitable	Not suitable	Good	Good	(2)
Potter (Mp, Po)	Not suitable	Poor (localized pockets).	Poor (localized pockets).	Good	Poor [4]	Steep; shallow to caliche; rock outcrops in places.
Pratt (Pr, Pt)	Not suitable	Fair (localized pockets).	Fair (localized pockets).	Good	Good	(2)
Randall (Ra)	Poor	Not suitable	Not suitable	Poor	Poor	Depressions fill with water from runoff.
Spearville (Sp, Sr)	Fair	Not suitable	Not suitable	Fair	Poor	(2)
Tivoli (Pt, Tv)	Not suitable	Good	Poor	Good if confined.	Good if confined.	Easily eroded
Ulysses (Ua, Ub, Uc, Uh, Un).	Good	Not suitable	Not suitable	Fair	Fair to good	(2)

[1] Prepared with the assistance of C. W. HECKATHORN, field soils engineer, and HERBERT E. WORLEY, soils research engineer, Kansas State Highway Commission.

[2] No detrimental features affect highway location.

[3] Practice not applicable to these mapping units.

properties of the soils—Continued

Soil features affecting—Continued						
Dikes or levees	Farm ponds		Agricultural drainage	Irrigation	Field terraces and diversion terraces	Waterways
	Reservoir area	Embankment				
Deep to moderately deep; fluctuating water table near the surface; low to moderate erodibility.	(3)	(3)	Fluctuating water table near the surface.	Somewhat poorly drained; fluctuating water table near the surface.	(3)	(3).
Fluctuating water table near the surface; pervious; rapid permeability.	(3)	(3)	(3)	(3)	(3)	(3).
Well drained; moderate to high plasticity and shrink-swell potential in the subsoil.	Slow permeability.	Impervious when compacted.	Well drained; sometimes inundated.	Deep; slow permeability; high water-holding capacity; sometimes inundated.	Low to moderate erodibility.	Deep; fertile; low to moderate erodibility.
(3)	Moderately slow permeability.	Impervious when compacted.	Well drained	Deep; high water-holding capacity; moderately slow permeability.	Deep, moderately slow permeability; good compaction.	Good fertility; low erodibility.
(3)	(3)	(3)	Well drained	Sloping; moderately shallow over caliche; moderate water-holding capacity; moderately slow permeability.	Moderately shallow; caliche at a depth of 18 to 26 inches.	Moderately shallow; highly calcareous; moderate stability; low erodibility.
(3)	Moderate permeability.	Good when compacted.	Well drained	Moderate to high water-holding capacity; moderate permeability.	(3)	(3).
(3)	(3)	(3)	Well drained	Moderate permeability.	(3)	(3).
(3)	(3)	(3)	(3)	(3)	(3)	(3).
(3)	(3)	(3)	Well drained	Low water-holding capacity; rapid intake rate.	(3)	(3).
(3)	Very slow permeability.	Impervious when compacted.	Poorly drained; water stands in depressions.	(3)	(3)	(3).
(3)	Slow permeability.	Impervious when compacted.	Well drained	Deep; nearly level to gently sloping; high water-holding capacity; slow permeability.	Deep; slow intake rate; high shrink-swell potential; moderate erodibility.	Deep; moderate erodibility.
(3)	(3)	(3)	(3)	(3)	(3)	(3).
(3)	Moderate permeability.	Impervious when compacted.	Well drained	Deep; high water-holding capacity; moderate permeability.	Deep; low to moderate erodibility; good compaction.	Deep; low to moderate erodibility.

[4] Caliche performs poorly in subgrade under a flexible surface but is useful for dry surfacing on local roads. It occurs in localized pockets and varies widely in characteristics.

TABLE 8.—*Engineering*

Soil name and location	Parent material	Kansas report number (S-59)	Depth	Horizon	Moisture-density [2]	
					Maximum dry density	Optimum moisture
			Inches		*Lb. per cu. ft.*	*Percent*
Harney silt loam:						
1,375 ft. E. and 1,390 ft. S. of NW. corner of sec. 1, T. 26 S., R. 24 W.	Loess.	29- 3-1	0-5	Ap	106	18
		29- 3-4	20-28	B22	100	22
		29- 3-7	40-56	Ccal	100	22
793 ft. S. and 65 ft. W. of NE. corner of sec. 11, T. 29 S., R. 25 W.	Loess.	29- 6-1	0-6	Ap	102	18
		29- 6-4	17-24	B22	99	21
		29- 6-7	37-51	Ccal	102	22
1,320 ft. W. and 90 ft. S. of NE. corner of sec. 3, T. 29 S., R. 26 W.	Loess.	29- 7-1	0-5	Ap	103	19
		29- 7-3	11-18	B22	100	18
		29- 7-5	23-43	Cca	100	20
1,056 ft. W. and 75 ft. S. of NE. corner of sec. 20, T. 29 S., R. 26 W.	Loess.	29-11-1	0-4	Ap	108	16
		29-11-3	9-15	B22	100	20
		29-11-5	21-40	Ccal	103	21
Mansic clay loam:						
2,640 ft. E. and 400 ft. S. of NW. corner of sec. 3, T. 29 S., R. 23 W.	Old alluvium.	29- 9-1	0-6	A1	104	18
		29- 9-3	11-74	C	110	15
52 ft. W. and 8 ft. S. of NE. corner of sec. 35, T. 29 S., R. 23 W.	Old alluvium.	29-10-1	0-5	A1	106	17
		29-10-3	11-52	C1	109	17
		29-10-4	52-86	C2	98	18
Ortello fine sandy loam:						
80 ft. N. and 50 ft. E. of W¼ corner of sec. 5, T. 27 S., R. 22 W.	Old alluvium and loess.	29- 4-2	4-9	A1	118	14
		29- 4-3	9-24	B2	118	13
		29- 4-4	24-67	C	118	11
		29- 4-5	67-90	D	111	15
1,200 ft. W. and 57 ft. S. of N¼ corner of sec. 22, T. 28 S., R. 21 W.	Old alluvium and loess.	29- 5-2	6-12	A1	122	10
		29- 5-3	12-29	B2	124	10
		29- 5-4	29-69	C1	121	12
Spearville silty clay loam:						
468 ft. S. and 36 ft. W. of NE. corner of sec. 19, T. 25 S., R. 25 W.	Loess.	29- 1-1	0-7	A1	96	22
		29- 1-2	7-13	B21	96	23
		29- 1-5	24-37	Cca1	96	24
		29- 1-6	37-60	Cca2	96	25
346 ft. S. and 178 ft. W. of NE. corner of sec. 22, T. 25 S., R. 26 W.	Loess.	29- 2-1	0-6	A1	102	18
		29- 2-2	6-13	B21	96	24
		29- 2-5	26-52	Cca1	98	21
		29- 2-6	52-63	Cca2	98	22
Ulysses silt loam:						
528 ft. N. and 300 ft. E. of center of sec. 19, T. 28 S., R. 23 W.	Loess.	29- 8-2	2-9	A1	103	19
		29- 8-3	9-17	AC	102	20
		29- 8-4	17-38	Cca1	105	18
266 ft. W. and 240 ft. N. of center of sec. 22, T. 26 S., R. 25 W.	Loess.	29-12-1	0-8	A1	103	18
		29-12-2	8-15	AC	101	20
		29-12-3	15-44	Cca1	104	18

[1] Tests performed by the State Highway Commission of Kansas under a cooperative agreement with the Department of Commerce Bureau of Public Roads, in accordance with standard procedures of the American Association of State Highway Officials (AASHO) (*2*) except as stated in footnotes 2 and 3.

[2] Based on AASHO Designation: T 99-57, Method A (*2*), with the following variations: (1) All material is ovendried at 230° F.; (2) all material is crushed in a laboratory crusher after drying; and (3) no time is allowed for dispersion of moisture after mixing with the soil material.

[3] Mechanical analyses according to the AASHO Designation: T 88-57 (*2*) with the following variations: (1) All material is ovendried at 230° F. and crushed in a laboratory crusher; (2) the sample is not soaked prior to dispersion; (3) sodium silicate is used

test data [1]

Mechanical analyses [3]							Liquid limit	Plasticity index	Classification	
Percentage of fraction passing sieve—			Percentage smaller than—						AASHO	Unified [4]
No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.				
----------	100	97	84	46	12	6	29	8	A-4(8)	ML-CL.
----------	100	98	93	67	35	22	51	29	A-7-6(18)	CH.
----------	100	99	91	62	22	11	41	18	A-7-6(11)	CL.
----------	100	98	88	44	17	13	31	7	A-4(8)	ML-CL.
----------	100	98	93	67	37	28	46	24	A-7-6(15)	CL.
----------	100	98	91	60	26	17	40	17	A-6(11)	CL.
----------	100	97	92	48	16	8	32	10	A-4(8)	ML-CL.
----------	100	97	90	64	30	21	45	24	A-7-6(15)	CL.
----------	100	96	88	60	26	16	41	18	A-7-6(11)	CL.
100	99	82	70	38	14	7	28	8	A-4(8)	CL.
----------	100	95	86	58	26	17	42	19	A-7-6(12)	CL.
100	99	94	80	52	22	14	38	18	A-6(11)	CL.
100	99	91	72	43	20	14	36	16	A-6(10)	CL.
100	99	91	75	48	24	18	31	13	A-6(9)	CL.
100	99	85	72	44	22	16	33	12	A-6(9)	CL.
----------	100	92	78	46	20	15	32	13	A-6(9)	CL.
100	99	83	62	33	13	9	30	5	A-4(8)	ML.
100	99	29	23	13	3	2	20	3	A-2-4(0)	SM.
100	99	26	19	11	6	4	19	3	A-2-4(0)	SM.
100	97	16	15	10	6	4	17	2	A-2-4(0)	SM.
100	99	68	58	36	16	7	29	12	A-6(7)	CL.
100	82	33	24	15	7	6	20	4	A-2-4(0)	SM.
100	81	31	23	14	7	6	20	4	A-2-4(0)	SM.
100	89	39	27	16	8	7	20	4	A-4(1)	SM.
100	99	96	86	54	24	16	37	15	A-6(10)	CL.
----------	100	98	92	71	48	36	54	28	A-7-6(18)	CH.
----------	100	99	88	62	28	19	41	16	A-7-6(11)	CL.
----------	100	97	83	44	18	11	41	15	A-7-6(10)	ML-CL.
----------	100	98	83	50	23	16	37	14	A-6(10)	ML-CL.
----------	100	99	94	72	44	34	59	34	A-7-6(20)	CH.
----------	100	98	89	54	25	15	42	15	A-7-6(10)	ML.
----------	100	97	88	54	22	16	42	14	A-7-6(10)	ML.
----------	100	79	64	32	10	6	33	11	A-6(8)	CL.
----------	100	74	70	39	16	7	36	13	A-6(9)	ML-CL.
----------	100	83	72	46	22	11	34	13	A-6(9)	CL.
----------	100	77	60	30	11	7	34	13	A-6(9)	CL.
----------	100	80	64	35	13	8	35	12	A-6(9)	ML-CL.
----------	100	76	59	37	15	9	32	11	A-6(8)	CL.

as the dispersing agent; and (4) dispersing time, in minutes, is established by dividing the plasticity index value by 2; the maximum time is 15 minutes, and the minimum time is 1 minute. Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soils.

[4] Based on the Unified classification system (*19*), SCS and Bureau of Public Roads have agreed to consider that all soils having plasticity indexes within two points from A-line to be given a borderline classification. An example of a borderline classification obtained by this use is ML-CL.

ally occupy slopes adjacent to areas suitable for reservoirs or embankments. However, in places the Mansker and Potter soils and the soils of the Mansic-Hobbs and Mansker-Potter complexes have stratified sand and gravel or pockets of sand in the bottom of the drainage channel, which make them unsuitable as a site for a farm pond. The Pratt and Lincoln soils and the soils of the Pratt-Tivoli complex are also not suitable as a site for a farm pond.

Among the features that affect agricultural drainage are a seasonally high water table and the location of the soil. The Las Animas, Leshara, and Lincoln soils are difficult to drain because of the seasonally high water table. The Randall soils are in upland depressions where drains are difficult to construct because of the flat topography.

Soil features that affect the suitability of a soil for irrigation are shown in the column "Irrigation." Soil features that affect the suitability for irrigation, and problems and limitations that affect irrigation are also discussed in the section "General Management of Irrigated Soils."

Field terraces and diversion terraces are not normally constructed on the Canadian, Las Animas, and Leshara soils, which are level or nearly level and are in stream valleys. Because of the hazard of wind erosion and the topography, terraces are not constructed on the nearly level, sandy Otero and Ortello soils, nor are they constructed on the hummocky, sandy Pratt soils. All the other arable soils, however, are suitable for terraces.

Some of the soils in the county are suitable for waterways. When a waterway must be constructed across an area of Canadian, Dale, Las Animas, Leshara, or Lincoln soils, however, it may be necessary to make a detailed field investigation of the material that will be exposed after the cut is made. Some soils, such as the Las Animas, Leshara, and Lincoln, may need a lining of topsoil on the exposed cut so that vegetation will grow and protect the soils from erosion. Additional information about waterways is given in the section "General Management of Dryland Soils."

Engineering test data

As shown in table 8, samples from 12 profiles of 5 of the principal series of Ford County were tested by standard AASHO procedures to help evaluate the soils for engineering purposes. Only selected layers of each soil were sampled.

The results of moisture-density tests are given in table 8. If a soil material is compacted at successively higher moisture content, assuming that the compactive effort remains constant, the density of the compacted material will increase until the optimum moisture content is reached. After that, the density decreases with increase in moisture content. The highest dry density obtained in the compaction test is termed "maximum dry density." Moisture-density data are important in earthwork, for as a rule, optimum stability is obtained if the soil is compacted to about the maximum dry density when it is at approximately the optimum moisture content.

Tests for liquid limit and plastic limit measure the effect of water on the consistence of the soil material. As the moisture content of any soil, except noncoherent and other nonplastic soil material, increases from a very dry state, the material changes from a solid to a semisolid or plastic state. As 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 in a plastic condition.

Formation, Classification, and Morphology of Soils

This section presents the outstanding characteristics of the soils of Ford County and relates them to the factors of soil formation. The first part discusses the factors of soil formation, the second, the classification of soils, and the third, the morphology of soils.

Factors of Soil Formation

Soil is produced by the action of soil-forming processes on materials deposited or accumulated by geologic agencies. The characteristics of a soil at any given point are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and has existed since accumulation; (3) the plant and animal life in and on the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil development have acted on the soil material.

Climate and organic materials (plants, animals, and micro-organisms) are the active factors of soil formation. They act on the parent material and slowly change it to a soil that has genetically related horizons. The effects of climate and organic material are conditioned by relief. The kinds of parent material also affect formation of soils. Under certain conditions the parent material almost entirely determines the characteristics of the soil.

Parent material

The weathered surface rocks and other material in which the soils of Ford County have developed belong to three geologic systems. The youngest is the Quaternary, the second youngest is the Tertiary, and the oldest is the Cretaceous. Loess, dune sand, alluvium, and terrace deposits are of the Quaternary period; and the Ogallala formation is of the Tertiary period. Materials of the Pleistocene and Recent epochs are of the Quaternary period. Materials of the middle and upper Pliocene epoch are of the Tertiary period.

Figure 12 shows a cross section of the soils in a small area west of Dodge City. It also shows the general landscape in which all of the major soil associations occur, except for the Tivoli and the Ortello-Dalhart-Lubbock-Carwile associations. This figure is based on plate 5 of "Geology and Ground-Water Resources of Ford County, Kans." (*18*).

Cretaceous period.—Rocks of the Cretaceous period, mainly the Dakota formation, underlie this county, but they are not exposed except in isolated areas along streams. They have not influenced the development and classification of soils in this county, except for soils mapped as inclusions with other soils, mainly the Mansker and Potter soils.

Because of considerable erosion of the Cretaceous rocks in geologic time, there was a diverse topography before the material of the Ogallala formation was deposited. The warping of the earth's crust also is believed to have taken place before or during the time when the material of the Ogallala formation was deposited. This warping helped change the landscape from one of erosion to one of deposition (*6*).

Tertiary period.—The Tertiary period was marked by an epoch of deposition during which streams that were heavily laden with material from the Rocky Mountains traversed the area that is now Ford County. These streams deposited the sediment of the Ogallala formation on a broad, alluvial plain (*18*).

The Ogallala formation consists of gravel, sand, silt, caliche, and structureless silt and silty sand. It contains hard and soft layers of sandstone and conglomerate, much of which is cross bedded and cemented with lime. Gravel and coarse sand are more common in the lower part of this formation, but lime-cemented beds are more common in the upper part (*6*).

The Ogallala formation underlies nearly two-thirds of the county, but it is absent or thin in the eastern and southeastern parts. It is a source of high-quality water at a depth of about 100 feet to 200 feet. Ogallala mortar beds outcrop in the northern part of the county along Sawlog, Duck, and Elm Creeks. These creeks have washed away the material of the Ogallala formation, and have exposed strata of Cretaceous age in some places along their banks.

Quaternary period (Pleistocene and Recent epochs).—Most of the soils of this county have developed in extensive deposits of loess and in material that resembles loess on slopes and in valleys throughout the upland. The upper layer of loess is brown to very pale brown when dry. It is loamy and highly calcareous, and it contains many soft lime concretions. The lower layer, which is made up of loess and alluvium, is similar to the upper layer, but it is strong brown to reddish yellow when dry. It also contains more sand and fine gravel and harder lime concretions.

These two layers, called Kingsdown silt in Ford County, may correspond to the Peorian and Loveland material that occurs in other places. These materials are shown in place in a deep cut about 3 miles east of Bucklin (fig. 13).

An area of clean, even-bedded volcanic ash that is 5 feet thick also occurs near the base of the Kingsdown silt near an exposure in section 13, T. 30 S., R. 23 W. (*18*). About 2 miles south of Bloom, Pearlette ash occurs below the Kingsdown loamy material.

Many buried soils have been observed throughout this county. Apparently, soils developed in layers of loess and were covered by later deposits.

Dune sand occurs south of the Arkansas River and in local areas north of that river, between the river and Coon Creek. Deposition of the sand probably started late in the Pleistocene epoch and continued into the Recent epoch. The sandy deposits probably developed from sandy material of both the Tertiary and Quaternary periods. The present flood plain apparently contributed little as a source of this sandy material.

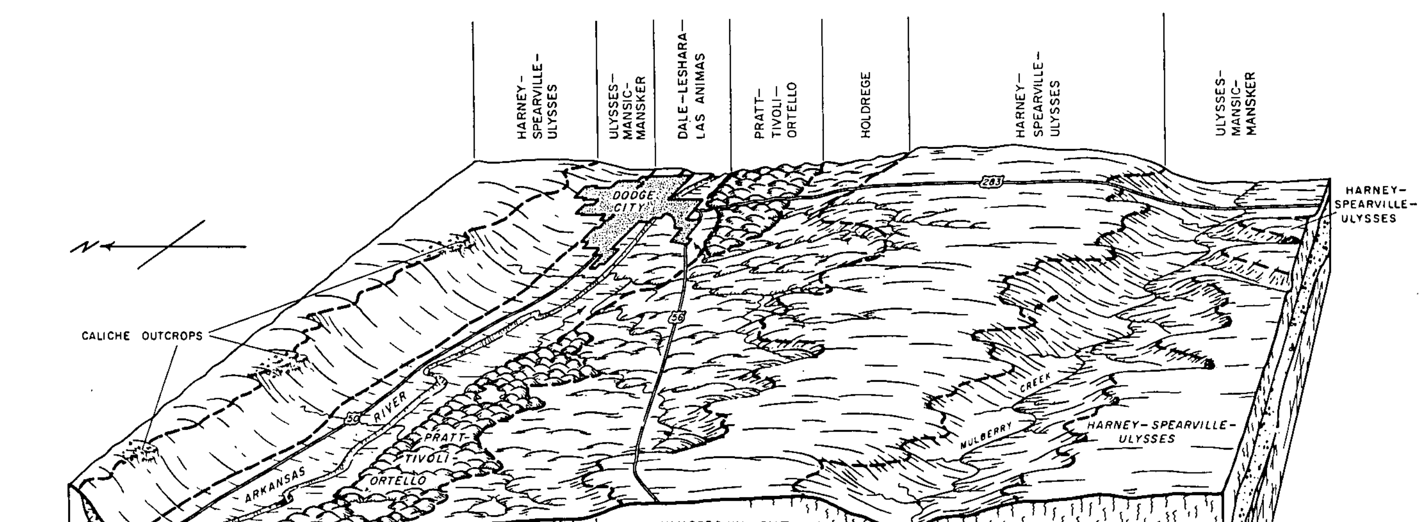

***Figure 12.*—A geologic cross section west of Dodge City showing the major soil associations in Ford County.**

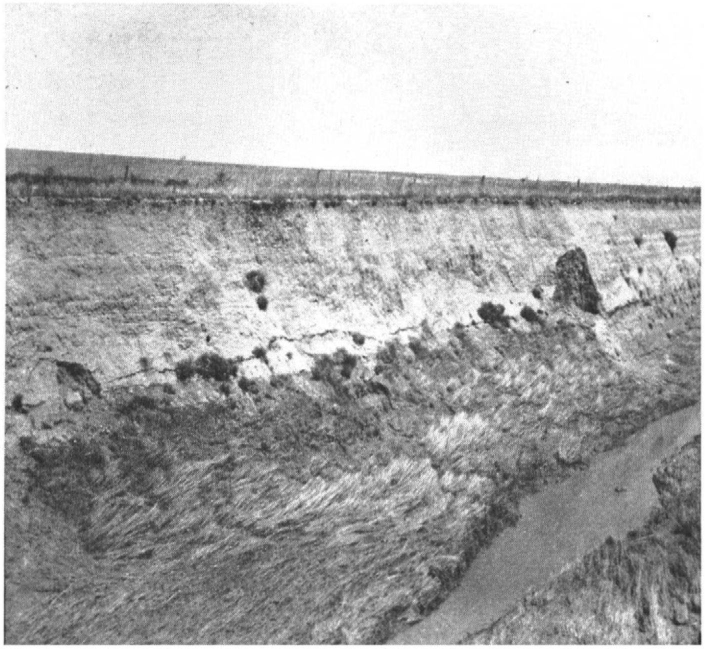

***Figure 13.*—A deep cut in an area of Kingsdown silt, showing the various strata of loamy material. A profile of Holdrege silt loam has developed in the uppermost layer.**

During the Recent epoch, the downcutting of streams produced terraces and flood plains adjacent to the streams. Along the Arkansas River is a low terrace about 5 to 8 feet above the flood plain, and a higher terrace about 15 to 25 feet above the flood plain. The deposits in these terraces are younger than Kingsdown silt (*18*). At present the flood plains are being reworked.

Climate

This county has a continental climate. Most of the rainfall comes in the form of thunderstorms in spring and summer. Little moisture falls as rain or snow in winter. Prevailing winds are from the south during the summer months and from the north during the winter months (*14*). The average annual wind velocity is about 15 miles per hour. Generally, summers are hot and dry. Humidity is low in summer and evaporation is high. The warmest month of the year is July, and the coldest is January. The uppermost 6 to 8 inches of soil material generally freezes and thaws several times a year.

The depth to a lime zone in most of the clayey and loamy soils indicates the average depth to which water penetrates. It ranges from a few inches to several feet, depending on the slope, the rate of water intake, and the movement of water through the soil. In nearly level soils that have good permeability, water penetrates to a greater depth than in strongly sloping soils. Only slight leaching of plant nutrients takes place in the soils of this county. Some sandy soils are leached of lime, but they have remained neutral to slightly alkaline. The sandy soils have been leached of plant nutrients to a greater degree than the loamy and clayey soils.

Climate has directly or indirectly caused many variations in the plant and animal life. Thus, climate affects the changes in soils that are brought about by plant and animal life.

Plant and animal life

Plant and animal life, both in and on the soil, are active in the soil-forming processes.

The kinds of plants, animals, and micro-organisms that live in and on the soil are determined by the other environmental factors of soil formation—climate, parent material, relief (slope), and age. As plants and animals die and decay, they add organic matter to the mineral part of the soil; consequently, the upper layers of the soil are darkened.

The soils of this county have developed under grasses, such as little bluestem, western wheatgrass, grama grass, and buffalograss. The root systems of these grasses have penetrated to a depth of 3 to 6 feet and have added a large amount of organic matter to the upper layers of the soil. Micro-organisms have transformed both the roots and tops of this organic material into humus, which provides plant nutrients for roots. Most nearly level and gently sloping soils absorb a greater amount of water and support a thicker stand of grass than the strongly sloping soils. As a result, the strongly sloping soils contain less organic matter than the less sloping ones and are not dark to so great a depth.

Small burrowing animals, earthworms, and other soil organisms influence soil formation by mixing and transforming the organic and mineral parts of the soil.

Relief

This county is near the eastern edge of the High Plains in the Great Plains province. The lowlands of the Arkansas River divide the High Plains into southern and northern parts. Most of the county is in the High Plains, which have a gradual rise in elevation from east to west of about 10 to 15 feet per mile (*12*). The elevation above sea level ranges from about 2,250 feet in the northeastern corner of the county to about 2,750 feet in the southwestern corner (*15, 16*).

In general the landscape is gently rolling, but the relief ranges from level to steep. The relief modifies the effects of climate and vegetation. The degree, aspect, and type of slope partly determine how much water runs off, how much water penetrates the soils, and how much material is likely to be lost through erosion. Differences in slope usually affect the temperature and the amount of moisture and air within the soils.

Soils that have developed in similar parent material and under a similar cover of plants, but that differ in relief or drainage, may be grouped in sequences called catenas. The best example of a catena in this county is the one that contains the Spearville, Harney, and Ulysses soils (see fig. 12). The Spearville soils are mainly nearly level, but they have some concave slopes that grade into depressions. The Harney soils are nearly level and gently sloping, and they occur in convex areas. The Ulysses soils are sloping and occur in convex areas. The soils of all three series developed in loess or in material that resembles loess.

Time

Considerable time is required for a soil to develop from the parent material. After the parent material has been deposited or has accumulated in place through weathering, the surface layer becomes darker because organic matter accumulates in it. The length of time required for a soil to develop a mature profile depends, to a large extent, on the other factors of soil formation. For example, a soil may develop more rapidly in a humid climate that has luxuriant vegetation than in a dry or cold climate where the vegetation is scanty. The following factors help to measure the relative age of a soil: (1) The leaching downward of calcium carbonate and other soluble minerals; (2) the downward movement of clay from the surface layer; and (3) the depth at which various amounts of clay have been deposited.

Generally, the older soils show a greater degree of differentiation between horizons than the younger ones. Horizons tend to develop more rapidly in soil material that weathers rapidly than in material that weathers slowly. Furthermore, the geologic age of the parent material is not the same as the age of the soil. Most of the present landscape of this county has developed a pattern of erosional drainage on loess that was deposited during Quaternary and Recent time.

While erosion and the downcutting of streams were taking place, there was some reshifting of the original loessal deposits at the surface. Some old, buried soils have about the same characteristics as present-day soils.

Classification of Soils by Higher Categories

Soils are placed in narrow classes for the organization and application of knowledge about their behavior within farms, ranches, or counties. They are placed in broad classes for study and comparisons of large areas, such as continents. In the comprehensive system of soil classification followed in the United States (*3*), the soils are placed in six categories, one above the other. Beginning at the top, the six categories are the order, suborder, great soil group, family, series, and type.

In the highest category, the soils of the whole country are grouped into three orders, whereas thousands of soil types are recognized in the lowest category. The suborder and family categories have never been fully developed and thus have been little used. Attention has been given largely to the classification of soils into soil types and series within counties or comparable areas and to the subsequent groupings of the series into great soil groups and orders. The soil series, soil type, and phase are described briefly in "How Soils Are Mapped and Classified."

Classes in the highest category of the classification scheme are the zonal, intrazonal, and azonal orders (*13*). The zonal order is made up of soils with evident, genetically related horizons that reflect the dominant influence of climate and living organisms in their formation. The intrazonal order is made up of soils with evident, genetically related horizons that reflect the dominant influence of one or more local factors of parent material or topography over the effect of climate and living organisms. In the azonal order are soils that lack distinct, genetically related horizons, commonly because of youth, resistant parent material, or steep topography.

In table 9 the soil series are classified by higher categories, and their important characteristics are given.

The soil series are discussed in the text by order and great soil group.

731-131—65——5

Zonal soils

Zonal soils have well-developed soil characteristics that reflect the influence of the active factors of soil formation—climate and plant and animal life, chiefly vegetation. Generally, these soils develop on well-drained upland from parent material that has been in place long enough to make a good balance between forces of soil formation. In Ford County the zonal soils are those of the Chernozem and Chestnut great soil groups.

Chernozems.—Like the Chestnut soils, the Chernozems are dark colored and have developed under grass. They contain a large amount of organic matter and have high natural fertility. Typical Chernozems in this county are the soils of the Harney, Holdrege, Ortello, and Spearville series.

When dry, all of these soils are dark grayish brown to a depth of about 2 feet. Below that depth, they are lighter colored and have a zone that is high in lime. They are neutral to mildly alkaline above the lime zone. The Harney, Holdrege, and Spearville soils all have a definite B horizon. The structure of the B horizon is granular or subangular blocky in the Holdrege soils, and it is subangular blocky or blocky in the Harney and Spearville soils.

Chestnut soils.—The soils of the Chestnut great soil group are dark and have developed under grass. Their content of organic matter is moderately high, and natural fertility is high. In this county the Bippus and Ulysses soils are in this great soil group. The Ulysses soils have some characteristics of Regosols. Dark colors prevail in the soils of the great soil group to a depth of about 12 to 18 inches. When dry, all of the soils are typically grayish brown to brown, but some of the soil material above the lime zone is dark grayish brown.

The lime zone is well defined in these soils, and it is at a depth of about 12 to 36 inches. The Bippus and Ulysses soils contain a large amount of lime.

The Bippus and Ulysses soils have a less well defined B horizon than the Reddish Chestnut soils. The Ulysses soils have a weak B horizon in which the structure is dominantly granular.

Reddish Chestnut soils.—The soils of the Reddish Chestnut great soil group developed under grass. The Dalhart, Lubbock, Mansic, and Pratt soils are in this great soil group. They have a brownish color, have gradual boundaries, and become lighter colored with increasing depth.

In these soils the lime zone is at a depth of 12 to 36 inches. The Mansic soils contain a large amount of lime, and the Dalhart, Lubbock, and Pratt soils contain a lesser amount. The Mansic soils have a large amount of lime in the parent material. The Pratt soils are sandy, however, and lime has leached to a greater depth in their profile than in the profile of the other Reddish Chestnut soils.

Intrazonal soils

Intrazonal soils have more or less well-developed characteristics that reflect the dominating influence of some local factor of relief or parent material over the normal influence of climate and vegetation. In this county the intrazonal soils are the Calcisols and Grumusols.

TABLE 9.—*Soil series classified by higher categories and some of their important characteristics*

Great soil group and soil series	Parent material	Topographic position	Drainage class	Native vegetation
ZONAL SOILS				
Chernozem:				
Harney	Loess	Upland	Well drained	Prairie mid and short grasses.
Holdrege	Loess	Upland	Well drained	Prairie mid and short grasses.
Ortello	Eolian sandy sediments.	Upland	Well drained	Prairie tall and mid grasses.
Spearville	Loess	Upland	Well drained	Prairie mid and short grasses.
Chestnut:				
Bippus	Plains outwash	Upland	Well drained	Prairie mid and short grasses.
Ulysses [1]	Loess	Upland	Well drained	Prairie mid and short grasses.
Reddish Chestnut:				
Dalhart	Loess	Upland	Well drained	Prairie mid and short grasses.
Lubbock	Eolian material from old alluvium.	Upland	Well drained	Prairie mid and short grasses.
Mansic	Old alluvium	Upland	Well drained	Prairie mid and short grasses.
Pratt	Eolian sandy sediments.	Upland	Well drained	Prairie tall and mid grasses.
INTRAZONAL SOILS				
Calcisol:				
Mansker	Plains outwash	Upland	Well drained	Prairie mid and short grasses.
Grumusol:				
Randall	Clay	Upland depressions	Poorly drained	Varied and unstable; consists of tall grasses, mid grasses, and weeds.
Planosol:				
Carwile	Old alluvium	Upland	Imperfectly drained	Prairie tall and mid grasses.
AZONAL SOILS				
Alluvial:				
Canadian	Recent alluvium	Terraces	Well drained	Prairie tall and mid grasses.
Dale [2]	Recent alluvium	Terraces	Well drained	Prairie tall and mid grasses.
Hobbs	Silty alluvium	Bottom lands	Well drained	Prairie tall and mid grasses.
Humbarger	Silty alluvium	Terraces and flood plains.	Well drained	Prairie tall and mid grasses.
Las Animas	Loamy alluvium	Bottom lands	Imperfectly drained; high water table.	Prairie tall and mid grasses.
Leshara	Loamy alluvium	Bottom lands	Imperfectly drained; high water table.	Prairie tall and mid grasses.
Lincoln	Sandy alluvium	Bottom lands	Somewhat excessively drained.	Varied and unstable.
Lithosol:				
Potter	Weathered caliche outcrops.	Upland	Excessively drained	Prairie mid and short grasses.
Regosol:				
Colby	Loess	Upland	Well drained	Prairie mid and short grasses.
Otero	Calcareous sandy loess	Upland	Well drained	Prairie tall and mid grasses.
Tivoli	Sand	Upland	Excessively drained	Prairie tall and mid grasses.

[1] Intergrading toward Regosols.

[2] Intergrading toward Chernozems.

Calcisols.—In this great soil group are soils in which calcium carbonate has accumulated to form a prominent horizon. The soils are not leached extensively, and there has been no movement and accumulation of iron, humus, or secondary silicate clay minerals that would form distinct horizons or that would otherwise be distinctly evident (7).

The Mansker soils are the only Calcisols in this county. When dry, these soils have a light-gray A horizon that is underlain by pale-brown soil material. A prominent layer of calcium carbonate has accumulated at a depth of about 18 to 26 inches, that is, at about the depth to which moisture from precipitation has penetrated. In most places the soil material beneath the calcium carbonate is dry. The profile of the Mansker soils is dominantly clay loam; the structure ranges from weak, medium, subangular blocky to moderate, medium, granular.

Grumusols.—This great soil group is made up of soils that have a profile rather high in content of clay. The profile is relatively uniform in texture, and is marked by signs of local soil movement resulting from shrinking when the soils are dry and swelling when they are wet. The Randall soils are the only Grumusols in this county.

The Randall soils are in depressions and are wet most of the time. They have little or no horizonation in the profile. These soils consist of massive clay that is dark gray when dry and plastic when wet. Large cracks appear in the clay when the soils are dry. The substratum ranges from sand to clay.

The Randall soils occur with soils formed in old alluvium in areas near the Arkansas River. They are also associated with loessal soils of the upland.

Planosols.—This great soil group is made up of soils that have a claypan underlying a leached surface horizon. In many places the claypan has been caused by the thick, clayey strata in the parent material.

The Carwile soils are the only Planosols mapped in this county. They have a surface layer of fine sandy loam about 10 inches thick over a subsoil that is clayey in the lower part.

Azonal soils

Azonal soils are any group of soils without well-developed profile characteristics, because they are too young for normal development of such characteristics, or because the nature of the parent material or the relief has prevented normal development of these characteristics. Stony or steep soils, soils that are shallow over bedrock or other decidedly different material, and soils of the alluvial flood plains are azonal soils. The azonal soils in this county are those of the Alluvial, Lithosol, and Regosol great soil groups.

Alluvial soils.—This great soil group is made up of a group of soils that consist of transported and relatively recently deposited material. The soils are characterized by a weak modification, or no modification, of the original material by soil-forming processes. In this county the Canadian, Hobbs, Humbarger, Las Animas, Leshara, and Lincoln soils are typical of this great soil group. The Dale soils are also Alluvial soils, but they have some characteristics of Chernozems.

The Alluvial soils in this county are on the flood plains and low terraces of the Arkansas River and along the larger creeks. The soils are more or less stratified but range from loamy sand to clay loam in texture, and they vary greatly in depth to sand or gravel. Little or no horizonation is evident in these soils.

Lithosols.—This great soil group is made up of skeletal soils that have no clearly expressed soil morphology. The soils are generally steep and consist of a freshly and imperfectly weathered mass of rock fragments. The Potter soils are the only Lithosols in this county.

The Potter soils developed under native grass and are on rolling and rough, broken slopes where there are outcrops of caliche. The surface layer of these soils is thin and is highly calcareous cobbly loam to clay loam. Caliche underlies the surface layer at a depth of 3 to 12 inches. In places this underlying material is soft, weakly indurated, fragmental caliche, and in other places it is hard, massive caliche. In some places the caliche outcrops at the surface and is called mortar bed. There is a large amount of runoff, and as a result, the Potter soils lose part of their soil material through erosión. A well-developed profile does not form, because the soil material is not in place long enough.

Regosols.—This great soil group consists of soils that lack definite genetic horizons, except for a slightly darkened surface layer. The soils have developed in deep unconsolidated or in soft, rocky deposits. The Regosols can be compared to the Lithosols in their stage of development. Their youthfulness can be attributed to the strong influence of the parent material. In Ford County the Regosols are the soils of the Colby, Otero, and Tivoli series.

The Colby series consists of sloping soils that are so eroded that only a thin, darkened layer of soil material remains. The parent material is highly calcareous loess through which little or no water percolates downward to the water table.

The Otero series consists of stratified, highly calcareous sandy loams and loamy sands. The soils have lenses of fine sandy loam throughout, and in places they contain lenses of clay loam. They are young sandy soils. From time to time since these soils developed, their surface layer has been recharged with limy material. The source of the limy material is apparently the sandy deposits of the Ogallala formation or secondary lime deposits of Loveland material that were reworked by wind. Both the sandy deposits of the Ogallala formation and the secondary lime deposits of Loveland material are near the surface and are weathering and eroding at the same time.

The Tivoli soils consist of sandy deposits that show little profile development, except for a slightly darkened surface layer. These soils are forming in young deposits of the Recent epoch. The source of the deposits is old alluvium that was moved about by wind during various epochs. The deposits lie south of the Arkansas River and locally, north of the river, between the river and Coon Creek.

Morphology of Soils

In the following pages, each soil series is described, and a detailed profile description of a soil representative of the series is given. The profile descriptions were prepared while studying profiles at specific sites in the county. Unless otherwise indicated, the color is that of a dry soil.

Bippus Series

The Bippus series consists of Chestnut soils of the upland. These soils are well drained and developed in colluvial and alluvial sediment from plains outwash. They are downslope from outcrops of the Ogallala formation. The slopes are between 2 and 5 percent.

The Bippus soils have a surface layer of clay loam, rather than one of silt loam like that of the Holdrege soils. They also lack a definite B horizon. Their surface layer is dark grayish brown but is thicker than that of the Mansic soils. The horizons beneath the surface layer are also less strongly calcareous than those of the Mansic soils.

Typical profile of Bippus clay loam about 10 miles northeast of Dodge City, 300 feet south and 100 feet west of the NE. corner of the NW. quarter of sec. 9, T. 25 S., R. 24 W.:

A1—0 to 17 inches, dark grayish-brown (10YR 4/2) clay loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; friable when moist, slightly hard when dry; calcareous; gradual boundary.

AC—17 to 28 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, granular structure; friable when moist, slightly hard when dry; calcareous; few, fine, soft lime concretions; many lime films and few, flattened fragments of caliche; gradual boundary.

C—28 to 62 inches, light brownish-gray (10YR 6/2) clay loam, grayish brown (10YR 5/2) when moist; weak, granular structure (almost structureless); friable when moist; strongly calcareous; many lime concretions and fragments of caliche.

The C horizon is stratified and contains many lime films. In general, the texture of the A horizon ranges from clay loam to light clay loam, but in small areas it is silt loam. The A horizon ranges from 8 to 24 inches in thickness. The color of the AC horizon ranges from dark grayish brown to grayish brown, and the color of the C horizon, from light brownish gray to pale brown.

Canadian Series

In the Canadian series are young soils developed in alluvium. They occur in the valley of the Arkansas River, about 6 to 12 feet above the present flood plain. The Canadian soils have little or no horizon development, except for some stratification. The uppermost 3 feet consists of friable, fairly uniform, calcareous fine sandy loam. Below a depth of 3 feet, the materials are strongly stratified and range from sand to clay loam. Thin strata of clay occur in places. Depth to the water table ranges from 7 to 15 feet.

The Canadian soils resemble the Las Animas soils, but they have a thicker, dark-colored solum over a sandy substratum. They are also unmottled and have a deeper water table.

Typical profile of a Canadian fine sandy loam about 4 miles southeast of Windhorst, 300 feet south and 100 feet west of the NE. corner of the SE. quarter of sec. 25, T. 26 S., R. 21 W.:

A1—0 to 16 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak to moderate, medium, granular structure; friable when moist; noncalcareous; gradual boundary.

AC—16 to 38 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) when moist; weak, granular structure; friable when moist; calcareous; gradual boundary.

C1—38 to 50 inches, pale-brown (10YR 6/3) loamy fine sand, brown (10YR 5/3) when moist; single grain (structureless); very friable when moist; calcareous; clear boundary.

IIC2—50 to 66 inches + stratified sand and fine gravel.

The A horizon is fine sandy loam or sandy loam. It ranges from dark grayish brown to brown in color and from 10 to 26 inches in thickness. The C horizon ranges from stratified sandy loam to loamy fine sand and is calcareous at a depth of 20 to 36 inches. Below a depth of 3 feet, the material is stratified, calcareous alluvium that is dominantly sand and fine gravel to sandy loam in texture.

Carwile Series

The Carwile soils are in the Planosol great soil group. They have a well-developed profile. The soils are imperfectly drained and are on the upland. Their parent material consists of eolian and alluvial sand and clay of the Pleistocene (Wisconsin) and Recent epochs.

The Carwile soils are similar to the Lubbock soils but are less well drained and have a more clayey, mottled subsoil. They have more clay in the B horizon than the Ortello and Dalhart soils.

Typical profile of Carwile fine sandy loam 550 yards north and 220 yards east of the SW. corner of the SE. quarter of sec. 14, T. 27 S., R. 22 W.:

A1—0 to 11 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; friable when moist, hard when dry; noncalcareous; pH 6.7; gradual boundary.

B1—11 to 20 inches, grayish-brown (10YR 5/2) heavy sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine and medium, granular structure; thin and discontinuous clay films; friable when moist, hard when dry; noncalcareous; pH 7.0; gradual boundary.

B21t—20 to 28 inches, brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) when moist; weak, coarse, subangular blocky structure; discontinuous clay films; friable when moist, hard when dry; noncalcareous; pH 7.2; clear boundary.

IIB22t—28 to 36 inches, dark-gray (10YR 4/1) clay, very dark grayish brown (10YR 3/2) when moist; common, medium, distinct mottles of browner and grayer shades than the soil mass; weak, fine, blocky structure; firm when moist, very hard when dry; calcareous; diffuse boundary.

IIC—36 to 48 inches +, gray (10YR 5/1) clay, dark gray (10YR 4/1) when moist; many, medium, distinct mottles of yellowish brown; massive (structureless); very firm when moist, extremely hard when dry; calcareous.

The texture of the A horizon is fine sandy loam or sandy loam, and the thickness of this horizon ranges from about 9 to 20 inches. The B horizon is brown sandy clay loam in the upper part and dark-gray, mottled clay in the lower part. It ranges from about 18 to 24 inches in thickness. The underlying material below a depth of 3 feet is stratified and calcareous. Its texture generally is clay loam but ranges from sand to clay.

Colby Series

Light-colored, well-drained soils make up the Colby series. These soils are calcareous Regosols. They have developed in loess and in sediments that resemble loess. The Colby soils occur with the Ulysses soils on slopes of 3 to 6 percent. They are cultivated or have been cultivated. Many rills and gullies are evidence of past erosion.

The Colby soils have a thinner and less dark A1 horizon, a more calcareous surface layer, and less profile development than the Ulysses soils. They have a lighter colored surface layer than the Mansic soils, and they have less clay throughout the solum.

Typical profile of Colby silt loam 220 yards north and 330 yards east of the SW. corner of sec. 21, T. 26 S., R. 25 W.:

Ap—0 to 4 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; friable when moist; calcareous; clear boundary.

AC—4 to 9 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure breaking to moderate, fine, granular; friable when moist; calcareous; few, fine, soft, white lime concretions and lime films; gradual boundary.

Cca—9 to 38 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) when moist; moderate, fine, granular structure; friable when moist; porous; many earthworm casts; strongly calcareous; many, fine, soft, white lime concretions and lime films; diffuse boundary.

IICC—38 to 66 inches +, light yellowish-brown (10YR 6/4) clay loam, yellowish brown (10YR 5/4) when moist; massive (structureless); friable when moist; porous; strongly calcareous.

The surface layer ranges from grayish brown to pale brown. Its thickness varies with the depth of plowing. The surface layer is generally calcareous, and it contains many nearly white, highly calcareous spots where there are lime films and concretions. In some small areas the texture throughout the solum is loam or light silty clay loam.

Dale Series

In the Dale series are young, dark-colored Alluvial soils that are intergrading toward Chernozems. The soils are well drained and have developed in well-stabilized, stratified, medium and moderately fine textured alluvium. Clay loam is the most common texture in the surface layer.

The Dale soils have more clay and less sand throughout the solum than the Canadian soils. They are less deeply leached of lime, have a thinner, darker surface layer, and are less frequently flooded than the Hobbs soils. The Dale soils are deeper over sand than the Leshara and Las Animas soils, and they lack the fluctuating water table that is generally near the surface in those soils.

Typical profile of Dale clay loam 250 feet north and 100 feet east of the SW. corner of sec. 16, T. 26 S., R. 26 W., at Howell:

A1—0 to 24 inches, dark grayish-brown (10YR 4/2) clay loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; friable when moist, slightly hard when dry; gradual boundary.

AC—24 to 30 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; friable when moist; slightly hard when dry; calcareous; few, thin lime films; gradual boundary.

C1—30 to 52 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) when moist; weak, medium, granular structure; friable when moist, slightly hard when dry; calcareous; gradual boundary.

C2—52 to 60 inches +, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) when moist; few, fine, faint brown to yellowish-brown mottles; weak, granular structure, almost massive; friable when moist, slightly hard when dry; strongly calcareous.

The A horizon ranges from silt loam to clay loam, but in most places it is clay loam. Its thickness ranges from 10 to 24 inches. The AC and C horizons are stratified silty clay loam and clay loam. In some places the Dale soils are weakly mottled below a depth of 40 inches. Depth to the water table is commonly more than 10 feet but less than 30 feet. Depth to calcareous material ranges from about 12 to 30 inches.

Dalhart Series

The Dalhart series consists of well-drained, gently sloping Reddish Chestnut soils that have a well-developed profile and are friable and permeable. The soils are on the upland. They have developed in calcareous, moderately coarse textured eolian deposits. In many places clay or sand is below a depth of 3 feet.

These soils occur on ridges and knobs in close association with the Lubbock soils. They contain less clay than the Lubbock soils and are less sandy than the Pratt soils.

Typical profile of Dalhart fine sandy loam, 100 feet north and 150 feet west of the SE. corner of SW quarter of sec. 4, T. 27 S., R. 22 W.:

A1—0 to 7 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; friable when moist; noncalcareous; gradual boundary.

B21t—7 to 14 inches, brown (10YR 4/3) sandy clay loam, dark brown (10YR 3/3) when moist; moderate, medium, granular structure; discontinuous clay films; friable when moist, hard when dry; noncalcareous; gradual boundary.

B22t—14 to 23 inches, brown (10YR 4/3) heavy fine sandy loam, dark brown (10YR 3/3) when moist; moderate, fine, granular structure; friable when moist, slightly hard when dry; noncalcareous; gradual boundary.

B3—23 to 44 inches, brown (10YR 5/3) heavy sandy loam, brown (10YR 4/3) when moist; weak, granular structure; very friable when moist; noncalcareous; abrupt boundary.

IICca—44 to 58 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 4/3) when moist; weak, medium, subangular blocky structure in upper part, massive below; firm when moist, hard when dry; calcareous; few, hard, medium-sized lime concretions and some lime films along cleavage planes; diffuse boundary.

IIC—58 to 70 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 4/3) when moist; massive (structureless); calcareous.

The texture of the A horizon is commonly fine sandy loam, but in some places it is loam. The A horizon ranges from 5 to 10 inches in thickness. The texture of the subsoil ranges from sandy clay loam to heavy sandy loam. The texture of the C horizon ranges from silty clay loam to clay loam. In some areas layers of sand or clay are below a depth of 3 feet.

Harney Series

The Harney soils are deep, well-drained Chernozems of the upland. Their surface layer is silt loam, and their subsoil is silty clay loam and silty clay. Normally, the lower part of the subsoil contains a zone of lime accumulation. These are the most extensive soils in Ford County. They developed in calcareous loess of the Pleistocene (Wisconsin) and Recent epochs. They are nearly level to gently sloping and are on convex slopes.

The Harney soils have more clay in the lower part of the subsoil than the Holdrege soils. They also have blocky, rather than subangular blocky, structure in the lower part of the subsoil.

Typical profile of Harney silt loam about 4 miles northeast of Dodge City, 2,100 feet east and 100 feet south of the NW. corner of sec. 4, T. 26 S., R. 24 W.:

A1—0 to 6 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak to moderate, medium, granular structure; friable when moist; noncalcareous; pH 6.2; gradual boundary.

B1—6 to 12 inches, dark grayish-brown (10YR 4/2) light silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; friable when moist, slightly hard when dry; noncalcareous; pH 6.5; gradual boundary.

B21t—12 to 18 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, subangular blocky structure; firm when moist, hard when dry; thin, continuous clay films; noncalcareous; pH 7.0; gradual boundary.

B22t—18 to 23 inches, grayish-brown (10YR 5/2) light silty clay, dark grayish brown (10YR 4/2) when moist; moderate, medium, blocky structure; firm when moist, very hard when dry; thick, continuous clay films; noncalcareous; pH 7.5; gradual boundary.

B2ca—23 to 30 inches, grayish-brown (10YR 5/2) light silty clay, dark grayish brown (10YR 4/2) when moist; moderate, medium, blocky structure; firm when moist, hard when dry; distinct but discontinuous clay films; calcareous; common, fine, soft lime concretions; pH 8.0; gradual boundary.

B3ca—30 to 46 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 5/3) when moist; moderate, medium, subangular blocky structure; friable when moist, hard when dry; calcareous and has coatings of lime on peds; common, fine, soft lime concretions; pH 8.0; diffuse boundary.

C—46 to 66 inches +, pale-brown (10YR 6/3) light silty clay loam, brown (10YR 5/3) when moist; massive, but there is a suggestion of subangular blocky structure; friable when moist, slightly hard when dry; calcareous with few, fine, soft lime concretions in upper part.

The A horizon ranges from 4 to 12 inches in thickness. Depth to silty clay ranges from 15 to 20 inches, and depth to the lime accumulation ranges from 20 to 30 inches.

Hobbs Series

In the Hobbs series are nearly level Alluvial soils. These soils are dark colored and well drained, and they developed in dark-colored alluvium. The alluvium washed mainly from soils of the Chernozem great soil group that developed on loess-mantled upland. The Hobbs soils are deeply leached of lime.

The Hobbs soils have a dark surface layer that is thicker than the surface layer of the Dale soils, and they are more frequently flooded than those soils. In this county the Hobbs soils are mapped only in complexes with the Mansic and Ulysses soils.

Typical profile of Hobbs silt loam about 10 miles south of Dodge City, 250 yards north and 200 yards west of the SE. corner of the NE. quarter of sec. 23, T. 28 S., R. 25 W.:

A11—0 to 14 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; friable when moist, slightly hard when dry; porous; many earthworm casts; noncalcareous; gradual boundary.

A12—14 to 30 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; friable when moist, slightly hard when dry; porous; noncalcareous; gradual boundary.

C—30 to 66 inches, brown (10YR 5/3) light silty clay loam, brown (10YR 4/3) when moist; weak, fine, granular structure; friable when moist; porous; calcareous.

In some places the A horizon is grayish brown, and it ranges from 12 to 36 inches in thickness. No B horizon is evident, but the soil material beneath the A horizon is stratified and consists mainly of medium-textured sediment that is calcareous at a depth of 24 to 48 inches.

Holdrege Series

The soils of the Holdrege series are Chernozems. They are dark colored, well drained, and moderately permeable, and they developed on the upland in calcareous loamy loess. These soils are nearly level or gently sloping. They are on convex slopes that range from 0 to 3 percent.

The Holdrege soils have a less clayey subsoil than the Harney and Spearville soils. Their A horizon and the upper part of their B horizon are dark colored and noncalcareous, and they are thicker than those of the Ulysses soils. The Holdrege soils also have more clay in the B horizon.

Typical profile of Holdrege silt loam 1.5 miles southeast of Ford, 600 feet east and 100 feet north of the SW. corner of sec. 9, T. 28 S., R. 22 W.:

A1—0 to 11 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; moderate, fine and medium, granular structure; friable when moist; noncalcareous; gradual boundary.

B1—11 to 19 inches, dark grayish-brown (10YR 4/2) light silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, subangular blocky structure; friable when moist; porous; clay films indistinct and not continuous; noncalcareous; gradual boundary.

B2t—19 to 33 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) when moist; moderate, medium, subangular blocky structure; firm when moist; clay films distinct but not continuous; noncalcareous; gradual boundary.

B3ca—33 to 48 inches, pale-brown (10YR 6/3) light silty clay loam, brown (10YR 4/3) when moist; weak, medium, subangular blocky structure; few patches of thin clay films; friable when moist; strongly calcareous; many lime films and common, fine, soft lime concretions; gradual boundary.

C—48 to 66 inches +, pale-brown (10YR 6/3) heavy silt loam or light silty clay loam, brown (10YR 5/3) when moist; almost massive; friable when moist; calcareous.

The color of the A horizon ranges from very dark grayish brown to grayish brown, and the thickness, from 6 to 15 inches. The texture of the surface layer is generally silt loam or loam, but in some places it is fine sandy loam. The texture of the B horizon ranges from granular silt loam to silty clay loam. Depth to calcareous material ranges from 20 to 36 inches.

Humbarger Series

In the Humbarger series are deep, dark Alluvial soils that are well drained and calcareous. These soils are on flood plains and low terraces along the valley of the Arkansas River and other large streams throughout the county. They are fertile and friable, but they are subject to occasional flooding. Depth to the water table ranges from about 5 to 10 feet. In some places the underlying material is mottled. The solum is calcareous at the surface or within about 12 inches of the surface.

The Humbarger soils have a thinner A horizon and are more calcareous than the Dale soils. They lack the shallow water table and the mottling in the subsoil that are common in the Leshara soils.

Typical profile of Humbarger clay loam about 6 miles west of Dodge City, along U.S. Highway No. 50, 220 yards south of the center of sec. 22, T. 26 S., R. 26 W.:

A1—0 to 14 inches, dark grayish-brown (10YR 4/2) clay loam, vary dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; friable when moist, slightly hard when dry; calcareous; gradual boundary.

AC—14 to 22 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, granular structure; friable when moist, hard when dry; highly calcareous; gradual boundary.

C1—22 to 54 inches, light brownish-gray (10YR 6/2) clay loam, grayish brown (10YR 5/2) when moist; weak, medium, subangular blocky structure; friable when moist, hard when dry; highly calcareous; gradual boundary.

IIC2—54 to 66 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; massive (structureless); highly calcareous; clear boundary.

IIIC3—66 to 72 inches, pale-brown (10YR 6/3) loamy fine sand, dark brown (10YR 4/3) when moist; single grain (structureless); mottled with brown stains; noncalcareous.

The texture of the A horizon ranges from clay loam to silt loam. The thickness of the A horizon ranges from about 5 to 15 inches.

Las Animas Series

The Las Animas series consists of young, nearly level Alluvial soils on the flood plains of the Arkansas River. The soils are mottled, calcareous sandy loams. They have a weakly developed profile and range from shallow to moderately deep over sand. These soils lie near the river channel and are closely associated with the Lincoln and Leshara soils.

The Las Animas soils have a lighter colored solum and a more strongly mottled subsoil than the Canadian soils. Their solum is also thinner over the sandy substratum than that of the Canadian soils, and the water table is nearer the surface.

Typical profile of Las Animas sandy loam 990 feet north and 50 feet east of the SW. corner of sec. 28, T. 27 S., R. 21 W.:

A1—0 to 6 inches, grayish-brown (10YR 5/2) sandy loam, dark grayish brown (10YR 4/2) when moist; moderate, medium and fine, granular structure; friable when moist, slightly hard when dry; calcareous; gradual boundary.

AC—6 to 11 inches, light brownish-gray (10YR 6/2) sandy loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; friable when moist, slightly hard when dry; calcareous; porous; many, open, fine rootlet channels; many worm casts; gradual boundary.

C1—11 to 23 inches, light brownish-gray (10YR 6/2) light sandy loam, brown (10YR 5/3) when moist; common, fine, distinct, strong-brown mottles; weak, fine, granular structure; very friable when moist, soft when dry; calcareous; porous; many, open, fine rootlet channels; diffuse boundary.

C2—23 to 32 inches, very pale brown (10YR 7/3) loamy fine sand, pale brown (10YR 6/3) when moist; common, medium, distinct, strong-brown and yellowish-brown mottles; single grain (structureless); loose; calcareous; abrupt boundary.

IIC3—32 to 37 inches +, stratified sand and fine gravel.

In most places the A horizon is sandy loam, but in some places there is a thin surface layer of fine sandy loam. The C horizon is stratified and consists mainly of sandy loam. Depth to sand ranges from 15 to 40 inches.

Leshara Series

The Leshara series is made up of nearly level, imperfectly drained Alluvial soils on the flood plain of the Arkansas River. These soils are deep and moderately deep, mottled, calcareous clay loams that are underlain by a sandy substratum. They are subject to flooding.

The Leshara soils have a darker surface layer than the Las Animas soils, and their subsoil is clay loam instead of sandy loam. They have a shallower water table than the Humbarger soils, and unlike the Humbarger soils, their subsoil is mottled.

Typical profile of Leshara clay loam 700 feet south and 100 feet west of the NE. corner of sec. 11, T. 27 S., R. 24 W.:

A1—0 to 26 inches, very dark grayish-brown (10YR 3/2) clay loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; friable when moist; porous and permeable; calcareous; gradual boundary.

AC—26 to 36 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) when moist; weak, medium, subangular blocky structure; common, fine, distinct, strong-brown and gray mottles; firm when moist; porous and permeable; calcareous; gradual boundary.

C1—36 to 45 inches, light brownish-gray (10YR 6/2) clay loam, grayish brown (10YR 5/2) when moist; massive (structureless); common, medium, distinct strong-brown and yellowish-brown mottles; calcareous; clear boundary.

IIC2—45 to 60 inches +, pale-brown (10YR 6/3) sandy loam, yellowish brown (10YR 5/4) when moist; common, coarse, prominent, strong-brown mottles; calcareous; stratified with subordinate lenses of loamy sand and clay loam.

The A horizon ranges from brown to very dark grayish brown in color and from 12 to 30 inches in thickness. The C horizon is commonly clay loam, but contains sandy loam and loamy sand in some areas. Depth to mottling ranges from 30 to 40 inches, but depth to sand ranges from 18 to 60 inches.

Lincoln Series

The Lincoln series consists of Alluvial soils on the flood plain of the Arkansas River. The soils are light colored and calcareous. They have a fluctuating water table at a depth of 2 to 5 feet. They are mainly on dikes, in channeled areas, and in weakly undulating areas near the main river channel, but they are between channels in some places.

The Lincoln soils are more sandy than the Las Animas soils.

Typical profile of Lincoln sand in the NE. quarter of the NE. quarter of sec. 32, T. 27 S., R. 21 W.:

A1—0 to 6 inches, grayish-brown (10YR 5/2) sand, dark grayish brown (10YR 4/2) when moist; single grain (structureless); loose when dry or moist; calcareous; gradual boundary.

C1—6 to 12 inches, pale-brown (10YR 6/3) fine sand, brown (10YR 5/3) when moist; single grain (structureless); loose when dry or moist; calcareous; stratified with thin lenses of sandy loam; clear boundary.

IIC2—12 inches +, erratically stratified sand and fine gravel that contains some lenses of sandy loam and clay loam.

The texture of the surface layer ranges from sand to fine sandy loam or clay loam. The material beneath the surface is calcareous sand or fine sand thinly stratified with fine sandy loam.

Lubbock Series

In the Lubbock series are well-drained, dark-colored Reddish Chestnut soils of the upland. These soils developed in eolian and old alluvial sediment. In this county they are mapped only with the Dalhart soils. They occur in a small area in the east-central part of the county between the Arkansas River and Coon Creek.

The Lubbock are darker than the Dalhart soils. They also contain more clay and less sand.

Typical profile of Lubbock clay loam 1,650 feet south and 150 feet east of the NW. corner of sec. 13, T. 27 S., R. 22 W.:

A1—0 to 8 inches, very dark grayish-brown (10YR 3/2) clay loam very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; friable when moist; noncalcareous; pH 6.2; gradual boundary.

B21t—8 to 15 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, subangular blocky structure; firm when moist, very hard when dry; thin, continuous clay films; noncalcareous; gradual boundary.

B22t—15 to 27 inches, brown (10YR 5/3) clay loam, dark brown (10YR 3/3) when moist; moderate, medium, subangular blocky structure; firm when moist, hard when dry; thin, discontinuous clay films; noncalcareous; gradual boundary.

B3ca—27 to 44 inches, brown (10YR 5/3) light clay loam, brown (10YR 4/3) when moist; weak, medium, subangular blocky structure; friable when moist, hard when dry; porous; many wormholes and fine rootlet channels; calcareous with a few, fine, lime concretions and thin coatings of lime on the surfaces of peds; clear boundary.

IIC—44 to 66 inches +, pale-brown (10YR 6/3) heavy sandy loam, brown (10YR 4/3) when moist; massive, but a suggestion of weak, fine, granular structure; friable when moist, slightly hard when dry; calcareous.

The A horizon ranges from very dark grayish brown to dark grayish brown in color and from 4 to 10 inches in thickness. The B horizon ranges from dark grayish brown to brown in color, from clay loam to heavy clay loam in texture, and from 15 to 24 inches in thickness. Depth to calcareous material ranges from 18 to 40 inches. Below a depth of about 3 feet, the texture ranges from sand to clay.

Mansic Series

In the Mansic series are Reddish Chestnut soils that are intergrading toward Regosols. These soils are deep, well-drained, dark, calcareous clay loams. They are nearly level to strongly sloping and occur throughout the county on the upland.

Unlike the Ulysses soils, the Mansic soils have a clay loam texture throughout the solum. They are also calcareous at the surface and have less structural development in the subsoil. The Mansic soils have a darker A horizon than the Mansker soils, and they also have a weaker horizon of lime accumulation.

Typical profile of Mansic clay loam, 850 feet west and 180 feet north of the SE. corner of sec. 19, T. 29 S., R. 25 W.:

A1—0 to 8 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; friable when moist, hard when dry; calcareous; gradual boundary.

AC—8 to 17 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, granular structure; firm when moist, hard when dry; calcareous; gradual boundary.

Cca—17 to 28 inches, light-gray (10YR 7/2) clay loam, grayish brown (10YR 5/2) when moist; weak, fine, granular structure; friable when moist, slightly hard when dry; strongly calcareous; many, fine and medium, soft lime concretions; gradual boundary.

C—28 to 46 inches +, light yellowish-brown (10YR 6/4) clay loam, yellowish brown (10YR 5/4) when moist; massive (structureless); friable when moist, hard when dry; calcareous; a few, fine, soft lime concretions.

The A horizon ranges from 5 to 12 inches in thickness. It is commonly calcareous at the surface, but in some places it is noncalcareous to a depth of as much as 7 inches. Depth to lime films and concretions ranges from 7 to 22 inches.

Mansker Series

The Mansker soils are in the Calcisol great soil group. They are grayish-brown soils of the upland and are shallow to moderately deep, highly calcareous, and well drained. These soils developed in old alluvium and in sediment that resembles loess. This sediment is high in lime and contains some caliche.

Some areas of Mansker soils in this county are mapped in a complex with the Potter soils, which are Lithosols. The complex occurs on slopes north of the valley of the Arkansas River and in some places along the major streams. Nearly level and gently sloping Mansker soils also occupy a small acreage between the Arkansas River and Coon Creek in the east-central part of the county.

The Mansker soils have a lighter colored surface layer than the Mansic soils. They also have a stronger lime zone.

Typical profile of Mansker clay loam about 2.5 miles north of Ford, 250 feet north and 100 feet east of the SW. corner of sec. 21, T. 27 S., R. 22 W.:

A1—0 to 7 inches, grayish-brown (10YR 5/2) light clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; friable when moist; calcareous; gradual boundary.

ACca—7 to 19 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 4/3) when moist; weak, medium, subangular blocky structure; slightly hard when dry; strongly calcareous with many, medium, soft lime concretions and lime films; gradual boundary.

Cca—19 to 48 inches +, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) when moist; massive (structureless); strongly calcareous with many, large, soft to hard lime concretions that make up about 20 percent of the soil mass.

In some places the texture of the A horizon is clay loam, loam, or fine sandy loam. In other places, where the Mansker soils grade to Pratt or Otero soils, the texture is loamy fine sand. The surface layer ranges from 4 to 12 inches in thickness. Depth to caliche ranges from 18 to 26 inches.

Ortello Series

The soils of the Ortello series are Chernozems. The soils are deep, dark colored, well drained, and nearly level to undulating, and they developed in noncalcareous eolian material. They are on the uplands in a narrow strip about 1 to 4 miles wide, south of the valley of the Arkansas River. The slopes are dominantly about 3 percent but range from 2 to 8 percent.

These soils are less sandy and are darker than the Pratt soils, and they have better drainage than the Carwile soils. They are darker than the Otero soils. The Ortello soils are also noncalcareous to a depth of about 4 feet, instead of calcareous at or near the surface.

Typical profile of Ortello fine sandy loam about 13 miles east of Dodge City, 100 feet north and 50 feet east of the SW. corner of NW. quarter of sec. 5, T. 27, S., R. 22 W.:

A1—0 to 14 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; friable when moist; uppermost 5 inches (the plow layer) has weak, platy structure; noncalcareous; pH 6.5; gradual boundary.

B2t—14 to 45 inches, brown (10YR 5/3) heavy fine sandy loam, brown (10YR 4/3) when moist; moderate, fine, granular structure; friable when moist; few rootlet channels; noncalcareous; pH 6.5; gradual boundary.

C—45 to 50 inches +, brown (10YR 5/3) loamy fine sand, brown (10YR 4/3) when moist; single grain (structureless); very friable when moist; noncalcareous.

The A horizon ranges from 7 to 14 inches in thickness. In some places the surface layer is winnowed loamy fine sand that ranges from 4 to 7 inches in thickness. The B2t horizon ranges from about 16 to 30 inches in thickness. The texture of the C horizon ranges from fine sandy loam to loamy fine sand. Below a depth of about 4 feet, the texture ranges from sand to clay, but in some places it is silt loam or clay loam that is calcareous.

Otero Series

The Otero soils are Regosols. They are light-colored, calcareous, sandy, well-drained soils of the upland. These soils are on stabilized hummocks in the southwestern part of the county. They are also in the central part, north of the Arkansas River. They have developed in highly calcareous eolian sediment and in old alluvial sediment. The sediment contains clay loam layers, pockets of sand, and layers of caliche. The different textures in the profile show that these soils have been reworked by wind.

The solum of the Otero soils is calcareous throughout, instead of noncalcareous like that of the Ortello soils. It is also more stratified than that of the Ortello soils. The layers consist of clay loam, sandy loam, and loamy sand.

Typical profile of Otero fine sandy loam about 23 miles southwest of Dodge City, 550 yards north and 440 yards west of the NE. corner of the SW. quarter of sec. 31, T. 29 S., R. 25 W.:

A1—0 to 9 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, fine and medium, granular structure; very friable when moist, soft when dry; calcareous; gradual boundary.

AC—9 to 19 inches, light brownish-gray (10YR 6/2) fine sandy loam, brown (10YR 4/3) when moist; weak, medium, granular structure; very friable when moist; strongly calcareous; diffuse boundary.

Cca—19 to 37 inches, pale-brown (10YR 6/3) loamy fine sand, brown (10YR 4/3) when moist; almost structureless; very friable when moist; strongly calcareous; many, fine, soft lime concretions and lime films; clear boundary.

IIC—37 to 60 inches, brown (10YR 5/3) clay loam, brown (10YR 4/3) when moist; weak, medium, subangular blocky structure; friable when moist; strongly calcareous; thin lime films on the surfaces of peds and few, fine, soft lime concretions.

The A horizon is commonly grayish-brown fine sandy loam that ranges from 9 to 18 inches in thickness. In many places, however, where the soil material has been winnowed, the surface layer is loamy fine sand and ranges from about 4 to 7 inches in thickness. The C horizon is commonly pale-brown loamy fine sand or fine sandy loam, but it contains lenses of fine sand and clay loam. The material below a depth of 3 feet is variable. In places it is highly calcareous, brown clay loam that contains large, white concretions. In other places it is very pale brown, calcareous loamy fine sand and may contain sand pockets or layers of caliche.

Potter Series

In the Potter series are highly calcareous, light-colored soils of the Lithosol great soil group. The soils are shallow, strongly sloping, excessively drained loams and clay loams of the upland. They are along the northern side of the valley of the Arkansas River, and locally they are in the valleys of the major streams in the county. The areas are rolling, rough, and broken, and in some places they include the shoulders of hills. In some places steep, nearly vertical banks of caliche are within the areas. The slope ranges from 15 to 40 percent.

In places the Potter soils are mapped in a complex with the Mansker soils. They are shallower, more sloping, and lighter colored than the Mansker soils.

Typical profile of Potter clay loam about 0.5 mile east of Fort Dodge, along the north side of U.S. Highway No. 154:

A1—0 to 5 inches, light brownish-gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) when moist; moderate, fine, granular structure; friable when moist; calcareous; few cobbles and pebbles of caliche on the surface and evenly distributed throughout the horizon.

C—5 to 12 inches, very pale brown (10YR 8/3) clay loam, pale brown (10YR 6/3) when moist; massive; strongly calcareous; abundant, large, soft lime concretions and numerous, semihard and hard caliche pebbles, cobbles, and stones; weakly indurated.

R—12 inches +, semihard and hard, fractured caliche.

The color of the A horizon ranges from light gray or pale brown to light brownish gray. The texture is clay loam or loam that ranges from about 4 to 10 inches in thickness. The underlying layers are mostly caliche, but there is some hardened material. There are pockets of sand and gravel in places.

Pratt Series

The Pratt soils are in the Reddish Chestnut great soil group. They are deep, very friable, noncalcareous sandy soils of the upland. These soils have a weak, textural B horizon, but there is only a weak horizon or no horizon where carbonates have accumulated. These soils have developed in a mantle of eolian material derived partly from old alluvium and partly from other deposits of loess.

The underlying material consists of layers of loamy fine sand, fine sand, and sandy loam. The layers vary in thickness. In some places pockets of gravel or sand occur.

The Pratt soils are darker, less sandy, and deeper over sand than the Tivoli soils. They are more sandy throughout than the Ortello soils.

Typical profile of Pratt loamy fine sand about 5 miles north of Ford and 330 yards north and 100 yards east of the SW. corner of sec. 8, T. 27 S., R. 22 W.:

A1—0 to 9 inches, grayish-brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; weak, fine and medium, granular structure; very friable when moist; noncalcareous; gradual boundary.

B2t—9 to 28 inches, brown (10YR 5/3) heavy loamy fine sand, brown (10YR 4/3) when moist; weak, medium and fine, granular structure; friable when moist; noncalcareous; diffuse boundary.

C—28 to 54 inches, pale-brown (10YR 6/3) loamy fine sand, brown (10YR 5/3) when moist, single grain (structureless); very friable when moist, soft when dry; noncalcareous.

The A horizon is mainly loamy fine sand about 7 to 11 inches thick. In some places, however, the soil material has been winnowed, and the surface layer is fine sand that is 4 to 7 inches thick. The color of the B2t horizon ranges from brown to grayish brown, and the texture, from heavy loamy fine sand to near light fine sandy loam. The material below a depth of 3 feet is stratified. It is commonly loamy fine sand or fine sand, but in some places there are layers of sandy loam and fine gravel. In some places there are pockets of gravel or sand.

Randall Series

The Randall soils, in the Grumusol great soil group, are deep, nearly level, poorly drained, gray, noncalcareous clays. They have little or none of the horizonation common to zonal soils. These soils are on the floors of enclosed depressions or intermittent lakes. They are often ponded, for the depressions hold water after rains. At times, however, they are dry for 1 to 3 years. The ponding delays or prohibits farming. The depressions are round or oblong. Their size ranges from small spots of less than 1 acre to large areas of more than a section. Most of the depressions are between 3 and 20 acres in size.

The Randall soils have less well-defined horizons and contain more clay than the Harney and Spearville soils. Also, they are 3 to 10 feet lower than those soils.

Typical profile of Randall clay about 6 miles north of Dodge City, 150 feet north and 50 feet west of the SE. corner of sec. 24, T. 25 S., R. 25 W.:

A1—0 to 31 inches, gray (10YR 5/1) clay, very dark gray (10YR 3/1) when moist; moderate, fine, blocky structure in upper part, moderate, medium, blocky structure in lower part; extremely hard when dry, plastic when wet; noncalcareous; gradual boundary.

AC—31 to 40 inches, grayish-brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) when moist; weak, medium, blocky structure; very hard when dry, plastic when wet; weakly calcareous; gradual boundary.

C—40 to 63 inches, light brownish-gray (10YR 6/2) silty clay loam, grayish brown (10YR 5/2) when moist; massive (structureless); friable when moist, slightly hard when dry; calcareous.

The clay ranges from about 3 feet to 10 feet in thickness. Its color ranges from gray to very dark gray. The substratum, below a depth of 40 inches, ranges from sand to clay.

Spearville Series

The Spearville soils are Chernozems. They are deep, dark, well-drained soils of the upland. Their subsoil is firm clay. These soils developed in calcareous loamy loess. They are nearly level or gently sloping; the slopes are mainly less than 1 percent. Part of the acreage is in the northwestern corner of the county, and part is near the town of Spearville.

The Spearville soils have a thinner A horizon than the Harney soils. They also have more clay in the subsoil.

Typical profile of Spearville silty clay loam about 8 miles northwest of Dodge City, 346 feet south and 178 feet west of the NE. corner of sec. 22, T. 25 S., R. 26 W.:

A1—0 to 6 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate medium, granular structure; friable when moist, hard when dry; noncalcareous; pH 6.5; clear boundary.

B21t—6 to 13 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) when moist; moderate, fine, blocky structure; very firm when moist, very hard when dry; clay films thick and continuous; noncalcareous; pH 7.0; gradual boundary.

B22t—13 to 21 inches, grayish-brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) when moist; moderate, medium, blocky structure; very firm when moist, extremely hard when dry; clay films thick and continuous; noncalcareous; pH 7.5; gradual boundary.

B3ca—21 to 26 inches, grayish-brown (10YR 5/2) heavy silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium and coarse, blocky structure; friable when moist, hard when dry; clay films thin and discontinuous; strongly calcareous; common, fine, soft lime concretions and lime films; gradual boundary.

C—26 to 52 inches +, pale-brown (10YR 6/3) light silty clay loam, brown (10YR 5/3) when moist; massive (structureless); friable when moist, slightly hard when dry; porous and permeable; calcareous.

The A horizon ranges from 4 to 10 inches in thickness. In some places its color is grayish brown instead of dark grayish brown. The color in the lower part of the B horizon and in the C horizon is lighter than that in the upper part of the B horizon. Depth to calcareous material ranges from 15 to 25 inches.

Tivoli Series

The Tivoli soils are light-colored, loose fine sands of the upland. They are in the Regosol great soil group. These soils are hummocky. The slopes range from 6 to 15 percent, but in most places they are about 8 percent.

The Tivoli soils are lighter colored than the Pratt. They also contain more sand.

Typical profile of Tivoli fine sand in the SW. quarter of sec. 2, T. 28 S., R. 21 W.:

A1—0 to 6 inches, pale-brown (10YR 6/) fine sand, brown (10YR 5/3) when moist; single grain (structureless); loose when moist or dry; noncalcareous; diffuse boundary.

C—6 to 60 inches +, very pale brown (10YR 7/4) fine sand, light yellowish brown (10YR 6/4) when moist; single grain (structureless); loose when moist or dry; noncalcareous.

The color of the A horizon ranges from brown to very pale brown, and the thickness, from 4 to 10 inches. The color of the C horizon ranges from very pale brown to brown. Depth to calcareous material ranges from 36 to more than 70 inches. The texture of the material below a depth of 4 feet ranges from sand to clay.

Ulysses Series

In the Ulysses series are deep, well-drained Chestnut soils that are intergrading toward the Regosol great soil group. These soils are gently sloping and sloping and are on the upland. They developed in loamy loess. Their structure is granular.

The Ulysses soils are darker than the Colby soils, and they are noncalcareous to a slightly greater depth. They contain less clay than the Mansic soils, and unlike those soils, they have a weak B horizon. They have less prominent horizons of carbonate accumulation than the Mansic or Mansker soils.

Typical profile of Ulysses silt loam about 15 miles southeast of Dodge City, 528 feet north and 300 feet east of the center of sec. 19, T. 28 S., R. 23 W.:

A1—0 to 9 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; friable when moist, slightly hard when dry; noncalcareous; gradual boundary.

B2—9 to 17 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure, breaking to moderate medium granular; friable when moist, slightly hard when dry; porous; numerous worm casts and insect burrows; calcareous; gradual boundary.

Cca—17 to 38 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) when moist; weak, medium, granular structure; friable when moist, slightly hard when dry; porous; many worm casts and open rootlet channels; strongly calcareous; many, fine, soft lime concretions and thin lime films; gradual boundary.

C—38 to 71 inches +, pale-brown (10YR 6/3) light clay loam, brown (10YR 5/3) when moist; massive (structureless); friable when moist, slightly hard when dry; porous and permeable; many worm casts and open rootlet channels; strongly calcareous; thin seams of lime in upper part.

The A horizon ranges from grayish brown to dark grayish brown in color and from 5 to 15 inches in thickness. Depth to calcareous material ranges from 5 to 15 inches. The color of the C horizon ranges from pale brown to very pale brown. The texture ranges from loam to light clay loam, but silt loam is the most common.

Climate[6]

Ford County, located in southwestern Kansas, has a dry, subhumid, continental climate. The Rocky Mountains, which lie 300 miles to the west, form a barrier to moisture from the Pacific Ocean. Air laden with moisture from the Gulf of Mexico generally flows toward the north, somewhat east of the county. The relatively dry air, the abundance of sunshine, and the elevation of approximately 2,500 feet contribute to the large daily range in temperature. The open plains permit cold air to invade from the north and favor great extremes in seasonal and annual temperature. Besides the fluctuations in temperature and precipitation that occur within a short period, there are longer climatic trends.

Detailed records of temperature and precipitation have been kept at the U.S. Weather Bureau at Dodge City since October 1874, the date the station was established. Data for precipitation have been kept at Bucklin since January 1920. The monthly means (averages) and extremes of temperature and precipitation, as recorded at Dodge City, are given in table 10.

Figure 14 shows the means and extremes of temperature and the possible periods when a temperature of 100° F., 32°, or 0° will occur. The information is based on records of the U.S. Weather Bureau at Dodge City. Also shown are the highest and lowest monthly temperatures on record and the dates that they occurred.

Temperatures have ranged from a maximum of 109° F., on both July 31, 1934, and August 13, 1936, to a minimum of −26° on February 12, 1899. (See fig. 14.) A temperature of 100° or higher has occurred as early as May 21 (1925) and as late as September 18 (1954). The earliest date on which a freezing temperature has occurred in fall is September 23 (1895), and the latest in spring is May 27 (1907). Temperatures of zero or below have been recorded as early in fall as November 17 (1880) and as late in spring as March 20 (1876). The highest minimum daily temperature on record was 80° on July 1, 1933, and on two later dates. The lowest maximum daily temperature was −13° on January 13, 1875.

The following, taken from records kept at Dodge City, shows the 5 years with the greatest number of days when the temperature reached 100° or higher:

Year	*Number of days*
1934	42
1936	36
1943	26
1952	22
1954	25

The following, also taken from records kept at Dodge City, shows the 7 years with the greatest number of days when the temperature dropped to zero or below:

Year	*Number of days*
1884–85	20
1887–88	19
1874–75	18
1880–81	17
1904–05	15
1911–12	15
1917–18	15

[6] By A. D. Robb, State climatologist, U.S. Weather Bureau, Topeka, Kans.

TABLE 10.—*Temperature and precipitation at Dodge City, Kansas*
[Elevation 2,594 feet]

Month	Temperature					Precipitation			
	Average	Absolute maximum		Absolute minimum		Average	Driest year	Wettest year	Average snowfall
	°F	°F	Day/year	°F	Day/year	Inches	Inches	Inches	Inches
January	30.0	79	5/1927	−20	19/1885	0.45	0.76	0.96	3.6
February	34.0	85	14/1954	−26	12/1899	.73	.34	.77	4.9
March	42.5	98	19/1907	−15	11/1948	1.00	.25	1.41	4.4
April	53.9	95	28/1910	9	2/1936	1.90	.99	4.13	1.0
May	63.3	101	[1] 26/1953	19	1/1909	3.02	1.44	6.95	([2])
June	73.4	107	[1] 30/1933	36	2/1917	3.17	1.20	4.53	0
July	78.8	109	18/1936	46	10/1905	2.83	2.13	5.40	0
August	77.6	109	13/1936	43	30/1915	2.52	1.08	5.11	0
September	69.3	106	3/1947	30	[2] 29/1895	1.76	.02	1.36	0
October	57.0	95	[2] 3/1954	10	27/1878	1.40	1.73	1.58	.2
November	42.7	86	[2] 10/1927	−13	20/1887	.75	.03	.93	1.7
December	33.3	86	24/1955	−15	26/1876	.57	([1])	1.16	3.2
Year	54.7	109	[2] Aug. 13, 1936	−26	Feb. 12, 1899	20.10	9.97	34.29	19.0

[1] Also occurred on earlier dates.
[2] Trace.

Extremes of both zero and 100° are to be expected each year. About one winter in eight, however, may pass without a reading of zero or lower. Summers without a temperature of 100° or higher are equally rare. During the 24 consecutive winters from the fall of 1896 to the spring of 1920, a temperature of zero or below was recorded at least 1 day in each season. On no day was there a temperature of 100° in the 3 consecutive years of 1883, 1884, and 1885. From 1915 through 1957, however, the temperature reached 100° or higher at least 1 day in each summer.

Records kept over the years show that temperatures of 32° or lower occur more frequently from December 25 to December 28 than at any other time. The chance that a freezing temperature will occur on each of these days is greater than 95 percent, and the chance that a minimum of 32° or lower will occur is 90 percent or greater on each day from December 6 through February 10. The period

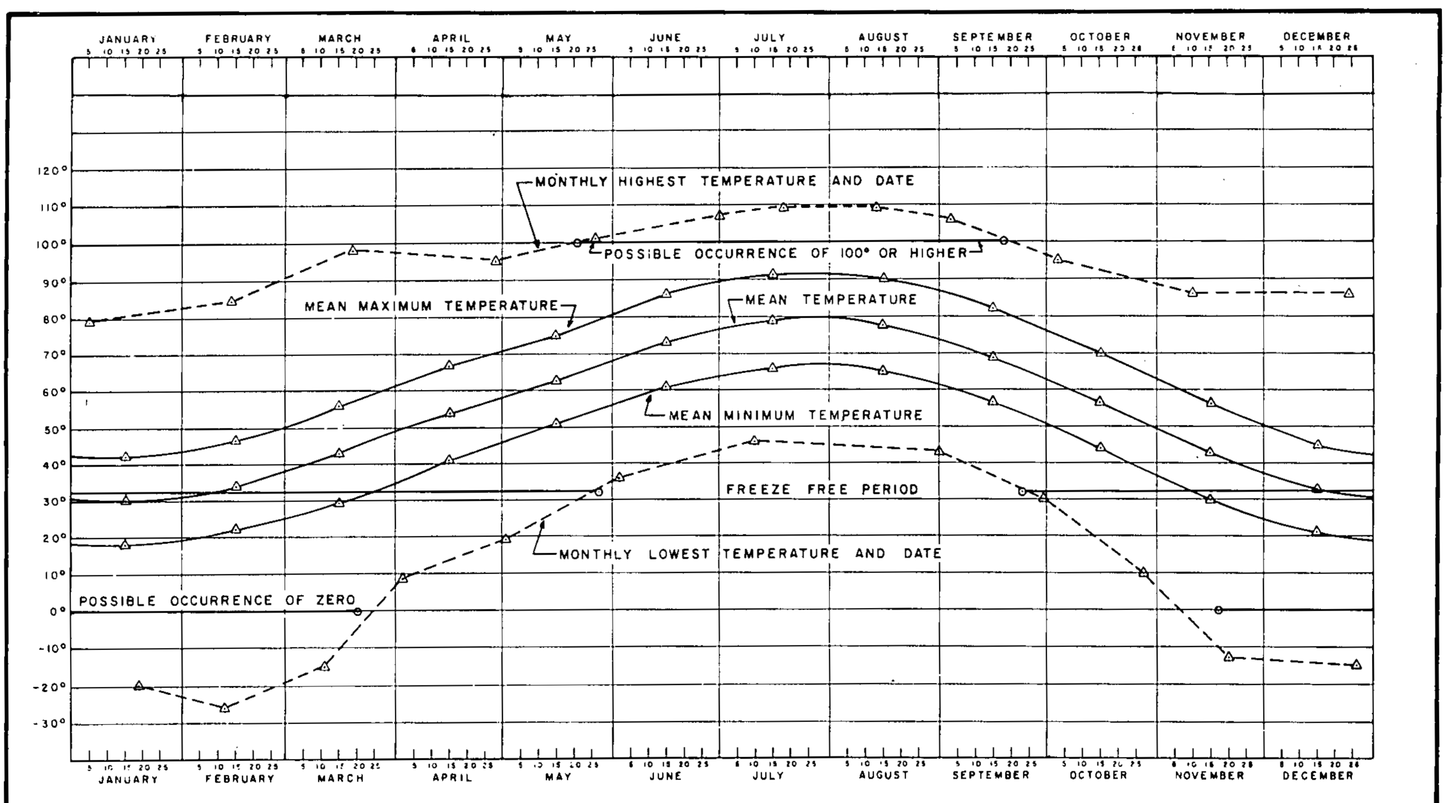

Figure 14.—**Means and extremes of temperature at Dodge City.**

when the chance is greatest that the minimum temperature will drop to zero or below on any 1 day is from January 1 to January 20, but during that period the temperature drops to zero only about once in 8 years. Approximately once in 20 years, the temperature remains below zero all day. This occurs most often in the period January 6 to February 4. Readings of 100° or higher occur about once in 8 years. The most likely time for the occurrence of a reading of 100° or higher is from August 2 to August 4.

Freezes late in spring or early in fall rarely damage crops on the upland or irrigated crops on the lowland. The average length of the growing season is 184 days, or April 22 to October 24. As determined by the occurrence of killing frosts, the shortest growing season on record was 148 days. That growing season lasted from May 11 to October 7 and occurred in 1891. The longest growing season on record was 238 days. It lasted from March 1 to October 25 and occurred in 1929. The earliest date of the last freezing temperature in spring (32° or lower) was March 1, 1929, and the latest date of the first freezing temperature in fall was November 13, 1937.

During much of the year, the precipitation is about evenly distributed throughout the 24 hours of the day. In the summer months of June through August, rainfall is much more frequent at night than during the day. The amount of rainfall also shows a corresponding decline in the daytime, especially between 8 a.m. and 1 p.m. (*5*). Rains that fall slowly, even though of small amount, are of greater benefit than hard, beating rains because they penetrate more deeply and cause little or no runoff.

Precipitation in this county is variable. Most of the rain falls in the form of thundershowers in summer. The showers are often accompanied by strong to violent winds, and sometimes by damaging hail. The average monthly precipitation increases from approximately one-half inch in December and January to 3 inches or slightly more in May and June. Accordingly, the number of days when there is a measurable amount of precipitation increases from 3 days in December to 11 in May. The larger amount of rain that has fallen in a 24-hour period, a total of 3 inches or more, generally has fallen during the period from July through October.

Both the lack of precipitation and the erratic nature of the precipitation are important to the production of crops in Ford County. An example of the erratic nature of the precipitation was the downpour of 6.03 inches which occurred during a 24-hour period on June 8 and 9 in 1899. At the opposite extreme, a total of 86 consecutive days occurred during the period June 14 through September 7, 1913, without as much as 0.25 of an inch of rainfall on any 1 day. About one dry period of at least 30 days without a 24-hour fall of 0.25 inch may be expected almost every year between April 1 and September 30 (*5*).

Grain sorghum, one of the major crops of the area, generally requires approximately 15 inches or more of precipitation during the growing season for production of a creditable crop (*10*). Slightly less than half the summers, 40 out of 86, had less than 15 inches of precipitation. Although 15 inches of rain is desirable during the growing season, it is not absolutely necessary for a good crop, because of the timeliness and amount of rainfall and the initial moisture stored in the soils. The frequency with which a deficiency of rainfall occurs shows that the best practices available are needed for managing the soils, and irrigation should be used if feasible.

Figure 15 shows the annual precipitation and the precipitation during the growing season of March through September, based on records of the U.S. Weather Bureau at Dodge City. The average annual precipitation at Dodge City was 20.10 inches for the period 1875 to 1960, as shown in figure 15. There is a wide range in the amount of precipitation. Only 9.97 inches fell in 1956, as compared to 34.29 inches in 1944. In eight of the years during the period 1875 to 1960, the annual precipitation was more than 30 inches, and in seven of those years it was less than 12 inches. The average precipitation for the growing season of March through September is 16.02 inches, as shown in figure 15.

Figure 15 shows a number of isolated years when the amount of rainfall was exceptionally large or exceptionally small. On the dry side, it shows that less than 15 inches of precipitation fell in each of two successive growing seasons eight times between 1875 and 1960. Also, less than 15 inches of precipitation fell in each of three successive growing seasons two times in the years between 1875 and 1960, and two times in each of four successive growing seasons during the same period.

The probability of receiving no rain or of receiving only a trace in a 1-week interval in this area drops from about 75 percent in the period from January 17 to 23, to 15 percent in the periods of May 24 to 30 and June 7 to 13. In contrast, the probability of receiving 1 inch or more of rain in a 1-week period rises to 31 percent from May 31 to June 6 and then drops to none in each of the 2 weeks from December 27 to January 9. The highest probability of receiving 3 inches or more of rain in a 1-week period (5.1 percent) is in the week of April 26 to May 2 (*4*).

Snowfall of measurable depth may fall from about mid-October until the latter half of April, or on rare occasions, early in May. Probably no weather element is more variable in this county than snow. The total amount of snowfall in winter has been as small as 0.2 inch, in the winter of 1903–04, but the amount has ranged to 57.5 inches, which fell in the winter of 1911–12. In six winters there has been more than 35 inches of snowfall, and in four winters there has been 4 inches or less. March is the month in which the greatest average amount of snowfall is received. The average amount of snowfall in March is 5.8 inches. The largest total snowfall on record for that month was 22.1 inches, which fell in 1957. Yet, in 11 of the 85 years for which records have been kept, there was either no snow in March or only a trace. The value of snow as a protective cover and as a source of moisture varies with the amount of drifting. Some drifting occurs in nearly all snowfall.

A newcomer to this area notices that the air is dry and that the wind blows almost constantly. Both of these factors cause rapid evaporation of soil moisture and increase the need for rain. On the other hand, they contribute to human comfort on hot summer days. The highest relative humidity is in the morning hours. In May the average relative humidity at 6 a.m. is 83 percent. At noon and at 6 p.m., the average from June through October is between 40 and 50 percent. The relative

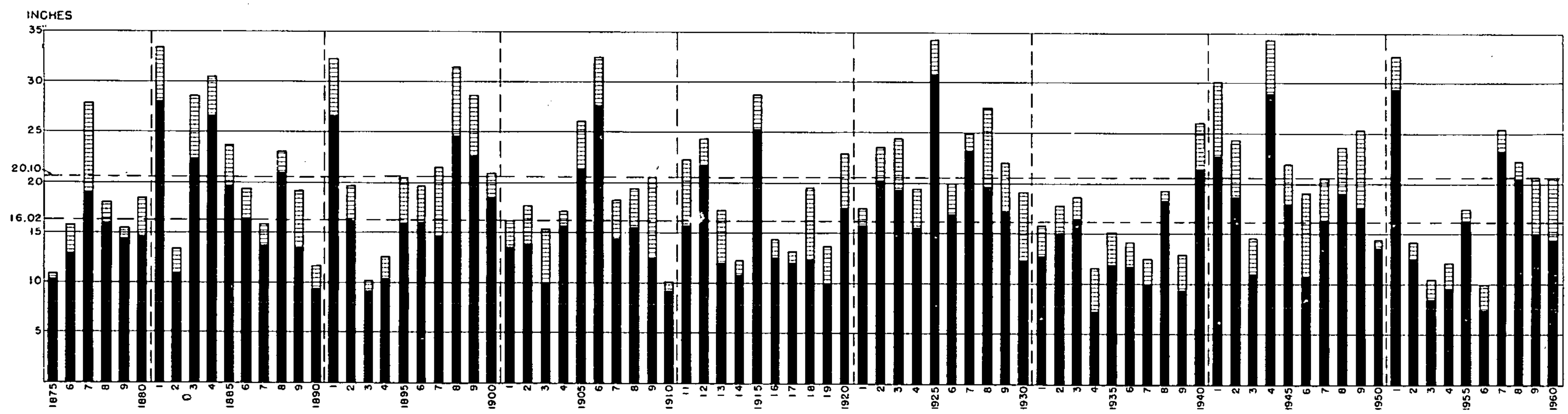

***Figure 15.*—Annual and crop season precipitation at Dodge City.** **The black, or lower, part of each bar shows the amount of precipitation during the growing season of March through September. The upper part shows the amount of precipitation from October through February.**

humidity may drop to near 10 percent for several hours on the hottest summer days.

The annual average windspeed, 15.1 miles per hour, is about 2 to 7 miles per hour higher than that in other parts of the State. There is, of course, the daily change in windspeed from the lower values during the night to increased speeds accompanying rising temperatures in daytime. There is also a seasonal difference from the high average of 16 to 17 miles per hour early in spring to the low of 14 miles per hour in July and August. Thunderstorms in summer generate the highest windspeeds. The fastest windspeed on record, 78 miles per hour, was recorded in July 1951.

Damaging storms in this area consist of hailstorms, thunderstorms, duststorms, storms accompanied by heavy, blowing snow, and an occasional tornado. Myriads of wind-driven hailstones the size of peas or marbles sometimes cut thousands of acres of wheat to shreads. Much more extensive losses of property occur occasionally, however, when the hailstones are the size of a baseball. Hailstorms occur the most frequently in May and June, but the average occurrence is only about 1 day per month for each of these 2 months. The greatest frequencies were 4 days in May, both in 1904 and in 1949, and 5 days in June in 1932.[7]

Duststorms sometimes cause erosion, when much of the surface layer is lost. They reduce visibility to a few yards, especially in long periods of dry weather when the surface is bare.

In recent years the most severe blizzards of fine snow driven by high winds occurred in March 1931, April 1938, November 1952, and March 1957. Less severe storms that cause low visibility and hazardous driving conditions may occur somewhat more frequently.

Additional Facts About the County

In this section the history of the county and the natural resources are discussed. Information is also given about the agriculture and the social and industrial development of the county. Unless otherwise indicated the agricultural statistics are from reports of the U.S. Bureau of the Census.

The county was organized in 1873. It was named for Col. James H. Ford, a commander at Fort Dodge. Fort Dodge, once a military reservation of about 12,000 acres, was the most important military outpost on the Santa Fe Trail from about 1864 to 1882.

In early days Dodge City, the county seat of Ford County, was a famous frontier town and shipping center. It was a supply station for soldiers, cowboys, buffalo hunters, homesteaders, and desperadoes from about 1822 to the early 1870's. At first it was known as Buffalo City. In 1872 it was organized as a town company, and in 1875 it was incorporated (*9*). The Santa Fe Railroad reached Dodge City in 1872 and made the city a major shipping point for cattle from the southwestern part of the United States. In 1960 Dodge City had a population of about 13,520. It is still one of the leading centers for feeder cattle in the southwestern part of Kansas.

[7] UNITED STATES DEPARTMENT OF COMMERCE and UNITED STATES WAR DEPARTMENT. THUNDERSTORM RAINFALL. Hydrometeorological Rpt. No. 5, pt. 1, pp. 146–151. (Mimeographed.)

Other towns in the county are Bucklin, Spearville, Ford, Kingsdown, Bloom, Windhorst, Howell, and Wright. These towns range from about 70 to 800 in population, and about half are unincorporated.

Natural Resources

Soil and ground water are important natural resources in this county. Depth to the water table ranges from less than 10 feet in areas along the valley of the Arkansas River to about 200 feet in parts of the upland. Artesian wells flow from gravel beds along a narrow belt that borders Crooked Creek in the southwestern part of the county. The flow ranges from a trickle to about 3 gallons per minute.

The Ogallala formation, the principal water-bearing formation in the county, ranges from a few feet to 250 feet in thickness.

The Dakota formation furnishes water to many wells in the northeastern part of the county. It is less productive than the Ogallala formation and the water is of poorer quality. A large supply of water is also obtained from wells in alluvium of the valley of the Arkansas River. Water is lost by transpiration and evaporation, by movement through small springs, and to some extent, through wells. The ground water in this county is used for livestock, for industrial purposes, for supplying cities, and for irrigation.

Deposits of sand and gravel are other natural resources in the county. These deposits are abundant along the Arkansas River, both in the streambed and in low terraces along the edge of the present flood plain. Deposits are also worked in the northern part of the county in terraces along Sawlog Creek and its tributaries. Sand and gravel are used chiefly for road surfacing; but a smaller amount is used in concrete aggregates for paving and building structures, such as road culverts and bridges.

Building stone has been quarried in the northern part of the county. Greenhorn limestone is the kind of stone most commonly used for building, though the Dakota formation has been quarried extensively. Greenhorn limestone is used for road material and for buildings and other structures. There has been little production of gas or oil in Ford County.

Thick deposits of salt in the Wellington formation underlie the county. In sec. 26, T. 27 S., R. 22 W., the top of the salt zone is 1,970 feet below the surface, and the layer of salt is about 440 feet thick. The deposits of salt have not been tapped in this county.

Volcanic ash occurs at one location on the line between Ford and Clark Counties.

In the north-central part of the county, the Dakota formation (Janssen member) has been quarried for ceramic clay. The clay of the Janssen member in this county has some characteristics of flint clay because it is hard and resists slaking in water. At present this clay is not being used (*18*).

In 1936 samples of rock from exposures of the Ogallala formation and Greenhorn limestone along Sawlog and Duck Creeks, northeast of Dodge City in Ford County, were tested to determine their suitability for making rock wool. Extremely fine, white rock wool was made from samples of mortar beds of the Ogallala formation (*18*).

Agriculture

Ford County is in the center of a large area that produces hard winter wheat and grain sorghum. The principal market for the grain produced in the southwestern part of the State is Dodge City. During the 20-year period from 1931 to 1951, including the drought years of the 1930's, the county held the State record for wheat produced in 1 year (8,541,000 bushels). In 1952 the county exceeded its own record and produced a crop of 8,601,000 bushels. A record crop was not produced in 1958, but a total of 5,397,000 bushels of wheat was harvested. Table 11 gives the acreage of the principal crops in stated years. Income from the sale of field crops accounted for nearly 31 percent of the total income derived from the sale of farm products.

TABLE 11.—*Acreage of principal crops in stated years*

Crop	1939	1949	1959
Small grains harvested:	*Acres*	*Acres*	*Acres*
Wheat	144, 411	320, 176	264, 169
Oats	222	1, 652	869
Barley	994	4, 610	8, 326
Rye	(1)	349	1, 088
Corn for all purposes	433	518	1, 095
Hay crops, total	1, 327	3, 868	4, 462
Alfalfa and alfalfa mixture cut for hay	764	2, 736	3, 454
Sorghum for all purposes except sirup	10, 502	22, 103	68, 609

[1] Not available.

In Ford County more than 69 percent of the total income derived from the sale of farm products was derived from the sale of livestock and livestock products. Cattle are the principal kind of livestock raised in the county, but sheep are also important. The numbers of cattle and sheep fluctuate from year to year, depending on the availability of sorghum stubble and wheat for grazing. The kinds and numbers of livestock in the county in stated years are given in table 12.

TABLE 12.—*Number of principal livestock on farms in stated years*

Livestock	1940	1950	1959
Cattle and calves	[1] 13, 110	32, 224	58, 666
Milk cows	4, 225	3, 203	2, 225
Horses and mules	[1] 1, 314	1, 233	604
Hogs and pigs	[2] 1, 869	3, 427	5, 197
Sheep and lambs	[3] 1, 353	3, 003	15, 596
Chickens	[2] 74, 998	[2] 72, 921	[2] 55, 633

[1] More than 3 months old.
[2] More than 4 months old.
[3] More than 6 months old.

Size, type, and tenure of farms.—The trend is toward larger farms in Ford County. Most of the farms are between 500 and 999 acres in size (*8*). In 1950 the average size of farms in Ford County was 564.2 acres; in 1954 it was 603.6 acres; and in 1959 it was 692.2 acres.

In 1959 the county had 536 cash-grain farms, 308 livestock farms other than poultry and dairy, 23 dairy farms, and 42 general farms. The rest of the farms were miscellaneous and unclassified.

The trend in the county is toward an increase in part ownership. Fewer farms are now operated by the owner. Many farms are operated by tenants, and a few are operated by managers.

Social and Industrial Development

Dodge City has five public elementary schools, one parochial elementary school, a junior high school, a senior high school, a junior college, and a senior college. Other facilities include a public library, two hospitals, 18 churches representing 16 denominations, a radio station, a television station, a daily newspaper, and a weekly newspaper. Spearville has a hospital and a weekly newspaper, and nearly all of the other towns have schools and churches. In addition to the schools located in the towns, four rural elementary public schools and a rural public high school are located in the county.

All the towns and more than 90 percent of the residents in the rural part of the county have electricity available. It is estimated that between 95 and 98 percent of the farms where residents live year round have electricity.

A generating plant in Fort Dodge uses natural gas to create steam as a source of power. A major transmission line from the plant at Fort Dodge to Medicine Lodge, Barber County, parallels the Arkansas River to Ford and crosses diagonally across the county to the southeast.

Transportation.—County roads are well located throughout this area. There are about 150 miles of black-top roads and 232 miles of sand-and-gravel roads in the county. These roads are kept in good condition, and they are readily accessible to all residents in the county.

The county is crossed by several major U.S. highways and by some of the minor highways. U.S. Highway No. 50 enters Ford County on the east near Offerle (Edwards County), continues through Dodge City, and leaves the county near Howell. U.S. Highway No. 54 crosses the southeastern corner of the county and runs parallel to the Rock Island Railroad. U.S. Highway No. 283 is the only north-south highway that crosses the county. U.S. Highway No. 56 crosses the county from southwest to northeast via Dodge City. U.S. Highway No. 154 begins at Dodge City and crosses to the southeast via Ford. Kansas Highway No. 34 begins at a point 4 miles northwest of Bucklin on U.S. Highway No. 154 and runs south via Bucklin.

In addition to the highways, the county is served by two railroads. Dodge City is served by one airline and five buslines.

Industries.—Dodge City is the home of a factory where auger-grain loaders are manufactured and of a company that makes portable cattle chutes. Two iron foundries in Dodge City cast most types of farm machinery and parts to meet the needs of the area. There is also a chemurgic dry-processing plant that uses biochemicals to convert grain into industrial products. Among the products derived from sorghum-grain bran and grits are wax, sizings and binders, adhesives, starch products, flour, cereals, dietary foods, livestock feed, dogfood, industrial alcohol, neutral spirits, antifreeze, brewing mash, and solvents. Concrete and concrete blocks produced in Dodge City are widely used.

The manufacturing industries in Dodge City and throughout the county produce many items. Examples are farm equipment, building material, canvas goods, food products, livestock and poultry feed, meat and dairy products, furniture, iron and metal works, neon signs, and stencils for painting textiles.

Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster, such as a clod, crumb, block, or prism.

Alkali soil. Generally, a highly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is reduced.

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

Blowout. An area from which soil material has been removed by wind.

Buried soil. One or more layers of another soil, usually at some variable depth of 18 inches or more beneath the present soil, that may be developed in the same soil as the present soil or in different soil material.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. (Called also *limy soil.*)

Caliche. A more or less cemented deposit of calcium carbonate in many soils of warm-temperate areas, as in the Southwestern States. The material may consist of soft, thin layers in the soil or of hard, thick beds just beneath the solum; or it may be exposed at the surface by erosion.

Catena. A sequence, or "chain," of soils on a landscape, developed from one kind of parent material but having different characteristics because of differences in relief and drainage.

Chlorosis. The yellowing or blanching of green parts of a plant, particularly the leaves, that is a condition resulting from the failure of chlorophyll (the green coloring matter) to develop, usually because of some deficiency of an essential nutrient. The color of leaves of chlorotic plants ranges from light green through yellow to almost white.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt. (See also Texture, soil.)

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

Clay loam. Soil textural class that contains 27 to 40 percent clay and 20 to 45 percent sand. (See also Texture, soil.)

Clayey soil. A broad group of textural classes of soils, including sandy clay, silty clay, and clay. (Also called *fine-textured soils.*)

Coarse-textured soils. A broad group of textural classes, including sands and loamy sands.

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 a concentration 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, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

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

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

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

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

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

Deep soil. Generally, a soil deeper than 40 inches to rock or other strongly contrasting material. Also, a soil that has a thick, black surface layer; or a soil in which the total depth of unconsolidated material, whether true soil or not, is about 40 inches or more.

Dispersion, soil. Deflocculation of the soil and its suspension in water.

Diversion, or diversion terrace. A ridge of earth, generally a terrace, that is built to divert runoff from its natural course and thus, to protect areas downslope from the effects of such runoff.

Eolian soil material. Soil parent material accumulated through wind action; commonly refers to sandy material in dunes.

Erosion, accelerated. Erosion of soil resulting from disturbance of the natural landscape, usually by man.

Fallow. Cropland left idle to restore productivity, mainly through the accumulation of water, plant nutrients, or both.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the oven-dry weight, after the gravitational, or free, water has been allowed to drain away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine-textured soil. A broad group of textural classes that include sandy clay, silty clay, and clay; contains 35 percent or more clay. (Also called *clayey soil.*)

Ground water. Water that fills all the unblocked pores of underlying material below the water table, which is the upper limit of saturation.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes.

Intake rate. The rate, usually expressed in inches per hour, at which rain or irrigation water enters the soil. The rate is controlled partly by surface conditions (infiltration rate) and partly by subsurface conditions (permeability).

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Basin.—Water is applied rapidly to relatively level plots surrounded by levees or dikes.

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops.

Furrow.—Water is applied in small ditches made by cultivation implements used for tree and row crops.

Sprinkler.—Water is sprayed over the surface of the soil through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Leveling. The reshaping or modification of the surface to a planned grade to provide a more suitable surface for the efficient application of irrigation water and to provide good surface drainage.

Loam. A textural class name for soils that contain a moderate amount of sand, silt, and clay. Loam contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. (See also Texture, soil.

Loess. Geological deposit of relatively uniform, fine material, mostly silt, usually transported by wind.

Morphology, soil. The makeup of the soil, including the texture, structure, consistence, color, and other physical, mineralogical, and biological properties of the various horizons of the soil profile.

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Natural drainage. Refers to the conditions that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable, and have a low water-holding capacity.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A horizon and upper part of the B horizon and have mottling in the lower part of the B and in the C horizon.

Imperfectly or somewhat poorly drained soils are wet for significant periods, but not all the time, and the podzolic soils commonly have mottling below a depth of 6 to 16 inches in the lower part of the A horizon and in the B and C horizons.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Parent material. The unconsolidated mass from which the soil profile develops.

Permeability, soil. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are *very slow, slow, moderately slow, moderate, moderately rapid, rapid, and very rapid.*

pH value. A numerical means for designating relatively weak acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity. (See also Reaction, soil.)

Profile, soil. A vertical section of the soil extending from the surface into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline	9.1 and higher
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

Saline soil. A soil that contains soluble salts in amounts large enough to impair the growth of plants but that does not contain excess exchangeable sodium.

Saline-alkali soil. A soil having a combination of a harmful quantity of salts and either a high degree of alkalinity or a high amount of exchangeable sodium, or both, so distributed in the soil profile that the growth of most crop plants is less than normal.

Sand. Individual rock or mineral fragments in soils having a diameter ranging from 0.05 millimeter to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay. (See also Texture, soil.)

Sandy clay. Soils of this textural class contain 35 percent or more clay and 45 percent or more sand. (See also Texture, soil.)

Sandy clay loam. Generally, soil material having 20 to 35 percent clay, less than 28 percent silt, and 45 percent or more sand. (See also Texture, soil.)

Sandy loam. As used in this report, a soil that contains 50 percent sand and less than 20 percent clay. Also used as a general term for a small group of textural classes of soils, including sandy loam and fine sandy loam. (See also Texture, soil.)

Sandy soil. A broad term for soil of the sand and loamy sand classes; it contains more than 70 percent sand and less than 15 percent clay.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil material of the silt textural class is 80 percent or more silt and less than 12 percent clay. (See also Texture, soil.)

Silt loam. Soil material having 50 percent or more silt and 12 to 27 percent clay, or 50 to 80 percent silt and less than 12 percent clay. (See also Texture, soil.)

Silty clay. Soil material having 40 percent or more clay and 40 percent or more silt. (See also Texture, soil.)

Silty clay loam. Soil of this textural class contains 27 to 40 percent clay and less than 20 percent sand. (See also Texture, soil.)

Slick spot. 1. A small area of alkali or Solonetz soil. 2. A small area that is slick when wet because of the presence of alkali or high exchangeable sodium (*1*).

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

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soils includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are (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).

Substratum. Any layer lying beneath the solum, or true soil; the C or D horizon.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness.

Tailwater. The water just downstream from a structure.

Texture, heavy loamy. A subdivision of the loamy soils called moderately fine textured soils; includes clay loam, sandy clay loam, and silty clay loam.

Texture, light loamy. A subdivision of loamy soils called moderately coarse textured soils; includes sandy loam and fine sandy loam.

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," and "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil. A presumably fertile soil or soil material, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

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

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GUIDE TO MAPPING UNITS, CAPABILITY UNITS, RANGE SITES, AND WINDBREAK SUITABILITY GROUPS

[See table 1, p. 6 , for approximate acreage and proportionate extent of the soils, and table 2, p. 31 for estimated average acre yields of principal dryland crops under two levels of management]

Map symbol	Mapping unit	Page	Capability unit				Range site		Windbreak suitability group	
			Dryland	Page	Irrigated	Page	Name	Page	Name	Page
Ad	Active dunes	6	VIIe-1	30	(1/)	---	Choppy sands	37	(2/)	---
An	Alluvial land	6	VIw-1	29	(1/)	---	Loamy Lowland	36	Deep Loamy and Clayey Lowland.	39
As	Alluvial land and slick-spots	6	IVs-1	28	(1/)	---	Saline Subirrigated.	36	Shallow Sandy and Clayey. Lowland.	40
Bc	Bippus clay loam, 2 to 5 percent slopes	7	IIIe-1	27	IIIe-1	34	Loamy Upland	36	Deep Loamy Upland.	39
Br	Broken alluvial land	7	VIIw-1	30	(1/)	---	(3/)	---	Deep Loamy and Clayey Lowland.	39
Ca	Canadian fine sandy loam	8	IIe-2	25	IIe-2	33	Sandy	37	Deep Sandy Lowland.	39
Da	Dale silt loam	8	IIc-2	26	I-1	33	Loamy Lowland	36	Deep Loamy and Clayey Lowland.	39
Dh	Dale and Humbarger clay loams	9	IIc-2	26	I-1	33	Loamy Lowland	36	Deep Loamy and Clayey Lowland.	39
Dl	Dalhart-Lubbock complex	9	IIe-3	26	IIe-4	34	Dalhart, Sandy; Lubbock, Loamy Upland.	37 36	Deep Loamy Upland.	39
Ha	Harney silt loam, 0 to 1 percent slopes	10	IIc-1	26	I-1	33	Loamy Upland	36	Deep Loamy Upland.	39
Hb	Harney silt loam, 1 to 3 percent slopes	10	IIe-1	25	IIe-1	33	Loamy Upland	36	Deep Loamy Upland.	39
Hd	Holdrege fine sandy loam, 1 to 3 percent slopes	10	IIIe-4	27	IIe-3	33	Sandy	37	Deep Loamy Upland.	39
Hg	Holdrege loam, 0 to 1 percent slopes	11	IIc-1	26	I-1	33	Loamy Upland	36	Deep Loamy Upland.	39
Ho	Holdrege silt loam, 0 to 1 percent slopes	11	IIc-1	26	I-1	33	Loamy Upland	36	Deep Loamy Upland.	39
Hs	Holdrege silt loam, 1 to 3 percent slopes	11	IIe-1	25	IIe-1	33	Loamy Upland	36	Deep Loamy Upland.	39

GUIDE TO MAPPING UNITS, CAPABILITY UNITS, RANGE SITES, AND WINDBREAK SUITABILITY GROUPS--CONT'D.

Map symbol	Mapping unit	Page	Capability unit: Dryland	Page	Capability unit: Irrigated	Page	Range site: Name	Page	Windbreak suitability group: Name	Page
La	Las Animas sandy loam------	11	IVw-1	28	IIIw-1	35	Saline Subirrigated.	36	Shallow Sandy and Clayey Lowland.	40
Lc	Las Animas-Lincoln complex-	12	VIs-1	30	(1/)	---	Saline Subirrigated.	36	Shallow Sandy and Clayey Lowland.	40
Ln	Las Animas-Tivoli complex--	12	VIe-2	29	(1/)	---	Las Animas, Saline Subirrigated; Tivoli, Sands.	36 37	Shallow Sandy and Clayey Lowland.	40
Ls	Leshara clay loam----------	13	IIIw-1	27	IIw-1	34	Saline Subirrigated.	36	Shallow Sandy and Clayey Lowland.	40
Lt	Leshara clay loam, moderately deep---------------	13	IVw-1	28	IIIw-1	35	Saline Subirrigated.	36	Shallow Sandy and Clayey Lowland.	40
Lu	Lincoln soils--------------	13	VIIw-1	30	(1/)	---	(3/)	---	(2/)	---
Ma	Mansic clay loam, 0 to 1 percent slopes-----------	14	IIc-1	26	I-1	33	Loamy Upland	36	Deep Loamy Upland.	39
Mb	Mansic clay loam, 1 to 3 percent slopes-----------	14	IIIe-1	27	IIe-1	33	Loamy Upland	36	Deep Loamy Upland.	39
Mc	Mansic clay loam, 1 to 3 percent slopes, eroded---	14	IIIe-1	27	IIIe-1	34	Limy Upland	36	Deep Loamy Upland.	39
Md	Mansic clay loam, 3 to 6 percent slopes-----------	14	IVe-2	28	IIIe-1	34	Loamy Upland	36	Deep Loamy Upland.	39
Mf	Mansic and Mansker soils, 3 to 6 percent slopes, eroded-------------------	15	IVe-2	28	(1/)	---	Limy Upland	36	Deep Loamy Upland.	39
Mh	Mansic-Hobbs complex-------	15	VIe-1	28	(1/)	---	Mansic, Limy Upland; Hobbs, Loamy Lowland.	36 36	Deep Loamy Upland.	39
Mn	Mansker clay loam, 0 to 3 percent slopes-----------	15	IIIe-1	27	IIIe-1	34	Limy Upland	36	Moderately Deep Loamy Upland.	40
Mp	Mansker-Potter complex-----	16	VIe-3	29	(1/)	---	Mansker, Limy Upland; Potter, Breaks.	36	(2/)	---
Of	Ortello fine sandy loam, level-------------------	17	IIe-2	25	IIe-2	33	Sandy	37	Deep Sandy Upland.	40

GUIDE TO MAPPING UNITS, CAPABILITY UNITS, RANGE SITES, AND WINDBREAK SUITABILITY GROUPS--CONT'D.

Map symbol	Mapping unit	Page	Capability unit				Range site		Windbreak suitability group	
			Dryland	Page	Irrigated	Page	Name	Page	Name	Page
Or	Ortello fine sandy loam, undulating	17	IIIe-3	27	IIe-2	33	Sandy	37	Deep Sandy Upland.	40
Os	Ortello-Carwile complex	17	IIIe-3	27	IIe-2	33	Sandy	37	Deep Sandy Upland.	40
Ot	Otero fine sandy loam, hummocky	18	IIIe-3	27	IIe-2	33	Sandy	37	Deep Sandy Upland.	40
Po	Potter soils	18	VIIs-1	30	(1/)	---	Breaks	37	(2/)	---
Pr	Pratt loamy fine sand, hummocky	18	IVe-1	28	IIIe-2	34	Sands	37	Deep Sandy Upland.	40
Pt	Pratt-Tivoli loamy fine sands	18	VIe-2	29	(1/)	---	Sands	37	Deep Sandy Upland.	40
Ra	Randall clay	19	VIw-2	29	(1/)	---	(3/)	---	(2/)	---
Sb	Sandy broken land	19	VIe-2	29	(1/)	---	Sands	37	Deep Sandy Upland.	40
Sp	Spearville silty clay loam, 0 to 1 percent slopes	20	IIs-1	26	IIs-1	34	Clay Upland	37	Deep Clayey Upland.	40
Sr	Spearville complex, 1 to 3 percent slopes, eroded	20	IIIe-2	27	IIIe-3	35	Clay Upland	37	Deep Clayey Upland.	40
Tv	Tivoli fine sand	21	VIIe-1	30	(1/)	---	Choppy Sands	37	(2/)	---
Ua	Ulysses silt loam, 1 to 3 percent slopes	21	IIe-1	25	IIe-1	33	Loamy Upland	36	Deep Loamy Upland.	39
Ub	Ulysses silt loam, 3 to 6 percent slopes	21	IIIe-1	27	IIIe-1	34	Loamy Upland	36	Deep Loamy Upland.	39
Uc	Ulysses-Colby complex, 3 to 6 percent slopes, eroded	21	IVe-2	28	IIIe-1	34	Limy Upland	36	Deep Loamy Upland.	39
Uh	Ulysses-Harney silt loams, 1 to 3 percent slopes	22	IIIe-1	27	IIe-1	33	Loamy Upland	36	Deep Loamy Upland.	39
Un	Ulysses-Harney complex, 1 to 3 percent slopes, eroded	22	IVe-2	28	IIIe-1	34	Loamy Upland	36	Deep Loamy Upland.	39
Up	Ulysses-Hobbs complex	23	IVe-2	28	IIIe-1	34	Ulysses, Loamy Upland; Hobbs, Loamy Lowland.	36 36	Deep Loamy Upland.	39

1/ Unsuitable for irrigation.

2/ Unsuitable for shelterbelts and windbreaks.

3/ No range site is assigned because of unstable conditions of soil and vegetation.

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