Issued October 1968

SOIL SURVEY
Haskell County, Kansas

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

Major fieldwork for this soil survey was done in the period 1959–64. Soil names and descriptions were approved in 1965. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1964. This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station as part of the technical assistance furnished to the Haskell County Soil Conservation District.

HOW TO USE THIS SOIL SURVEY

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

Locating Soils

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

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

Finding and Using Information

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

Individual colored maps showing the relative suitability or limitations of soils for many specific purposes can be developed by using the soil map and information in the text. Interpretations not included in the text can be developed by grouping the soils according to their suitability or limitations for a particular use. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

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

Game managers, sportsmen, and others concerned with wildlife will find information about soils and wildlife in the section "Wildlife Management."

Ranchers and others interested in range can find under "Range Management" groupings of the soils according to their suitability for range, and also the plants that grow on each range site.

Engineers and builders will find under "Engineering Properties of Soils" tables that give engineering descriptions of the soils in the county and that name soil features that affect engineering practices and structures.

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

Newcomers in Haskell County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "General Facts About the County," which gives additional information about the county.

Cover picture: **Farmstead and cropland. The soils are of the Richfield and Ulysses series.**

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402

Contents

Issued October 1968

SOIL SURVEY OF HASKELL COUNTY, KANSAS

BY VERNON L. HAMILTON, DONALD R. JANTZ, MARION A. LOBMEYER, QUINTEN L. MARKLEY, AND WILLIAM R. SWAFFORD, SOIL CONSERVATION SERVICE[1]

UNITED STATES DEPARTMENT OF AGRICULTURE IN COOPERATION WITH KANSAS AGRICULTURAL EXPERIMENT STATION

HASKELL COUNTY, located in the southwestern part of Kansas (fig. 1), has an area of about 371,200 acres or 580 square miles. Sublette, the county seat, is in the south-central part of the county.

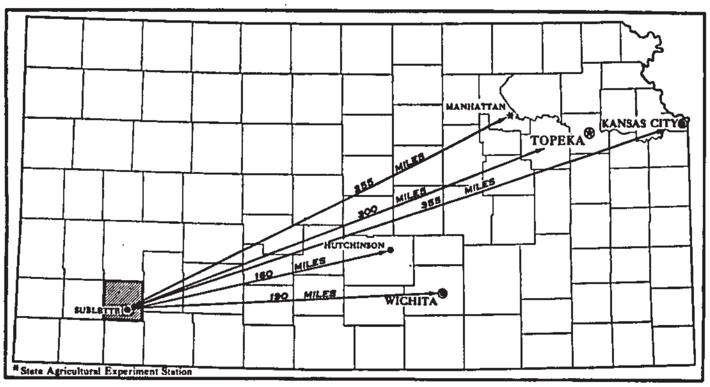

Figure 1.—**Location of Haskell County in Kansas.**

The farm income of the county is derived mainly from the sale of wheat, grain sorghum, and cattle. Cattle-feeding yards are increasing. In most of the county the soils are loamy and suitable for cultivation. About 306,500 acres was cropland in 1964, and most of this was cultivated or in summer fallow. About one-fourth of the cropland was irrigated. Range and improved pasture totaled about 59,000 acres. Most of the range is in the sandhills and in the rough, broken, and steep areas along the Cimarron River.

The climate of the county is characterized by low rainfall, rapid evaporation, low humidity, high winds, and cool nights. This climate tends to limit the growth of crops.

Gas-producing wells are in about two-thirds of the county, for the county is at the edge of the Hugoton gasfield. Only a few wells produce oil. A booster station is at Satanta. An alfalfa-dehydrating mill is located at Tice.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Haskell 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 survey efficiently it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, 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. Richfield 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 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. Ulysses silt loam and Ulysses loam are two soil types in the Ulysses series. The difference in texture of their surface layers is apparent from their names.

Some types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into phases. The name of a soil phase indicates a feature that affects

[1] Assisting with the fieldwork were KENNETH H. SALLEE, HAROLD P. DICKEY, RAYMOND C. ANGELL, and RODNEY F. HARNER, Soil Conservation Service.

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 the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that greatly help in drawing boundaries accurately. The soil map in the back of this survey was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil type or a phase of a soil type. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil type or soil phase.

In preparing some detailed 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, Tivoli-Vona loamy fine sands. Also, on most soil maps, areas are shown that are so rocky, so shallow, or so frequently worked by wind and water that they cannot be classified by soil series. These areas are shown on a soil map like other mapping units, but they are given descriptive names, such as Active dunes, and are called land types.

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

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in 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 surveys. On the basis of yield and practice tables and other data, the soil scientists set up trial groups, and then 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

Figure 2 is a general soil map that shows the soil associations of Haskell County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

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

Following are descriptions of the five soil associations in Haskell County.

1. Tivoli-Vona Association

Deep, undulating to rolling soils of the sandhills

This association is in the undulating to rolling sandhills, mainly in the northern part of Haskell County. Intermittent streams and drainageways enter the sandhills from the south, but they are indefinable after they extend a short distance within the hummocks and dunes (fig. 3). Soil blowing is common. This association covers about 5 percent of the county.

The Tivoli soils make up more than 65 percent of this association. These soils occur in the steeper, choppy parts of the sandhills. They have a fine sand surface layer that contains some organic matter and is about 4 inches thick. It is underlain by light-colored fine sand. These soils are low in fertility and have low water-holding capacity. Lime has been leached from them to a depth of more than 40 inches.

The Vona soils make up about 30 percent of this association. These soils are at the outer edge of the sandhills and are more undulating than the rolling Tivoli soils. Vona soils have a moderately dark colored loamy fine sand surface layer about 9 inches thick. Their subsoil is fine sandy loam that is easily penetrated by air, water, and plant roots. Lime has been leached from these soils to a depth of about 36 inches. Water-holding capacity is low.

Also in the association are Active dunes, which are bare blowout areas. These dunes are still active and among them are some nearly level areas consisting of loose sand blown from the Tivoli soils. Active dunes make up 5 percent of the association.

The Tivoli soils are used mainly for range because they are too sandy for cropland. The Vona soils are better suited to grass production than to cultivated crops, but they can be cultivated if management is intensive. If the range in this association is managed well, stands of mixed tall and mid grasses are thick enough to protect the soils and to supply forage for grazing. Because most of the rain that falls soaks into these soils, ground water is recharged.

2. Satanta-Manter Association

Deep, nearly level to gently undulating, loamy soils between the sandhills and tablelands of the High Plains

This association is in a transitional area between the sandhills and the nearly level tablelands. Concave and convex slopes are intermingled in the nearly level to gently undulating landscape. Rainfall is low, and soil blowing

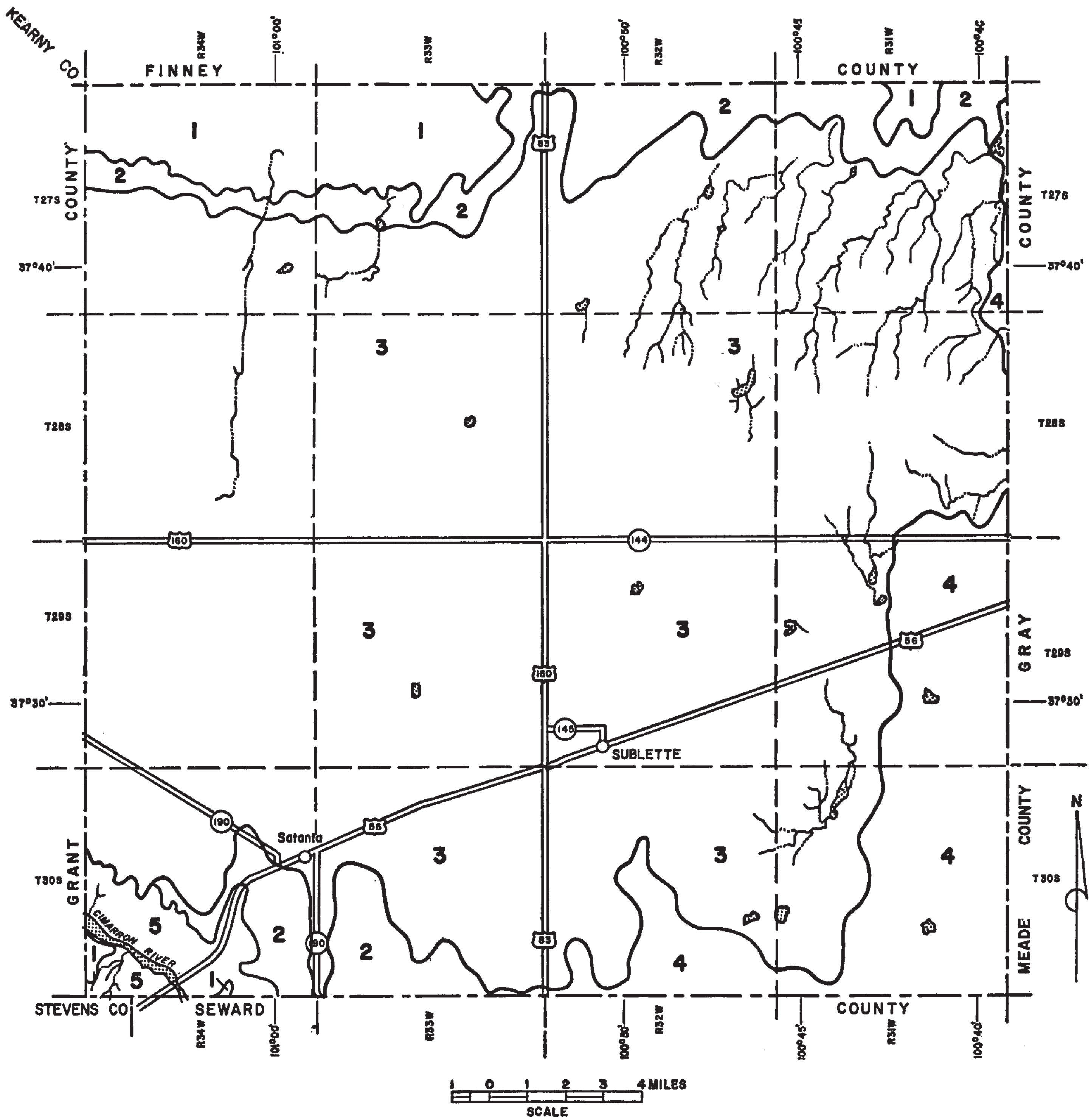

Figure 2.—General Soil Map, Haskell County, Kansas.

1. Tivoli-Vona association: Deep, undulating to rolling soils of the sandhills.
2. Satanta-Manter association: Deep, nearly level to gently undulating, loamy soils between the sandhills and tablelands of the High Plains.
3. Richfield-Ulysses association: Deep, nearly level to gently sloping, loamy soils of the High Plains.
4. Richfield-Spearville-Ulysses association: Deep, nearly level, loamy soils that are on the High Plains and have a loamy or clayey subsoil.
5. Otero-Colby-Likes association: Deep, gently sloping to strongly sloping, calcareous, sandy and loamy soils in the valley of the Cimarron River.

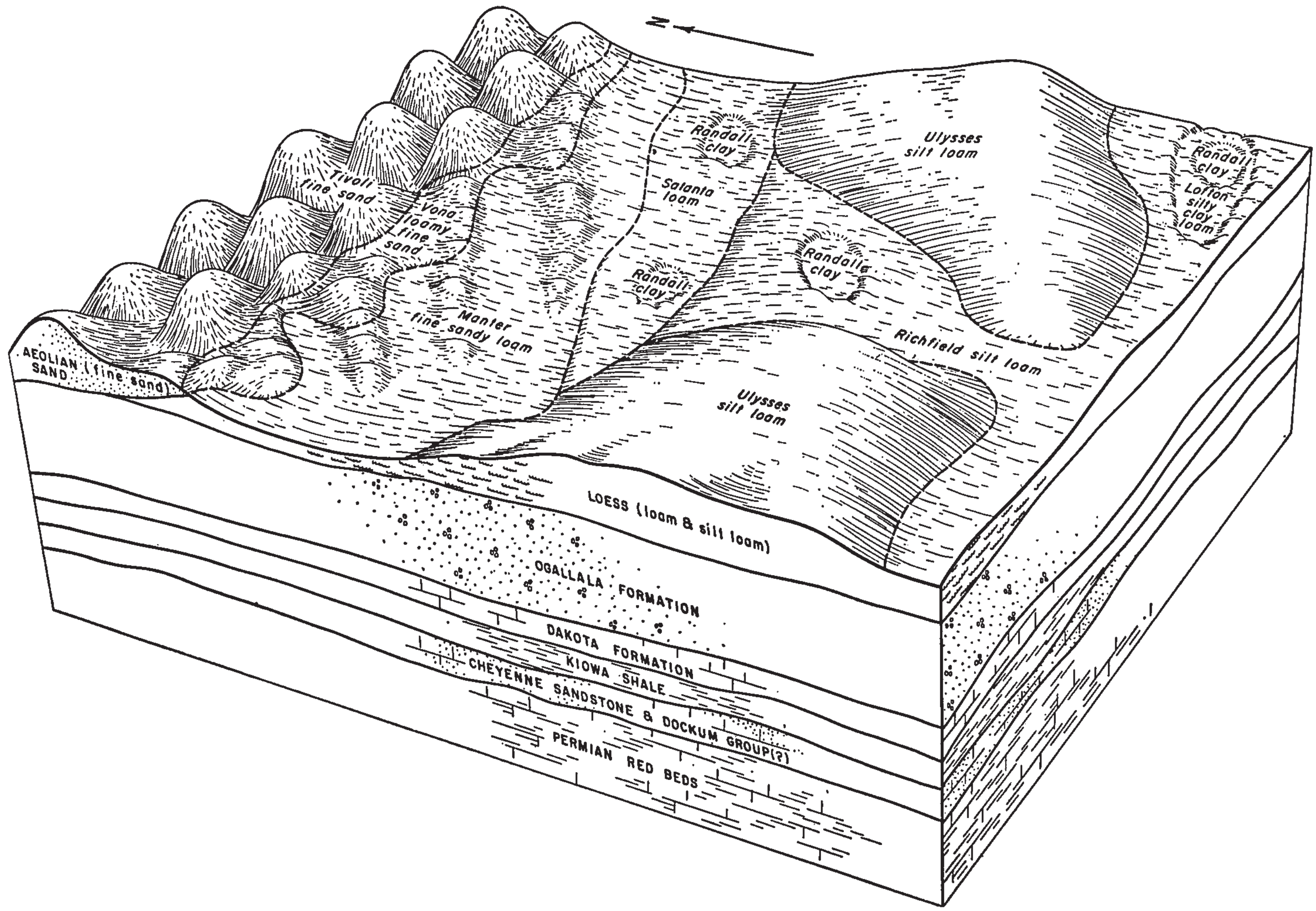

Figure 3.—**Typical topographic relation of three soil associations in Haskell County. Tivoli-Vona association, the farthest north, blocks drainageways flowing from the Satanta-Manter and the Richfield-Ulysses associations to the south.**

is a hazard. The association is mostly in the northern part of the county, but a small area is in the southwestern corner. This association covers about 7 percent of the county.

Satanta soils occupy about 45 percent of this association. These nearly level to gently sloping soils are dark, deep, fertile, and noncalcareous. They have a fine sandy loam and loam surface layer 6 to 16 inches thick. Their subsoil is sandy clay loam to clay loam that is easily penetrated by air, water, and plant roots. The subsoil has high water-holding capacity. Soil blowing is the main hazard on these soils, but water erosion is likely in sloping areas. These soils are slightly lower in the landscape than the Ulysses and Richfield soils.

The Manter soils occupy about 20 percent of this association. They occur on uplands and are fertile, deep, moderately dark colored, and noncalcareous. These soils have a fine sandy loam surface layer that is about 14 inches thick. The subsoil is heavy sandy loam that is easily penetrated by air, water, and plant roots. Soil blowing is the main hazard, but water erosion is likely in the gently sloping areas.

Also in this association are the Ulysses, Otero, and Colby soils. The Ulysses soils occupy 20 percent of this association; the Otero soils, 10 percent; and the Colby soils, 5 percent. The Ulysses soils are on uplands and are undulating, deep, dark, and friable. They have a noncalcareous, loamy surface layer that is about 6 to 10 inches thick and is easy to work. The subsoil is calcareous light silty clay loam that is easily penetrated by water, air, and plant roots. Water-holding capacity is high. Water erosion is a major hazard, but these soils blow when they are bare.

The Otero soils occur on uplands and are gently undulating to moderately undulating. These soils are deep, light colored, and calcareous. Their surface layer of fine sandy loam is underlain by loam or sandy loam. These soils are moderately fertile and have moderate water-holding capacity. Soil blowing and water erosion are hazards.

The Colby soils are light colored and have a thin, calcareous silt loam surface layer and subsoil. They are gently sloping and occur with Ulysses soils on uplands.

The soils in this association are used for dryland and irrigated farming. A few areas are in native grass. Grain sorghum is the main dryland crop on the Satanta, Manter, Otero, and Ulysses soils. Wheat is another crop grown on the Ulysses and Satanta soils. Irrigation is practiced, mostly in nearly level areas. The main irrigated crops are corn, wheat, sorghums for grain and forage, alfalfa, and sweetclover.

3. Richfield-Ulysses Association

Deep, nearly level to gently sloping, loamy soils of the High Plains

This association covers 70 percent of the county. It is on the nearly level to gently sloping tablelands that extend in a broad area across the county from the western to the eastern boundary (fig. 4).

The Richfield soils make up 65 percent of this association. They are nearly level and are in broad, continuous areas that have poorly defined drainageways. Their surface layer is about 6 inches thick and consists of friable, noncalcareous silt loam that is easily cultivated. The subsoil is noncalcareous silty clay loam, and the underlying material is loess that has good water-holding capacity.

The Ulysses soils occupy about 30 percent of this association. They occur on uplands and are nearly level to gently sloping. They have a friable silt loam or loam surface layer that is about 5 inches thick and is easily cultivated. Their subsoil consists of light silty clay loam about 8 inches thick. Underlying the subsoil is friable loess that is easily penetrated by air, water, and plant roots.

The Lubbock, Lofton, and Randall soils occupy about 5 percent of this association. The Lubbock soils are in the northeastern part of the county in depressional areas, and they receive extra water that runs off the Ulysses and Richfield soils. Lubbock soils are deep, very dark colored, noncalcareous, and fertile. They developed in loamy lacustrine material.

The Lofton soils are on benches above Randall soils and below the normal upland positions of Richfield and Ulysses soils. Lofton soils are clayey, deep, and noncalcareous and are subject to infrequent ponding. The Randall soils are on the floors of undrained depressions and are ponded more often than the Lofton soils. Randall soils are deep, dark colored, and clayey.

The soils in this association are used for dryfarmed and irrigated crops. Production of the dryfarmed crops is limited by climate. The dryfarmed crops are wheat and grain sorghum, and the irrigated crops are wheat (fig. 5), corn, grain and forage sorghums, sugar beets, beans, grass, and garden crops. Some irrigated areas are seeded to bromegrass. Most of this association is cultivated, but some small areas are in native grass.

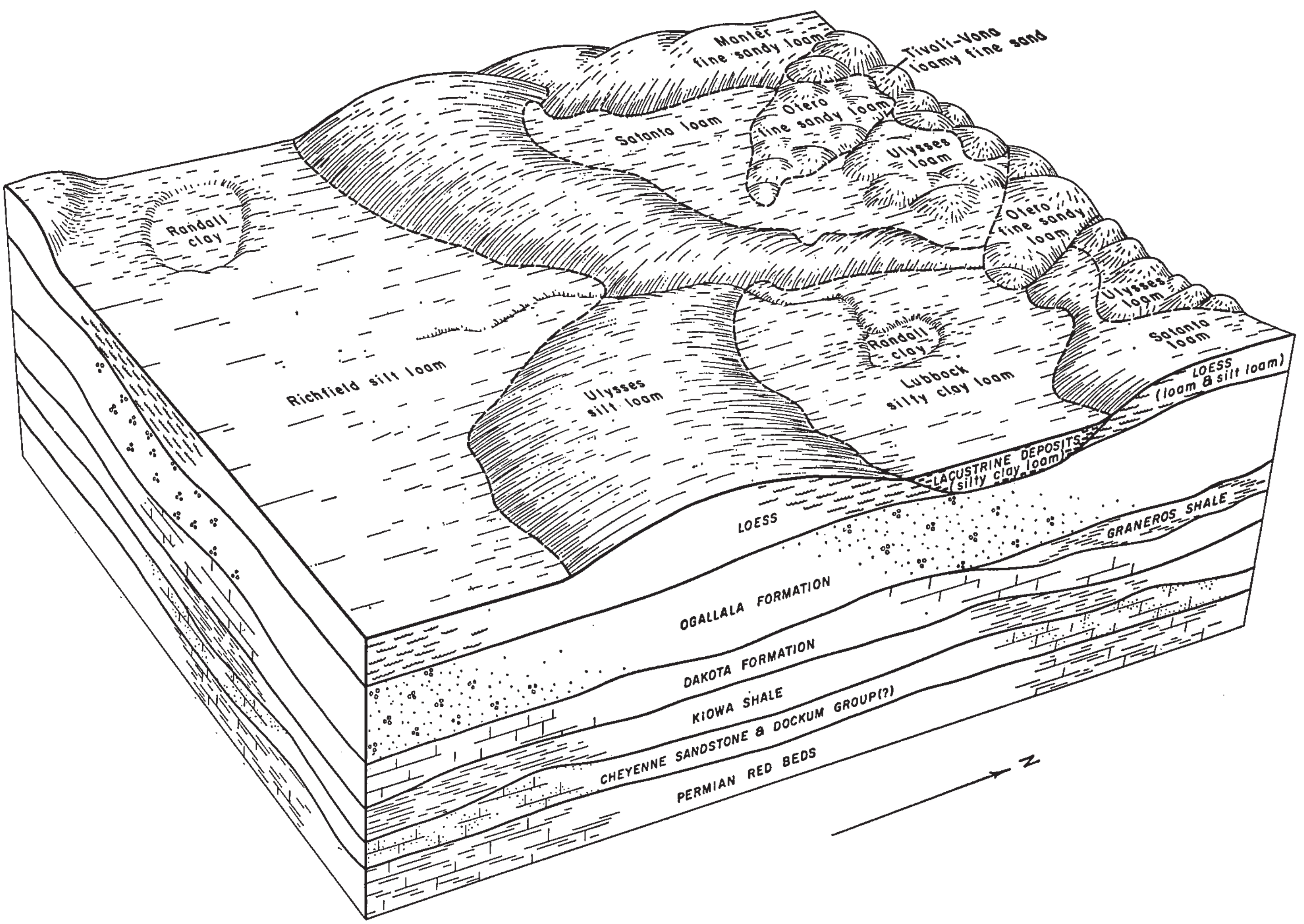

***Figure 4.*—Soils of the Richfield-Ulysses association in the central part of the county.**

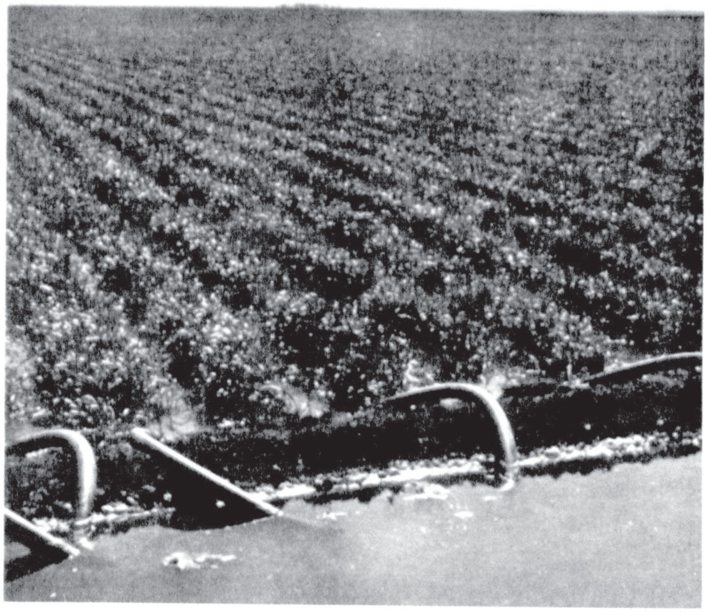

Figure 5.—**Furrow irrigation of wheat on Richfield silt loam, 0 to 1 percent slopes, in the Richfield-Ulysses association.**

4. Richfield-Spearville-Ulysses Association

Deep, nearly level, loamy soils that are on the High Plains and have a loamy or clayey subsoil

This association is on nearly level uplands where there are a few large depressions and some hills. It is mainly in the southeastern part of the county in a loessal area (fig. 6), but a small area is along the northeastern border. The association covers about 15 percent of the county.

The Richfield soils make up 60 percent of this association. These soils are deep, dark colored, noncalcareous, and fertile. They have a friable silt loam surface layer that is easily cultivated. The subsoil is firm, noncalcareous silty clay loam. It is underlain by porous, calcareous silt loam that is easily penetrated by air, water, and plant roots. Permeability is moderately slow, but water-holding capacity is high.

The Spearville soils occupy about 20 percent of this association. These soils are deep, dark colored, clayey, noncalcareous, and fertile. They have a firm silty clay loam surface layer and are more difficult to work than the Richfield or Ulysses soils. The subsoil of Spearville soils is very firm silty clay or clay that has slow or very slow permeability. These soils take in water slowly but have high water-holding capacity. They release moisture slowly to plants and are droughty.

The Ulysses soils occupy about 15 percent of this association. They are on uplands and are nearly level to sloping. The surface layer is silt loam that is friable and easily worked. The subsoil is friable heavy silt loam or light silty clay loam that is easily penetrated by air, water, and plant roots. It has high water-holding capacity.

Also in this association, and making up about 5 percent of its acreage, are the Colby, Lofton, and Randall soils. The Colby soils are on uplands, where they are intermingled with the Ulysses soils. Lofton soils occupy benches along the outer edges of depressions. They are deep, dark-colored, noncalcareous soils that are likely to be ponded by water that runs in from higher soils. The Randall soils are on the floors of the larger depressions and are deep, dark colored, and clayey. Water ponds on these soils for a considerable time after heavy rains.

Most of this association is dryfarmed or irrigated. The dryland crops are generally wheat and grain sorghum. Much of this association is used for irrigated wheat, sorghums, corn, alfalfa, sugar beets, soybeans, and dry beans. Irrigation water is pumped from deep wells by gas engines. Shortage of rainfall limits use of the nearly level Ulysses and Richfield soils (fig. 7). The clayey subsoil limits use of the nearly level Spearville soils. Also, the nearly level soils on uplands are subject to soil blowing, and soil blowing and water erosion are hazards on the sloping Ulysses and Colby soils.

5. Otero-Colby-Likes Association

Deep, gently sloping to strongly sloping, calcareous, sandy and loamy soils in the valley of the Cimarron River

This association consists of gently sloping to strongly sloping, sandy and loamy areas along the Cimarron River in the southwestern corner of the county (fig. 8). The association covers about 3 percent of the county.

The Otero soils occupy about 40 percent of this association. They are on uplands and are gently sloping to strongly sloping. Otero soils have a fine sandy loam surface layer that is underlain by a loam to sandy loam subsoil and substratum. Deposits of sand and gravel occur among these soils.

The Colby soils occupy about 30 percent of this association. They are on uplands and are gently sloping to strongly sloping. Colby soils are light colored and calcareous. They have a loamy surface layer and a loam or silt loam subsoil. These soils are low in fertility and are better suited to permanent grass than to crops because soil blowing is likely in cultivated areas.

The Likes soils occupy about 20 percent of this association. They are on undulating alluvial fans that slope to the Cimarron River. Likes soils are sandy and calcareous. They have low water-holding capacity because their substratum is coarse textured.

Also in this association are small areas of Manter and Glenberg soils. Each of these kinds of soil makes up about 5 percent of this association. The Manter soils are deep, noncalcareous sandy loams that occur on uplands and are level to gently sloping. Some areas are in wheat and sorghums. The Glenberg soils are on the nearly level flood plain. They are moderately dark colored and have a sandy surface layer and subsurface layer. These soils are not suited to cultivated crops, but they are well suited to grasses.

Most of this association is in permanent grass and is used as range. Some formerly cultivated areas have been seeded to grass. Areas of Colby soils have sites suitable for building dams that impound water for livestock.

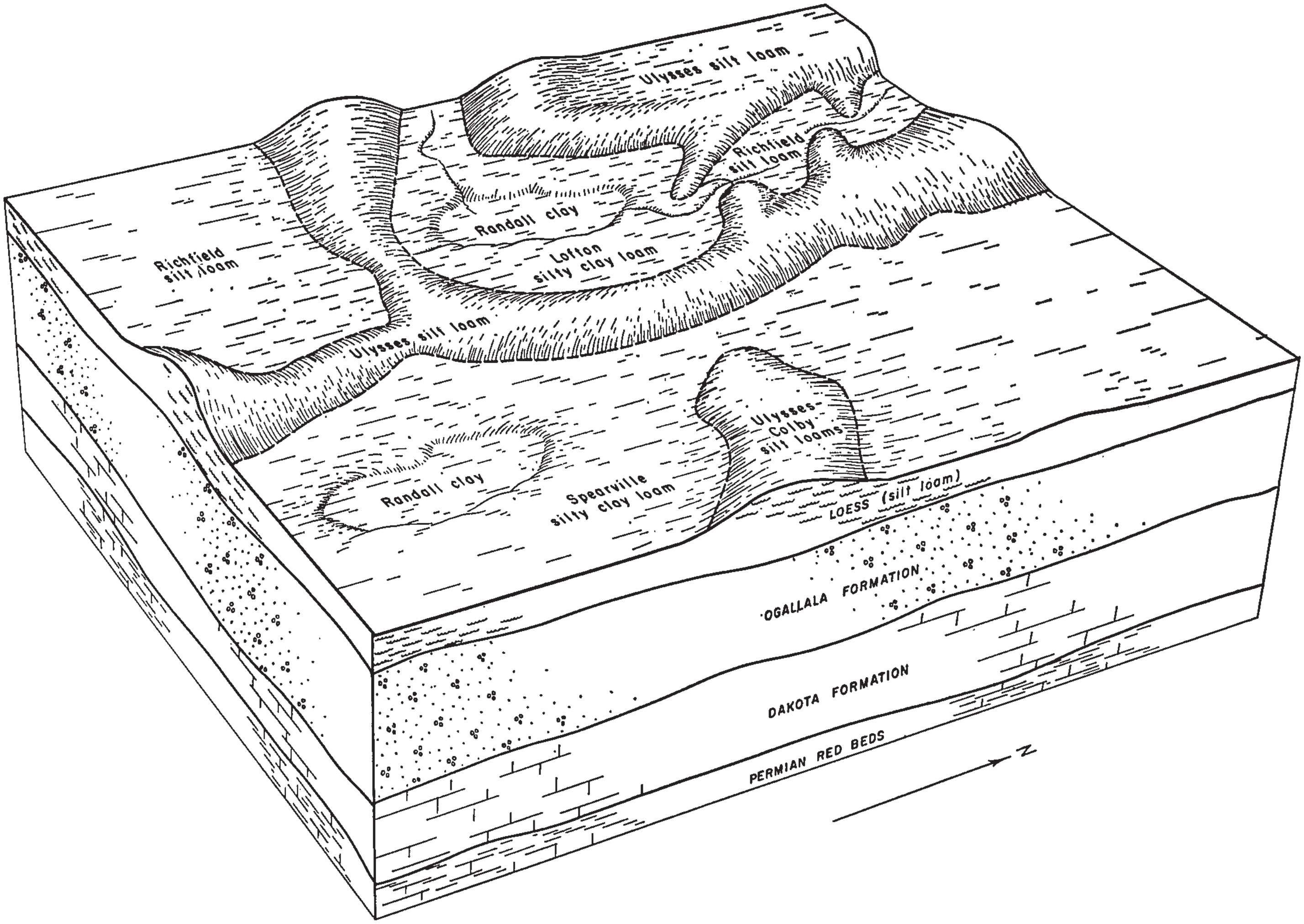

Figure 6.—**Landscape showing soils of the Richfield-Spearville-Ulysses association in the southeastern part of the county.**

Effects of Erosion

Erosion is the removal of soil and geologic materials by natural agencies, mainly wind, running water, and gravity. This discussion deals with accelerated erosion, which should not be confused with geologic erosion. Accelerated erosion is the increase in soil erosion brought about by manmade changes in vegetation or condition of the soil.

Wind and water are the main active forces of soil erosion in Haskell County. Wind erosion, or soil blowing, is always a hazard and becomes serious during the recurring droughts. The high velocity of the wind and limited plant growth during periods of drought contribute to soil blowing on the High Plains.

Water erosion is a hazard on all sloping, silty and loamy soils that are cultivated. The rate of water erosion depends on the gradient of the slope, the texture of the soils, the use of the land, and the intensity of the rainfall. Runoff is rapid during the hard, dashing thunderstorms in which rain falls more rapidly than the water can enter the soil. On unprotected, sloping, silty soils, the runoff causes sheet erosion, or the removal of thin layers of soil material, more or less evenly, from the entire surface.

Practices that slow or decrease runoff help to conserve valuable moisture and to control water erosion. Among these practices are stubble mulching, keeping tillage to a minimum, terracing, tilling on the contour, seeding severely eroded and nonarable areas to suitable native grasses, and managing the range so that it is not overgrazed.

During the fieldwork of this soil survey, the soils in about 2,500 acres where erosion is moderate to severe were mapped as eroded soils. Some of the effects of soil blowing were as follows:

1. Where soil blowing is active, small, low hummocks and drifts of soil form along fence rows, along the edges of cultivated fields in stubble, and on native range adjacent to the cultivated fields. The drifts may damage or even destroy the native vegetation on the range to such an extent that grasses have to be reestablished by reseeding or by deferred grazing. If the surface is roughened by tillage, and kept rough until the vegetation grows, there will be no serious, permanent damage and full use of the soils can be restored.
2. The tops of ridges and knolls on the undulating tablelands of the High Plains are more exposed

to wind than are adjacent areas of nearly level soils. Consequently, the soil material blows more often in these areas, and much of it has been deposited in smoother areas nearby. Some of the finer soil particles are blown long distances and are lost from the area. The silt and sand particles that are deposited in nearby areas are often calcareous. Since calcareous sediments tend to blow more readily than the noncalcareous ones, these deposits may start soil blowing in a field that would otherwise be stable. During periods when they are not protected by a cover of plants or plant residue, undulating soils are susceptible to water erosion as well as soil blowing.

3. During droughts, some of the very sandy, nonarable soils in range may be grazed so much that the protective vegetation is destroyed and soil blowing is severe. The soils are permanently damaged, and their value for grazing is greatly reduced. Also, the drifting sand damages cultivated crops and grass in nearby areas and increases the hazard of soil blowing in areas where sandy sediments are deposited.

Mapped as eroded soils in Haskell County are soils that have been so eroded that use and management requirements have changed. For example, in areas of Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded, 30 to 70 percent of the acreage is eroded to the extent that the plow layer consists of a mixture of material from the original surface layer and the subsoil. Soils that are subject to erosion but that were not more than slightly eroded were not mapped as eroded soils.

Soils that have lost their original identity through severe erosion are designated as land types. The land type Active dunes was probably Tivoli fine sand at one time, but now it consists of shifting fine sand on hills and ridges and in cone-shaped dunes, and it lacks a definable profile. Active dunes occupy a fairly large acreage, 80 percent of which is bare. In this survey, areas less than 20 acres in size are shown by blowout symbols on the soil map. Each symbol represents an area of 10 acres or less.

Loamy fine sands and fine sands show the most drastic effects of erosion. In cultivated areas of these soils, dunes as high as 8 feet are common along fence rows. Farmers often have to replant two or four times because shifting sand destroys their crops, which are mostly grain sorghum. A windstorm may be severe enough to close country roads.

The seriousness of erosion lies not only in permanent damage to the soils, but also in the cost of repairing areas that are temporarily damaged. Costly but necessary practices for repairing damage are replanting crops, reseed-

***Figure 7.*—Strips are used for controlling wind erosion on Ulysses and Richfield soils in soil association 4.**

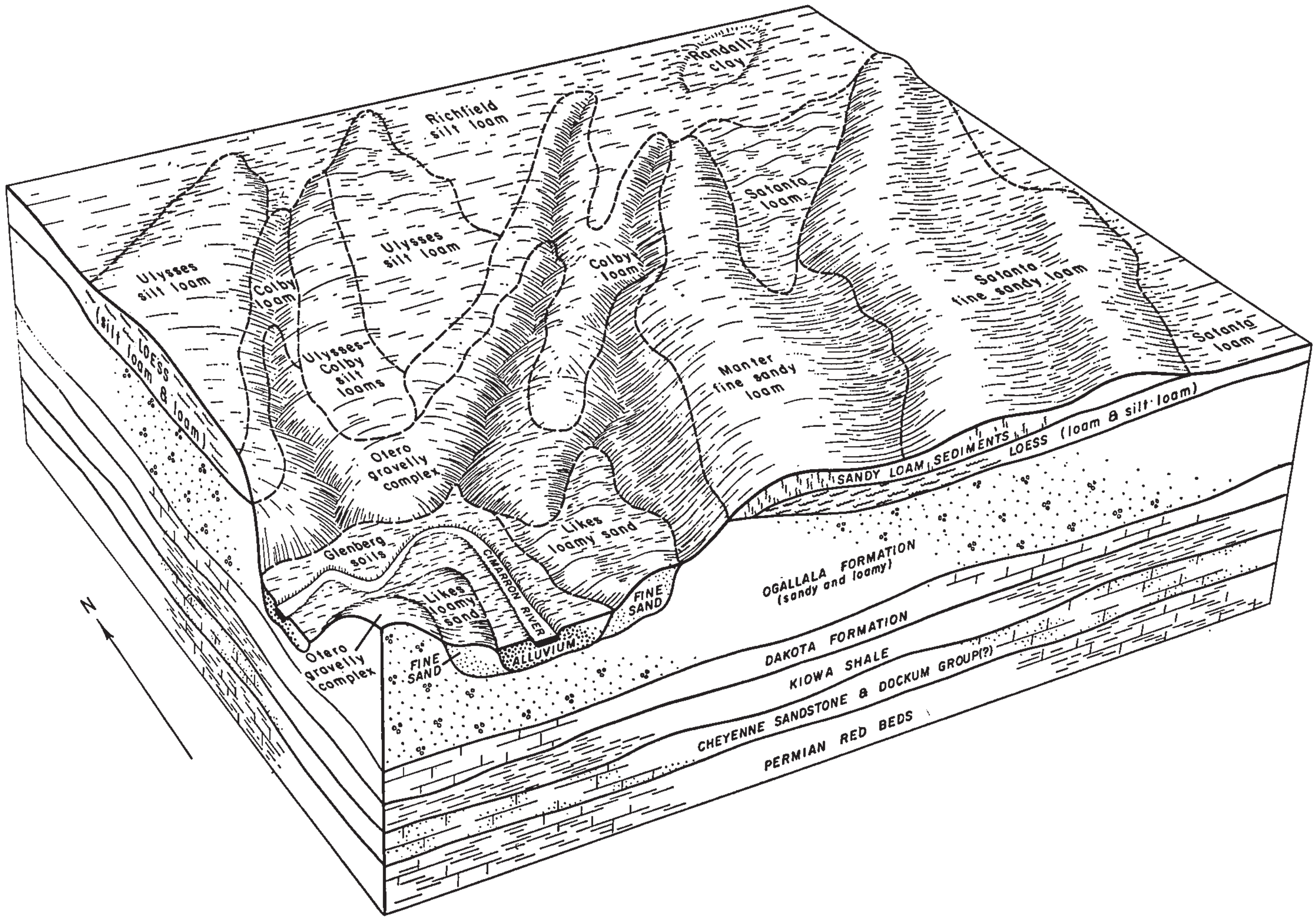

Figure 8.—Typical topographic relation of three soil associations: Otero-Colby-Likes association in the southwestern corner; Richfield-Ulysses association to the north; and Satanta-Manter association to the east.

ing rangeland, smoothing the soils, and using emergency tillage. For more information about controlling erosion and repairing its damage, see a local representative of the Soil Conservation Service.

Descriptions of the Soils

This section describes the soil series and mapping units in Haskell County. The acreage and proportionate extent of each mapping unit are shown in table 1.

The procedure is first to describe the soil series, and then the mapping units in the series. Thus, to get full information on any one mapping unit, it is necessary to read the description of that unit and also the description of the series to which it belongs. An essential part of each soil series is the description of the soil profile, the sequence of layers beginning at the surface and continuing downward to depths beyond which roots of most plants do not penetrate. Each soil series contains both a brief nontechnical and a detailed technical description of the soil profile. The nontechnical description will be useful to most readers. The detailed technical description is included for soil scientists, engineers, and others who need to make thorough and precise studies of the soils.

Each mapping unit contains suggestions on how it can be managed under dryfarming and irrigation. Management of soils under native grass, however, is discussed in the section "Range Management." In that section the soils are placed in range sites. A range site is a group of soils that produce about the same kind of range vegetation and that require about the same management when used for grazing. Suitability of the soils for trees and shrubs used in windbreaks is given in the section "Windbreak Management." Behavior of the soils when used as sites for structures or as material for construction is discussed in the section "Engineering Properties of Soils."

Active Dunes

Active dunes (Ad) have formed in severely eroded areas of Tivoli soils. These dunes are in barren or sparsely vegetated areas where loose sand is continually shifted by the wind and is shaped into hills, ridges, and cone-shaped dunes. This continual movement of the sand has prevented the formation of a soil profile. Vegetation is lacking on 80

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

Soil	Area	Extent
	Acres	*Percent*
Active dunes	250	0. 1
Colby loam, 5 to 12 percent slopes	1, 200	. 3
Glenberg soils	420	. 1
Likes loamy sand	600	. 2
Lofton silty clay loam	550	. 1
Lubbock silty clay loam	9, 200	2. 5
Manter fine sandy loam, 0 to 1 percent slopes	2, 620	. 7
Manter fine sandy loam, 1 to 3 percent slopes	3, 680	1. 0
Otero gravelly complex	1, 820	. 5
Otero-Ulysses complex, 1 to 3 percent slopes	4, 800	1. 3
Randall clay	6, 980	2. 0
Richfield silt loam, 0 to 1 percent slopes	219, 000	59. 0
Richfield silt loam, 1 to 3 percent slopes	1, 300	. 3
Richfield and Ulysses complexes, bench leveled	15, 640	4. 2
Satanta fine sandy loam, 0 to 1 percent slopes	1, 700	. 4
Satanta fine sandy loam, 1 to 3 percent slopes	1, 330	. 4
Satanta loam, 0 to 1 percent slopes	16, 700	4. 5
Spearville silty clay loam, 0 to 1 percent slopes	7, 300	2. 0
Tivoli fine sand	8, 560	2. 3
Tivoli-Dune land complex	1, 100	. 3
Tivoli-Vona loamy fine sands	7, 500	2. 0
Ulysses loam, 1 to 3 percent slopes	900	. 2
Ulysses silt loam, 0 to 1 percent slopes	40, 120	10. 8
Ulysses silt loam, 1 to 3 percent slopes	13, 800	3. 7
Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded	1, 090	. 3
Ulysses-Colby silt loams, 3 to 5 percent slopes, eroded	1, 150	. 3
Vona loamy fine sand	1, 630	. 4
Intermittent lakes	100	(1)
Cimarron River	160	(1)
Total	371, 200	100. 0

[1] Less than 0.05 percent.

percent of this land type, and the stands of giant sandreed or other grasses are not thick enough to prevent soil blowing. The sand tends to spread slowly northward, but within areas of Active dunes, it shifts according to the direction of the wind. Areas of these dunes range from 20 to 80 acres in size.

Active dunes should be fenced to keep out livestock. After a protective cover of weeds or sorghum is established, the areas should be seeded to suitable native grasses. (Capability unit VIIe–1, dryland; Choppy Sands range site)

Colby Series

The Colby series consists of friable, strongly sloping, calcareous soils in deep loamy sediments on uplands. The profile of these soils is weakly developed.

In a typical profile, the surface layer of these soils is about 4 inches thick and consists of grayish-brown loam that has moderate, fine, granular structure. Beneath the surface layer is loam that contains free lime and has weak, medium, granular structure. A few granules from worm casts are present in this layer. The underlying material is loam that is porous, friable, and limy. It is easily penetrated by air, water, and plant roots.

Colby soils are well drained. Their rate of water intake and internal drainage are medium, and permeability is moderate. Water-holding capacity is high. These soils are moderate in natural fertility, but they are susceptible to severe soil blowing and water erosion in cultivated areas.

Most areas of Colby soils are still in native grass range and are used for grazing. Because these soils blow and wash easily, they are not well suited to cultivated crops.

Typical profile of Colby loam, 5 to 12 percent slopes, 300 feet west and 100 feet north of the southeast corner of NE¼, section 19, T. 30 S., R. 34 W., in native grass pasture:

A1—0 to 4 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) when moist; moderate, fine, granular structure; slightly hard when dry, very friable when moist; numerous granules from worm casts; calcareous, smooth, gradual boundary.

AC—4 to 14 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) when moist; weak, medium, granular structure; slightly hard when dry, friable when moist; calcareous; few granules from worm casts; smooth, diffuse boundary.

C—14 to 48 inches, pale-brown (10YR 6/3) loam, brown (10YR 5/3) when moist; massive (structureless); soft when dry, very friable when moist; porous; calcareous.

The surface layer (A1 horizon) of Colby soils ranges from loam to silt loam in texture and from 4 to 6 inches in thickness. This layer is darkest in areas of native grasses. The AC horizon is transitional between the A and C horizons and ranges from 8 to 14 inches in thickness. The C horizon, or substratum, ranges from loam to silt loam. Erosion retards the development of a B horizon. Free lime occurs throughout the profile. In a few places pebbles that have been rounded by water are scattered on the surface.

The Colby soils occur closely with the Ulysses and the Otero soils. Colby soils have a lighter colored, more limy surface layer than the Ulysses soils and are less sandy than the Otero soils.

Colby loam, 5 to 12 percent slopes (Co).—This is an inextensive, strongly sloping soil that occurs on uplands along large drainageways. Runoff is rapid to very rapid. The profile of this soil is the one described as typical of the Colby series. Underlying the surface layer, segregated lime makes up 5 percent of the soil mass.

Included with this soil in the mapping were a few areas that have a silt loam surface layer and a few local pockets of sand. Also included were valley walls that are steeper than 12 percent and that have been geologically eroded. A few deposits of sand and gravel crop out on these eroded walls.

Nearly all areas of this soil are in native grasses and are used as range. This soil is not suited to cultivated crops, because it washes and blows in cultivated areas. Suitable native grasses need to be seeded in a few small areas that are parts of large cultivated fields and in other areas that are cultivated. Sites on this soil are suitable for the construction of ponds. (Capability unit VIe–1, dryland; Limy Upland range site)

Glenberg Series

The Glenberg series consists of calcareous, nearly level soils on the flood plains along the Cimarron River. They developed in moderately sandy alluvium. The surface layer varies in texture.

In a typical profile, the surface layer is grayish-brown, very friable fine sandy loam about 4 inches thick. This layer is structureless. It is underlain by grayish-brown fine sandy loam that has weak granular structure and is about 12 inches thick. The substratum is light brownish-gray sandy loam that is porous, friable, and easily penetrated by plant roots.

In Glenberg soils, the infiltration rate is moderately high and internal drainage is medium. Permeability is moderately rapid, and water-holding capacity is moderate. These soils are moderate in fertility, and they are susceptible to soil blowing. The water table is well below the root zone.

Some runoff from higher areas benefits these soils. Glenberg soils are suitable as range, but they are not suited to cultivated crops.

Typical profile of a Glenberg soil that has a surface layer of fine sandy loam, 1,000 feet north and 500 feet east of the southwest corner of section 29, T. 30 S., R. 34 W., in native grass pasture:

A1—0 to 4 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; massive (structureless); soft when dry, very friable when moist; calcareous; few water-rounded pebbles; abrupt, smooth boundary.

AC—4 to 16 inches, grayish-brown (10YR 5/2) heavy fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak granular structure; slightly hard when dry, friable when moist; calcareous; few water-rounded pebbles; gradual boundary.

C—16 to 48 inches, light brownish-gray (10YR 6/2) sandy loam, dark grayish brown (10YR 4/2) when moist; massive (structureless); slightly hard when dry, friable when moist; calcareous; few water-rounded pebbles.

The surface layer (A1 horizon) of these soils ranges from 4 to 10 inches in thickness and is fine sandy loam, loam, or loamy sand. In some places it is underlain by loam and sandy loam that may be highly stratified. In a few places the A1 is underlain by a thin layer of loamy sand. The AC horizon, a transitional layer, ranges from grayish brown to pale brown in color and from 8 to 20 inches in thickness. In places, the C horizon is strongly calcareous and contains soft concretions of lime. The entire profile is limy and contains small, scattered pebbles.

Glenberg soils occur with the Likes soils but are less sandy and more stratified.

Glenberg soils (0 to 2 percent slopes) (Gb).—These nearly level soils occur in the southwestern part of Haskell County on the flood plains along the Cimarron River. Except that texture of the surface layer is loamy sand or loam in some places, these soils have a profile like the one described as typical of the Glenberg series.

Glenberg soils are used mostly as range, but in some places the sand in the substratum is mined and used for building roads or other structures. Cultivation on these soils is prevented by the very severe scouring that occurs during the infrequent floods. The native grasses are mainly western wheatgrass, little bluestem, switchgrass, and blue grama. (Capability unit VIw–1, dryland; Sandy Lowland range site)

Likes Series

The Likes series consists of calcareous, gently sloping soils that occur on sandy and gravelly fans. These soils formed in colluvial-alluvial sediments that washed from nearby upland slopes.

In a typical profile, the surface layer is about 5 inches thick and consists of limy, grayish-brown loamy sand that takes in water rapidly. This layer contains some organic matter but is structureless. It is underlain by brown loamy sand that is about 7 inches thick and is structureless but coherent. The substratum is loamy sand and fine sand that both contain much lime. This material has low water-holding capacity and is not readily penetrated by plant roots.

Likes soils are excessively drained. The rate of water intake is high, and internal drainage is rapid. Permeability is moderately rapid, and water-holding capacity is low. These soils are low in natural fertility and are highly susceptible to soil blowing and water erosion where their native cover of grass is removed or where they are overgrazed.

Likes soils are mostly in native grass range and are well suited to that use. They are not suitable for cultivation, because their surface layer is sandy and highly susceptible to soil blowing, their sandy substratum has low water-holding capacity, and they are low in fertility.

Typical profile of Likes loamy sand, 100 feet west and 100 feet north of the southeast corner of section 33, T. 30 S., R. 34 W., in native grass pasture:

A1—0 to 5 inches, grayish-brown (10YR 5/2) loamy sand, dark grayish brown (10YR 4/2) when moist; single grain (structureless); soft when dry, very friable when moist; weakly calcareous; gradual boundary.

AC—5 to 12 inches, brown (10YR 5/3) loamy sand, dark brown (10YR 4/3) when moist; structureless but weakly coherent; loose when dry, very friable when moist; weakly calcareous; gradual boundary.

C1—12 to 24 inches, very pale brown (10YR 7/3) light loamy sand, brown (10YR 5/3) when moist; single grain (structureless); loose when dry, very friable when moist; moderately calcareous; few, small, hard concretions of calcium carbonate; clear, smooth boundary.

C2—24 to 50 inches, pale-brown (10YR 6/3) fine sand, brown (10YR 5/3) when moist; soft to loose when dry, very friable when moist; calcareous.

The surface layer (A1 horizon) ranges from 4 to 10 inches in thickness and from loamy sand to light sandy loam in texture. In some places it is covered with 2 to 4 inches of silty sediment or sandy loam. The AC horizon ranges from sandy loam to fine sand or sand, and it contains strata of clay loam in places.

Likes soils are more sandy than Glenberg soils and have more distinct layers in the profile.

Likes loamy sand (0 to 3 percent slopes) (Lk).—This soil occurs on fans between the gravelly Otero soils on uplands and the Glenberg soils on the flood plains. Its profile is the one described as typical of the Likes series.

This soil is well suited as range, and most of it is used for that purpose. It is not suitable for cultivation, because it is droughty, susceptible to erosion, low in fertility, and unproductive. Water-holding capacity is low, though most of the precipitation is absorbed.

In good management of pasture, overgrazing is prevented and desirable grasses are maintained. Desirable grasses are sand bluestem, little bluestem, switchgrass, and Canada wildrye. Sand sagebrush infests areas that are heavily grazed. Some areas should be reseeded to increase production of forage.

Low water-holding capacity, low fertility, and soil blowing are concerns of management. A good practice is seeding cultivated areas with desirable native grasses. These soils are good sites for feedlots because the sandy substratum is excessively drained. (Capability unit VIe–2, dryland; Sands range site)

Lofton Series

The Lofton series consists of deep, moderately fine textured soils that occur on uplands with Randall soils, which are in slight depressions. The Lofton soils occupy benches above the Randall soils.

In a typical profile, the plow layer of Lofton soils is firm, gray silty clay loam about 6 inches thick. This layer is free of lime. It has moderate, fine and medium, granular structure. The subsoil contains more clay than the surface layer and is gray light silty clay in the upper part and grayish-brown heavy silty clay loam in the lower part. This layer is noncalcareous and has granular structure. The underlying material at a depth of about 30 inches consists of pale-brown silty clay loam that contains free lime and can be easily penetrated by plant roots.

Lofton soils are moderately well drained. They have a slow rate of water intake and very slow permeability. Internal drainage is moderately slow. Water-holding capacity is high, but moisture is released slowly to plants. These soils are droughty because of the fine-textured subsoil. They are high in fertility and are very susceptible to soil blowing if bare.

These soils are suited to wheat, grain sorghum, and native grasses. Some areas are irrigated.

Typical profile of Lofton silty clay loam, 1,000 feet north and 600 feet west of the southeast corner of section 18, T. 28 S., R. 32 W., in a cultivated field:

Ap—0 to 6 inches, gray (10YR 4.5/1) heavy silty clay loam, very dark gray (10YR 3/1) when moist; moderate, fine and medium, granular structure; hard when dry, firm when moist; noncalcareous; clear, smooth boundary.

B2t—6 to 24 inches, gray (10YR 5/1) light silty clay, very dark grayish-brown (10YR 3/2) when moist; moderate, medium, subangular blocky structure; very hard when dry, very firm when moist; shiny faces on peds; noncalcareous; gradual, smooth boundary.

B3—24 to 30 inches, grayish-brown (10YR 5/2) heavy silty clay loam, dark grayish-brown (10YR 4/2) when moist; moderate, fine, granular structure; hard when dry, firm when moist; noncalcareous; gradual, smooth boundary.

C—30 to 50 inches, pale-brown (10YR 6/3) light silty clay loam, brown (10YR 5/3) when moist; weak granular structure; slightly hard when dry, friable when moist; calcareous; few masses of soft lime concretions.

The plow layer ranges from 6 to 10 inches in thickness, and the B horizon ranges from 12 to about 24 inches. Depth to calcareous material ranges from 20 to 30 inches. The substratum is faintly mottled in some places.

Lofton soils are less clayey in the surface layer than the Randall soils and are less likely to be ponded. They are darker and more clayey in the surface layer and subsoil than the Richfield soils. Lofton soils have more clay in the subsoil than Lubbock soils. The clay in the Lofton soils extends to greater depths than that in the Spearville soils.

Lofton silty clay loam (0 to 1 percent slopes) (Lo).—This nearly level soil is on concave slopes above Randall soils and below Richfield and Ulysses soils. Generally it is on benches that surround areas of Randall soils. In this county individual areas and the total acreage are small. This soil is mostly in the northeastern part of the county. The profile of this soil is the one described as typical of the Lofton series.

This soil is suited to dryfarmed grain sorghum and wheat, but it is not suited to irrigated crops. In dryfarmed areas, production is limited by insufficient moisture. In some years, however, runoff is ponded long enough to delay planting and harvesting, and in some years crops are drowned and lost. Bur-ragweed is a pest in cultivated areas.

Most areas of this soil are cultivated in the same way as surrounding soils more suitable for cultivation. Unless this soil is protected by growing plants or crop residue, soil blowing is likely. Runoff from the surrounding soils is decreased if they are terraced, cultivated on the contour, or stubble mu'ched. Stubble mulching is also needed on this soil for increasing the infiltration of water and reducing soil blowing. More moisture is stored if this soil is summer fallowed. (Capability unit IVw-1, dryland; Clay Upland range site)

Lubbock Series

The Lubbock series consists of deep, nearly level soils in slight depressions on the uplands. These soils formed in lacustrine deposits. In addition to the rainfall, water runs onto these soils from the uplands.

In a typical profile, the surface layer is dark grayish-brown light silty clay loam that is free of lime and about 9 inches thick. This layer has moderate, fine to medium, granular structure. A few of the granules are from worm casts. The subsoil is firm silty clay loam that has weak or moderate subangular blocky structure. It is about 33 inches thick and is noncalcareous at about 24 inches from the surface. It is dark grayish brown in the upper part and grayish brown in the lower part. Underlying the subsoil is loess of light silty clay loam texture that, in turn, is underlain by lacustrine deposits. The substratum is easily penetrated by plant roots, water, and air.

Lubbock soils are well drained. They have a moderately slow rate of water intake and medium internal drainage. Permeability is moderately slow, and water-holding capacity is high. These soils are high in fertility, but they are susceptible to soil blowing. Water erosion is negligible.

Most areas of Lubbock soils are cultivated. These soils are suited to wheat, grain sorghum, and other dryland crops, and to native grass. Many areas are irrigated. Corn, wheat, and grain sorghum are the main irrigated crops.

Typical profile of Lubbock silty clay loam, 500 feet north and 100 feet east of southwest corner of section 13, T. 27 S., R. 31 W., in a cultivated field:

A1—0 to 9 inches, dark grayish-brown (10YR 4/2) light silty clay loam; very dark grayish brown (10YR 3/2) when moist; moderate, fine to medium, granular structure; slightly hard when dry, friable when moist; noncalcareous; few granules from worm casts; clear, smooth boundary.

B21t—9 to 18 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine to medium, subangular blocky structure; hard when dry, firm when moist; noncalcareous; thin, patchy, shiny clay films on blocks; gradual, smooth boundary.

B22t—18 to 24 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, subangular blocky structure; very hard when dry, firm when moist; noncalcareous; thick patchy clay films; clear, smooth boundary.

B3ca—24 to 42 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; weak subangular blocky structure; hard when dry, friable when moist; calcareous; soft concretions of calcium carbonate; gradual, smooth boundary.

C1ca—42 to 50 inches, light brownish-gray (10YR 6/2) light silty clay loam, dark grayish brown (10YR 4/2) when moist; weak granular structure; hard when dry, friable when moist; calcareous; soft concretions of lime; clear, smooth boundary.

A1b—50 to 68 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 2/1) when moist; weak granular structure; slightly hard when dry, friable when moist; strongly calcareous; some white lime; clear, smooth boundary.

C2—68 to 72 inches, light-gray (5Y 7/2) light silty clay loam, olive gray (5Y 5/2) when moist; massive (structureless); slightly hard when dry, friable when moist; strongly calcareous.

The surface layer (Al horizon) ranges from 8 to 12 inches in thickness, from light silty clay loam to silt loam in texture, and from dark grayish brown to very dark grayish brown in color. The B horizon is silty clay loam. Depth to the light-gray substratum ranges from 48 to 72 inches. Depth to calcareous material ranges from 18 to 40 inches.

The Lubbock soils are darker colored and finer textured than the Richfield soils and are leached of lime to a greater depth. They have a coarser textured subsoil than the Lofton soils. Layers in the Lubbock soils are more distinct than those in the Ulysses soils.

Lubbock silty clay loam (0 to 1 percent slopes) (Lu).—This nearly level soil occupies slight depressions in the northeastern part of the county. Fields range from 80 to 320 acres in size. Surface runoff is slow, and the extra water that runs in from upland areas is beneficial. The profile of this soil is the one described as typical of the Lubbock series.

This soil is suited to dryfarmed and irrigated crops and is used for those purposes. Winter wheat and grain sorghum are the main dryfarmed crops, though others may be grown. Practices are needed that conserve moisture and control soil blowing. Among these practices are using a suitable cropping sequence, managing crop residue, and tilling at a minimum. A suitable cropping sequence is sorghum, summer fallow, and wheat. The summer fallow helps in storing moisture. Managing crop residue by using a stubble mulch controls soil blowing and increases the intake of water. Other practices that conserve moisture are terracing, contour tillage, and stripcropping. Stripcropping can be used effectively with stubble mulching. The amount of crop residue needed at seeding time varies with the cropping sequence and the mechanical practices used.

This soil is suited to all irrigated crops suited to the area. The crops grown are wheat, corn, sorghums, alfalfa, pinto beans, and garden crops. Irrigated grasses are also grown. Good management of this soil includes practices that maintain or improve fertility and tilth, that protect against soil blowing, and that use irrigation water effectively. Crop residue and manure are needed for maintaining organic matter and tilth. By adding commercial fertilizer, the amount of crop residue is increased. The fertilizer should contain a large percentage of nitrogen. Including a legume in the cropping system is beneficial. By managing irrigation water efficiently, labor is reduced, the risk of erosion is lessened, and water is not wasted.

Land leveling is generally needed for efficient use of irrigation water. Lined ditches and underground pipe prevent loss of water and erosion in ditches. Also needed is a drainage system that removes excess runoff during heavy rains. All irrigation methods can be used on this soil, but the border (fig. 9) and furrow methods are most common. (Capability unit IIIc-2, dryland; I-1, irrigated; Loamy Lowland range site)

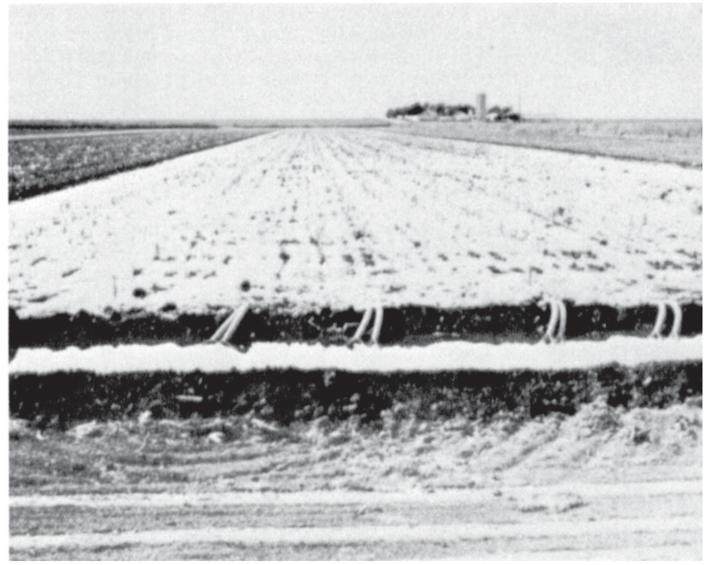

***Figure 9.*—Border irrigation of Lubbock silty clay loam in the northeastern part of the county.**

Manter Series

The Manter series consists of nearly level and gently sloping, noncalcareous soils on uplands. These soils formed on the High Plains in calcareous sediments of outwash that have been reworked by wind.

In a typical profile, the surface layer is brown fine sandy loam 14 inches thick. It is very friable. Its structure is weak granular in plowed areas and moderate, medium, granular in undisturbed areas. A few of the granules are from worm casts. The subsoil is brown, calcareous heavy fine sandy loam about 10 inches thick. It is friable and has weak granular structure. The substratum consists of pale-brown, calcareous fine sandy loam that is friable and easily penetrated by plant roots, air, and water. It is more calcareous in the upper part than in the lower. The upper part contains soft concretions of lime.

Manter soils are well drained. The rate of water intake is moderately high, and internal drainage is moderate. Permeability is moderately rapid, and water-holding capacity is moderate. These soils are fertile, but they are susceptible to soil blowing. The more sloping areas are also susceptible to water erosion.

The Manter soils are cultivated in most areas. They are suited to wheat, grain sorghum, and other dryland crops but are probably better suited to native grasses. Grain sorghum is the crop most widely grown. A few of the nearly level areas are irrigated.

Typical profile of Manter fine sandy loam, 1 to 3 percent slopes, 300 feet north and 200 feet west of the southeast corner of NE¼, section 20, T. 27 S., R. 33 W., in cultivated field:

A1—0 to 14 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) when moist; moderate, medium, granular structure; slightly hard when dry, very friable when moist; noncalcareous; few granules from worm casts; gradual, smooth boundary.

B2—14 to 24 inches, brown (10YR 5/3) heavy fine sandy loam, brown (10YR 4/3) when moist; weak granular structure; slightly hard when dry, friable when moist; few granules from worm casts; calcareous; gradual, smooth boundary.

C1ca—24 to 42 inches, pale-brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) when moist; massive (structureless); slightly hard when dry, friable when moist; calcareous; few soft masses of lime; gradual, smooth boundary.

C2—42 to 50 inches, pale-brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) when moist; massive (structureless); slightly hard when dry, friable when moist; calcareous.

The surface layer (A1 horizon) ranges from 10 to 18 inches in thickness and from fine sandy loam to loamy fine sand in texture. In many areas in cultivated fields, the top 2 to 4 inches of the plow layer is loamy fine sand because the wind has blown away fine soil material. In many places the B horizon is heavy sandy loam that ranges from 12 to 16 inches in thickness. The C horizon is silt loam or loam in some places. Depth to calcareous material is about 14 inches in most places but ranges from 10 to 24 inches.

Manter soils are more sandy in the subsoil than the Satanta soils and are less sandy in the surface layer than the Vona soils. Manter soils are free of lime to a greater depth than are the Otero soils.

Manter fine sandy loam, 0 to 1 percent slopes (Ma).—This nearly level soil occupies upland areas between the sandhills and the silty uplands. Areas range from 40 to 80 acres in size. Surface runoff is slow because most of the water is absorbed. The profile of this soil is similar to the one described as typical of the Manter series, but the noncalcareous surface layer is about 16 inches thick, and the subsoil is about 14 inches thick. Depth to calcareous material ranges from 12 to 20 inches.

Included in areas mapped as this soil were small areas of Satanta fine sandy loam, 0 to 1 percent slopes, and of Satanta loam, 0 to 1 percent slopes.

This Manter soil is mostly dryfarmed, but some areas are irrigated. Wheat, grain sorghum, and forage sorghum are the main dryfarmed crops. In dryfarmed areas sorghums are generally grown continuously, but sometimes the sequence is sorghum-summer fallow-wheat. Good management provides using crop residue effectively by using stubble mulching to conserve moisture and to control soil blowing. Soil blowing is more likely than water erosion. Tillage should be at a minimum. Where wheat is grown, the summer fallow is necessary for increasing the amount of water available. Wind stripcropping is more effective than terracing or contour tillage because the rate of water intake is high. The width of strips depends on the amount of residue on this soil at seeding time.

Suitable irrigated crops are corn, beans, and alfalfa. In irrigated areas, good management provides use of a suitable cropping sequence, use of crop residue, application of manure and commercial fertilizers where needed, and effective application of irrigation water. Nitrogen is the most needed element, and crop response is good if a nitrogen fertilizer is applied. Land leveling is generally necessary for efficient use of water. Loss of water can be prevented by lining the ditches. All methods of irrigation can be used on this soil, but the border and furrow methods are most common. Bench leveling is used to reduce the grade and increase efficiency. (Capability unit IIIe–3, dryland; IIs–1, irrigated; Sandy range site)

Manter fine sandy loam, 1 to 3 percent slopes (Mb).—This gently sloping soil is in undulating areas of the uplands. Areas range from 40 to 80 acres in size. Runoff is medium to slow because most of the precipitation is absorbed. The profile of this soil is the one described as typical of the Manter series. Depth to the limy material is commonly about 14 inches but ranges from 10 to 20 inches.

Included with this soil in the mapping were small areas of Satanta fine sandy loam, 1 to 3 percent slopes, and of Otero fine sandy loam, 1 to 3 percent slopes. It is impractical to map these small areas separately.

Soil blowing is the most serious hazard on this soil, and it is likely where there is not enough plant cover for protection. In some places the surface layer is winnowed, and the top few inches is loamy fine sand. Water erosion is a hazard on some of the longer slopes.

This is a good soil for farming. Most areas are dryfarmed, but a few areas have been seeded to native grass, and a few areas are irrigated. Grain sorghum is the main dryfarmed crop, and it is generally grown continuously, but a sequence of sorghum, summer fallow, and wheat can be used if the crop residue is managed. Tillage should be kept to a minimum. If wheat is grown, summer fallow is needed for conserving water and stubble mulching is needed for protection against soil blowing. Wind stripcropping is more effective than terracing, contour farming, or contour stripcropping. The width of strips depends on the amount of residue on the surface at seeding time. In years that have above average rainfall, crops respond well to a nitrogen fertilizer.

Wheat and sorghums are the main irrigated crops, but most irrigated crops grown in the county are suited. The border, contour furrow, contour ditch, and sprinkler methods of irrigation can be used without altering the slope. Irrigation is more efficient, however, if bench leveling is used to reduce the gradient, and the border, level border, or furrow method is applied. Crop residue should be managed by stubble mulching so that moisture is conserved and soil blowing and water erosion are controlled. Wind stripcropping is a good practice, and in some places terraces are needed to control washing. The use of underground pipe is another good practice. (Capability unit IIIe–2, dryland; IIe–2, irrigated; Sandy range site)

Otero Series

The Otero series consists of deep, calcareous, gently sloping to strongly sloping soils on uplands, mainly along drainageways. These soils formed in strongly calcareous material that to some extent has been reworked by wind.

In a typical profile, the surface layer is grayish-brown, calcareous fine sandy loam about 6 inches thick. This layer is very friable. It has moderate, medium, granular structure under grass and is structureless or has weak granular structure where cultivated. Underlying the surface layer is a transitional layer of brown fine sandy loam about 10 inches thick. It contains soft masses of lime and has weak granular structure. This layer is underlain by limy fine sandy loam outwash that is friable, porous, and easily penetrated by plant roots, air, and water. In some areas this layer contains deposits of sand and gravel that are excellent for road construction.

Otero soils are well drained. The rate of water intake is medium to moderately high, and internal drainage is medium. Permeability is moderate to moderately rapid, and water-holding capacity is low to moderate. These soils are moderate in fertility but are highly susceptible to soil blowing and water erosion.

These soils are well suited to native grass range, and the strongly sloping Otero soils are used for that purpose. The moderately sloping soils are cultivated. They are not well suited to cultivation, but wheat and grain sorghum can be grown if crop residue is managed well. Irrigation is not practical.

Typical profile of Otero fine sandy loam, 1 to 3 percent slopes, in the Otero-Ulysses complex, 500 feet south and 100 feet east of the northwest corner of section 15, T. 27 S., R. 31 W., in a cultivated field:

Ap—0 to 6 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; massive (structureless); slightly hard when dry, very friable when moist; calcareous.

AC—6 to 16 inches, brown (10YR 5/3) fine sandy loam, brown (10YR 4/3) when moist; weak granular structure; slightly hard when dry, very friable when moist; calcareous; few, small, soft masses of lime; gradual, smooth boundary.

Cca—16 to 60 inches, pale-brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) when moist; massive (structureless); slightly hard when dry, very friable when moist; calcareous; faint films of lime.

The texture of the horizons varies considerably from place to place. In some cultivated areas 2 to 4 inches of loamy fine sand is at the surface because the finer soil particles have blown away. The A horizon ranges from 4 to 8 inches in thickness. The AC horizon ranges from grayish brown to pale brown, and in most places it contains soft lime concretions. The C horizon ranges from loamy sand to light clay loam. In most places the soil profile is calcareous, but under grass it may be leached of lime to a depth of about 6 inches.

Otero soils are more calcareous than the Manter soils and are more sandy than the Colby soils.

Otero gravelly complex (5 to 15 percent slopes) (Og).—This mapping unit occurs on uplands and is strongly sloping and hilly. It is made up of limy, calcareous fine sandy loam that occurs in the smoother areas and of a gravelly soil that occurs in the steeper and hilly areas. The fine sandy loam makes up 75 percent of this complex and the gravelly soil 25 percent. The gravelly soil has a gravelly sandy loam surface layer about 10 inches thick that is underlain by a substratum of sand and gravel. In these gravelly areas high-quality sand and gravel is obtained for road construction.

The soils of this complex are not suitable for cultivation, because they are strongly sloping, have low water-holding capacity, and are susceptible to erosion. They are better suited to native grass range. (Capability unit VIe–3, dryland; Sandy range site)

Otero-Ulysses complex, 1 to 3 percent slopes (Ou).—The Otero and the Ulysses soils in this complex are so closely intermingled that it is not practical to map them separately. The Otero soils make up 60 percent of the complex, and the Ulysses soils make up 40 percent. The Otero soils are on the steeper slopes and on knolls and ridgetops. They have a light-colored, calcareous fine sandy loam surface layer. The Ulysses soils have a moderately dark colored, granular loam and light loam surface soil. They are generally not so steep as the Otero soils and are at the base of slopes. Runoff is medium on the Ulysses soils and is slow to medium on the Otero.

Included with these soils in the mapping were small areas of Satanta, Colby, and Manter soils. Also included were small eroded areas and blowouts.

The soils in this complex are better suited to native grasses than to crops, but they can be used for dryfarmed grain sorghum and wheat if management is intensive. Soil blowing and water erosion are hazards, and practices are needed to conserve moisture. Good management includes use of crop residue by stubble mulching, tilling at a minimum, and use of suitable crops. If these soils are summer fallowed, a stubble mulch is needed to protect the surface from soil blowing and water erosion. Terracing, contour farming, and contour stripcropping are less effective than stubble mulching and wind stripcropping. The amount of residue on these soils determines the width of strips needed. Many areas of these soils have been seeded to native grasses. (Capability unit IVe–3, dryland; Otero soil, Sandy range site; Ulysses soil, Loamy Upland range site)

Randall Series

The Randall series consists of deep, nearly level, noncalcareous soils on the floor of undrained depressions in the uplands. These depressions, locally called potholes, have no outlets and are ponded for as long as a week or more before the water either passes through the soil or evaporates.

In a typical profile, the plow layer is gray light clay about 4 inches thick. It is very firm and free of lime. The subsurface layer is gray, noncalcareous clay about 26 inches thick. It is very firm and has moderate, fine, angular blocky structure. Underlying the subsurface layer is a transitional layer of silty clay loam that is firm and calcareous. The substratum is very pale brown light silty clay loam.

Randall soils are poorly drained. The rate of water intake is very slow, internal drainage is slow, and water is often ponded on the surface. Permeability is very slow. The capacity to hold water is high, but water is released slowly to plant roots. These soils are highly susceptible to soil blowing in bare areas.

Randall soils are not suitable for cultivation, though some areas are planted to wheat and sorghum, as are the soils on the surrounding uplands. These crops grow well on Randall soils in years of low rainfall.

Typical profile of Randall clay, 1,000 feet south and 400 feet east of the northwest corner of section 2, T. 29 S., R. 32 W., in cultivated field:

Ap—0 to 4 inches, gray (10YR 5/1) light clay, dark gray (10YR 4/1) when moist; weak to moderate, fine, granular structure; very hard when dry, very firm when moist; noncalcareous; clear, smooth boundary.

A1—4 to 30 inches, gray (10YR 5/1) clay, very dark gray (10YR 3/1) when moist; moderate, fine, angular blocky structure; very hard when dry, very firm when moist; few root hairs; shiny faces on surface of peds; noncalcareous; diffuse, smooth boundary.

AC—30 to 36 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; weak granular structure; very hard when dry, firm when moist; calcareous, gradual boundary.

C—36 to 60 inches, very pale brown (10YR 7/3) light silty clay loam, brown (10YR 5/3) when moist; massive (structureless); hard when dry, friable when moist; calcareous.

Figure 10.—**Upland depression after rain. Randall clay occupies the floor of this depression.**

The clay plow layer ranges from gray to light gray in color and from 4 to 8 inches in thickness. The A1 horizon ranges from 18 to 40 inches in thickness. From one depression to another, the characteristics of these soils vary greatly, particularly in the texture of the A and AC horizons and in the depth to calcareous material. These horizons range from silty clay loam to clay, and the depth to calcareous material ranges from 18 to 60 inches.

Randall soils are more clayey than the Richfield, Ulysses, and Spearville soils, which occur in upland areas where the drainage pattern is not well defined. They are also more clayey than the Lofton soils.

Randall clay (0 to 1 percent slopes) (Ra).—This soil occurs on the floor of upland depressions throughout the county. Its profile is the one described as typical of the Randall series. The clay is thicker in the larger depressions than in the smaller. Areas of this soil range from 5 to 80 acres in size.

This soil is compact and very slowly permeable to almost impervious. It contracts when dry and swells when wet. In dry periods wide cracks form, but they seal in wet periods, and water collects and drowns all vegetation. Runoff water flows into these depressions after heavy rains (fig. 10).

Randall clay is not suitable for cultivation; it is best used as pasture or for wildlife. Crop losses are expected when this soil is farmed, but an average crop is harvested in years of average rainfall. Wind erosion is a hazard if this soil is not adequately protected by a cover of plants or crop residue. If runoff water from the surrounding uplands can be controlled by terracing or contour farming, western wheatgrass or similar grasses can be seeded. If pits are dug, they fill with water that can be used by wildlife and fish. (Capability unit VIw-2, dryland)

Richfield Series

The Richfield series consists of deep, well-drained, nearly level and gently sloping soils of the loess-mantled uplands. These soils are extensive and they occur throughout the county.

In a typical profile, the surface layer is dark grayish-brown or very dark grayish-brown, noncalcareous, friable silt loam about 6 inches thick (fig. 11). It has weak granular structure and is easily worked. Granular worm casts are numerous in this layer. The subsoil is dark grayish-brown to brown, firm silty clay loam about 16 inches thick. It contains a few granules from worm casts. The upper part of the subsoil is noncalcareous and has weak prismatic structure that breaks to moderate, medium, subangular blocky. The lower part of the subsoil has weak subangular blocky structure. It is strongly calcareous and contains many soft concretions of lime. The loessal underlying material, or substratum, is light silty clay loam or heavy silt loam. It is easily penetrated by air, water, and plant roots.

The Richfield soils permit moderate infiltration and have moderately slow permeability and high water-holding capacity. These soils are high in fertility, but they are susceptible to soil blowing and water erosion.

Nearly all areas of Richfield soils are used for dryfarmed or irrigated crops. Winter wheat is the most widely grown dryfarmed crop, but grain sorghum and other crops are also dryfarmed. The irrigated crops are corn, alfalfa,

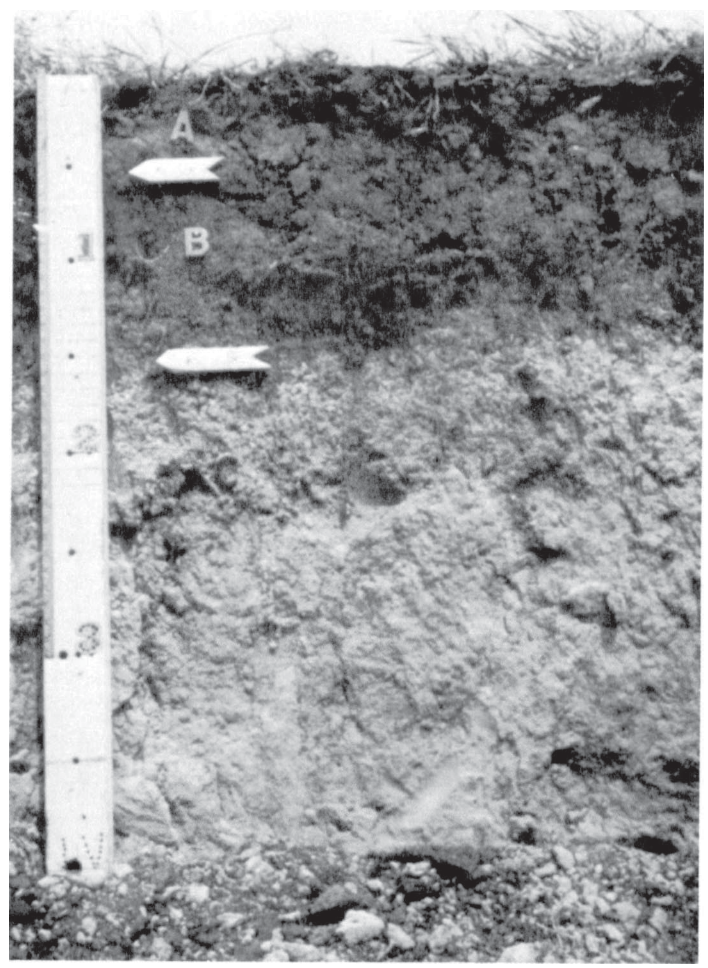

Figure 11.—**Typical profile of a Richfield silt loam.**

forage and grain sorghums, and sugar beets. A few irrigated acres are in grass and are grazed.

Typical profile of Richfield silt loam, 0 to 1 percent slopes, about 1,000 feet south and 100 feet east of northwest corner of section 4, T. 29 S., R. 33 W., in a cultivated field:

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) heavy silt loam, very dark grayish brown (10YR 3/2) when moist; weak granular structure; slightly hard when dry, friable when moist; noncalcareous; clear, smooth boundary.

B21t—6 to 14 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak prismatic structure breaking to moderate, medium, subangular blocky; hard when dry, firm when moist; few granules from worm casts; scattered clay films; noncalcareous; gradual, smooth boundary.

B22t—14 to 18 inches, brown (10YR 4/3) heavy silty clay loam, dark brown (10YR 3/3) when moist; moderate, medium, subangular blocky structure; very hard when dry, firm when moist; continuous, thick clay films; noncalcareous; smooth boundary.

B3ca—18 to 22 inches, brown (10YR 5/3) silty clay loam, brown (10YR 4/3) when moist; weak subangular blocky structure; hard when dry, friable when moist; strongly calcareous; many soft concretions of calcium carbonate; gradual, smooth boundary.

Cca—22 to 42 inches, very pale brown (10YR 7/3) light silty clay loam, brown (10YR 5/3) when moist; hard when dry, friable when moist; calcareous; few soft concretions of lime; gradual, smooth boundary.

C—42 to 60 inches, pale-brown (10YR 6/3) heavy silt loam, brown (10YR 5/3) when moist; massive (structureless); slightly hard when dry, friable when moist; porous; calcareous; few soft concretions of lime.

The A horizon ranges from 4 to 8 inches in thickness and from heavy silt loam to light silty clay loam in texture. The B horizon ranges from 8 to 20 inches in thickness and from light silty clay loam to heavy silty clay loam. Depth to the calcareous material ranges from 12 to 24 inches, but in most places is about 18 inches. In some places a dark layer is at a depth of 24 to 48 inches or more. It is the surface layer of an old buried soil.

The Richfield soils occur closely with the Ulysses soils. They have a more strongly developed, more clayey B horizon than Ulysses soils and are noncalcareous to a greater depth. Layers in the Richfield soils are more distinct than those in the Satanta soils. Richfield soils are less clayey than Spearville soils and have less profile development than the Lubbock soils.

Richfield silt loam, 0 to 1 percent slopes (Rm).—This nearly level soil occupies tablelands and is the most extensive soil in the county. Areas range from 320 to 640 acres in size. Drainage is good, though runoff is slow to medium. Little erosion has occurred. The profile of this soil is the one described as typical of the Richfield series.

Included with this soil in the mapping were small areas of Ulysses silt loam, 0 to 1 percent slopes, and of Spearville silty clay loam, 0 to 1 percent slopes. These included areas are so small that it is not practical to map them separately.

This is an excellent soil for farming, and nearly all of it is dryfarmed or irrigated. Wheat and grain sorghum are suitable dryfarmed crops. The main concerns in managing this soil are low rainfall and soil blowing where fields are left bare. Summer fallowing is essential for storing moisture, and stubble mulching is needed for reducing soil blowing. In most years dryfarmed crops grow well if this soil is left fallow in summer. Terracing and contour farming may be used, but wind stripcropping is more effective in reducing soil blowing. Water erosion is not a hazard in dryfarmed areas.

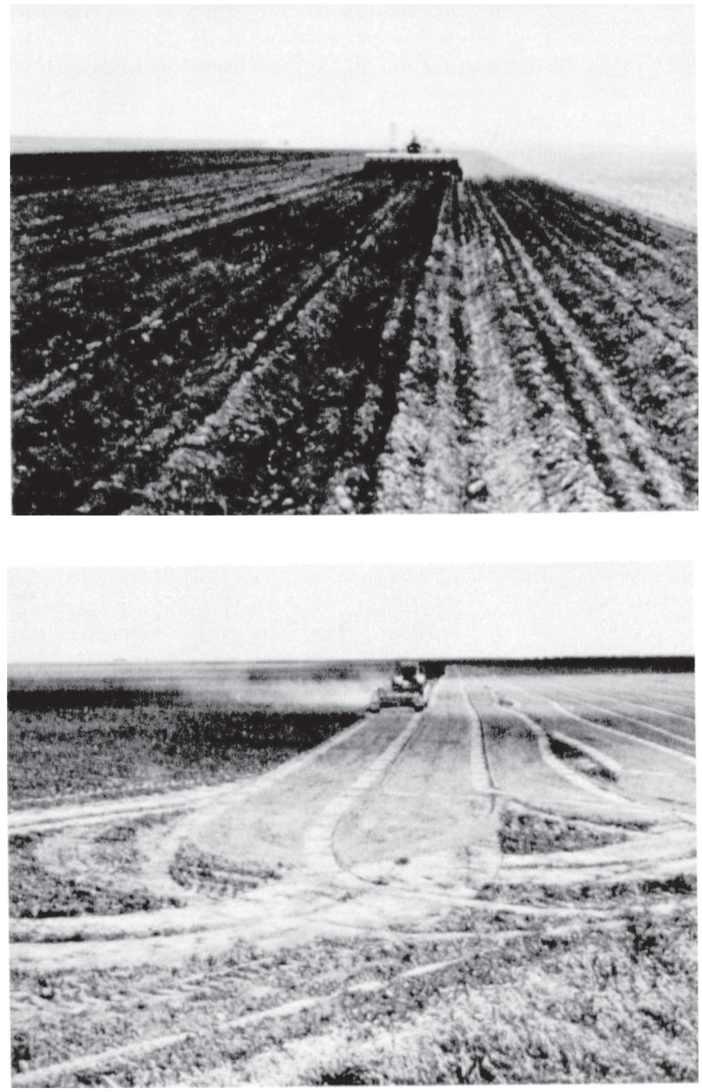

Figure 12.—Nearly level Richfield and Ulysses soils: *Top,* planting wheat; *bottom,* land leveling.

This soil holds a large amount of water and is very good for irrigation. Suitable irrigated crops are wheat (fig. 12), sorghums, corn, pinto beans, alfalfa, and garden crops. A cropping system that included a legume is desirable. Crop residue and manure are needed to maintain fertility and improve tilth. Also needed is a fertilizer that contains nitrogen. Land leveling to a uniform grade reduces erosion, encourages uniform penetration of moisture, and conserves moisture (see fig. 12). Use of underground pipe also conserves moisture and reduces erosion. Water must be applied carefully so as to avoid overirrigation and the resulting loss of water as tailwater, or flow from the irrigated field. All methods of irrigation may be used, but the border and the furrow methods are most common. (Capability unit IIIc-1, dryland; I-1, irrigated; Loamy Upland range site)

Richfield silt loam, 1 to 3 percent slopes (Rn).—This gently sloping soil occurs on uplands, mainly in the eastern part of the county. Slopes generally are less than 2 percent.

The profile of this soil is thinner than the one described for the Richfield series, but otherwise is much like it. The surface layer is silt loam about 5 inches thick, and the subsoil is silty clay loam about 10 inches thick. Lime occurs at a depth of 12 to 18 inches.

Included with this soil in the mapping were small areas of Ulysses silt loam, 0 to 1 percent slopes. These included areas are so small that it is not practical to map them separately.

This soil is fertile and is suitable for dryfarmed and irrigated crops. Wheat and grain sorghum are suitable dryfarmed crops. The cropping sequence generally followed is sorghum, summer fallow, and wheat. The sorghum may show signs of chlorosis during early growth. Terracing and contour farming are needed to control water erosion, the main hazard on this gently sloping soil. These practices also conserve moisture. Stubble mulching is needed for controlling soil blowing and conserving moisture. The effectiveness of this practice depends on the amount of stubble left on the surface. During summer fallowing, tillage is needed for controlling weeds, but the tillage should be kept to a minimum.

In irrigated areas, suitable crops are corn, wheat, grain sorghum, and sugar beets. The cropping system should include legumes and other close-growing crops. Management is needed that controls erosion, uses irrigation water effectively, and maintains fertility. Erosion is reduced and the water held is increased if contour furrows and contour ditches are used with terraces. Also suitable on this soil are the corrugations, contour furrows, and sprinklers. Drop structures and underground pipe are needed to prevent erosion in ditches and to conserve water. Bench leveling increases the uniform penetration of water, reduces erosion, and reduces the amount of labor needed. The water must be applied carefully so as to avoid loss of tailwater. On irrigated fields, it is advisable to apply fertilizer and, when available, barnyard manure. (Capability unit IIIe-1, dryland; IIe-1, irrigated; Loamy Upland range site)

Richfield and Ulysses complexes, bench leveled (0 to 1 percent slopes) (Ru).—This mapping unit consists of areas of Richfield, Ulysses, Colby, and Satanta soils that have been leveled for irrigation. As a result of the cutting and filling, the soil material of these soils is so intermingled that the soils cannot be mapped separately. Not all of these soils are present in every area mapped, but in any area there are at least two kinds. In some areas all four kinds of soils occur, and even other soils.

Leveling has affected the soils in several ways. In areas where the soil material has been removed, the subsoil is exposed. The plow layer depends on the characteristics of the soil before leveling and on the depth of the material removed. The Colby soils are generally in areas where, to a considerable depth, material has been removed from the Richfield, Ulysses, or Satanta soils. The areas of fill are stratified, and the strata vary in texture, color, and reaction. The soil series cannot be identified in some areas that have received 20 inches or more of fill material.

Much of the leveling has been done where the slope was less than 1 percent, but in order to square fields, cuts as much as 5 feet deep have been made in small areas. The difference in elevation between benches is generally about 1 or 2 feet (fig. 13).

Figure 13.—**Richfield and Ulysses complexes, bench leveled. The leveling reduces water erosion and permits more efficient use of irrigation water.**

A few areas of Ulysses loams have been leveled. These areas were undulating, and they had slopes ranging from 0 to 3 percent. In areas of Satanta and Ulysses soils, a few areas of Manter fine sandy loam, 0 to 1 percent slopes, have been leveled. Also, depressions consisting of Randall clay have been filled. In these areas, the slowly permeable clay layer below the fill material restricts the downward movement of air and water, and crops are damaged if the soil remains saturated too long.

Crop growth is generally reduced for several years after leveling because the plow layer consists of light-colored, calcareous material low in fertility. On the highly calcareous soils of this mapping unit, chlorosis is common in young sorghum plants. In cut areas, fertility and soil structure can be improved by working crop residue and animal manure into the soil. The amount of crop residue available is increased by applying commercial fertilizer.

All of this mapping unit is irrigated. These soils are suited to sorghums, wheat, sugar beets, alfalfa, and other irrigated crops. The areas shown on the map as Richfield and Ulysses complexes, bench leveled, are those that were leveled by the end of 1963. Since that time other areas have been leveled, but they are not indicated on the soil map.

Good management on these soils includes practices that maintain or improve fertility and tilth. A cover of crop residue protects these soils against soil blowing, and if the residue is worked into the soil, it helps maintain organic matter and tilth. Also beneficial is a deep-rooted legume in the cropping system. Nitrogen generally is insufficient. Effective management of irrigation water is needed for reducing labor and for preventing erosion and waste of water. (Capability unit IIIc-1, dryland; I-1, irrigated; Loamy Upland range site)

Satanta Series

The Satanta series consists of deep, nearly level and gently sloping soils on uplands. These soils developed in loamy to sandy sediments over loess.

In a typical profile, the surface layer is friable, dark grayish-brown loam about 9 inches thick. This layer has moderate, fine, granular structure and is easily worked. It is free of lime. Granules from worm casts are numerous in the surface layer. The subsoil is about 25 inches thick. It is dark grayish-brown heavy loam in the upper part, grayish-brown light clay loam in the middle part, and pale-brown loam in the lower part. The subsoil is friable, and most of it has subangular blocky structure. Worm casts are few. The underlying material is pale-brown loam that is friable, porous, and calcareous.

Satanta soils are well drained. The rate of water intake is medium to moderately high, and water-holding capacity is high. Internal drainage is medium, and permeability is moderate. These soils are high in fertility, but they are susceptible to soil blowing.

Most areas of Satanta soils are cultivated to dryfarmed or irrigated crops. Wheat, grain sorghum, and native grasses are grown without irrigation. Suitable irrigated crops are wheat, corn, sorghums, alfalfa, sweetclover, and sugar beets.

Typical profile of Satanta loam, 0 to 1 percent slopes, about 800 feet south and 100 feet east of northwest corner of section 9, T. 27 S., R. 31 W., in a formerly cultivated field that has been reseeded to grass:

A1—0 to 9 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure: slightly hard when dry, friable when moist; numerous worm casts in lower part; neutral; gradual, smooth boundary.

B1—9 to 13 inches, dark grayish-brown (10YR 4/2) heavy loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, prismatic structure breaking to moderate, fine, subangular blocky structure; slightly hard when dry, friable when moist; few worm casts; neutral; clear, smooth boundary.

B2t—13 to 23 inches, grayish-brown (10YR 5/2) light clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, subangular blocky structure; hard when dry, friable when moist; thin clay films on some ped faces; few worm casts; mildly alkaline; gradual, smooth boundary.

Bca—23 to 34 inches, pale-brown (10YR 6/3) loam, brown (10YR 5/3) when moist; weak, coarse, subangular blocky structure; hard when dry, friable when moist; calcareous; threads and films of segregated lime; gradual, smooth boundary.

C—34 to 60 inches, pale-brown (10YR 6/3) loam, brown (10YR 5/3) when moist; massive; slightly hard, friable; porous; calcareous.

The surface layer (A horizon) ranges from 6 to 12 inches in thickness and from loam to fine sandy loam in texture. In some cultivated areas, the plow layer is winnowed, and its texture is light fine sandy loam. The B horizon is loam, clay loam, or sandy clay loam. It ranges from 17 to 46 inches in thickness. Depth to calcareous material ranges from 15 to 30 inches.

Satanta soils are more loamy and more friable than the associated Richfield soils. The horizons of Satanta soils are less sandy and more distinct than those of the Manter soils. The profile of Satanta soils is leached of lime to a greater depth than that of the Ulysses soils.

Satanta fine sandy loam, 0 to 1 percent slopes (Sa).—This nearly level soil occurs on broad, smooth uplands, mostly in the southwestern part of the county. Areas range from 40 to 160 acres in size, but the total acreage in the county is small. The profile of this soil is somewhat similar to the one described as typical of the Satanta series, but the surface layer is fine sandy loam and the subsoil is sandy clay loam. This soil absorbs most of the precipitation, and runoff is slow.

Included with this soil in the mapping were small areas of Manter fine sandy loam, 0 to 1 percent slopes, and of Satanta loam, 0 to 1 percent slopes. Also included were some winnowed areas that have a loamy fine sand surface layer 4 inches thick. It is impractical to show these small areas separately on the soil map.

Most of this soil is cultivated to dryfarmed or irrigated crops. Winter wheat and grain sorghum are the principal dryland crops. A sorghum is generally grown continuously, but the sequence sorghum, summer fallow, and wheat is also used. Wind stripcropping and stubble mulching are the main practices needed for controlling soil blowing and conserving moisture. If wheat is dryfarmed, summer fallow is essential for conserving moisture. Because this soil is nearly level, wind stripcropping is more effective than terracing or contour farming. The width of the strips depends on the amount of residue on the surface at seeding time.

Suitable irrigated crops are winter wheat, corn, grain sorghum, forage sorghum, and alfalfa. Good management provides practices that maintain or improve fertility and tilth. Common practices are use of a suitable crop sequence, use of crop residue, application of manure and commercial fertilizer, and efficient application of irrigation water. Land leveling is generally necessary for efficient application of irrigation water. Lined ditches prevent the loss of water. All methods of irrigation can be used, though the border and furrow methods are most common. (Capability unit IIIe-3, dryland; I-2, irrigated; Sandy range site)

Satanta fine sandy loam, 1 to 3 percent slopes (Sb).—This gently sloping soil occurs on uplands, mostly in the southwestern part of the county. Areas range from 40 to 80 acres in size. The profile of this soil is somewhat similar to the one described as typical of the Satanta series, but the surface layer is fine sandy loam and the subsoil is sandy clay loam. Also, the surface layer varies more in thickness.

Included with this soil in the mapping were some areas that have a winnowed surface layer of loamy fine sand. Also included were lighter colored eroded areas.

Most of this soil is used for dryfarmed crops, but small areas are irrigated. The main dryfarmed crops are winter wheat and grain sorghum. Soil blowing is the main hazard in dryfarmed areas, but there is also some water erosion. Carefully managing crop residue is a good way to control soil blowing and water erosion. In some fields, terracing and contour farming are needed for controlling water erosion. Dryfarmed grain sorghum is generally grown continuously because the rate of water intake is high and moisture-holding capacity is moderate. If wheat is dryfarmed, summer fallow, along with stubble mulching and stripcropping, is needed so that enough moisture is stored. Also helpful in conserving moisture are terracing, contour farming, and contour stripcropping. The amount of residue needed on the surface at seeding time depends on the crop sequence and the mechanical practices used.

Suitable irrigated crops are corn, alfalfa, winter wheat, and grain sorghum. Management is needed for controlling erosion, applying irrigation water efficiently, and maintaining fertility and tilth. Crop residue protects this soil from erosion and improves tilth. Commercial fertilizer should be applied for maximum crop growth. A close-growing crop is needed in the cropping system. Irrigation methods that can be used without altering the slope are the border, contour, furrow, contour ditch, and sprinkler, but the water applied is used more efficiently if this soil is bench leveled to reduce the gradient. Underground pipe prevents the waste of water. (Capability unit IIIe-2, dryland; IIe-2, irrigated; Sandy range site)

Satanta loam, 0 to 1 percent slopes (Sn).—This nearly level soil is on upland slopes, where it occurs with soils that are more sandy. It is inextensive but widely scattered throughout the county. Soil areas range from 80 to 320 acres in size. Runoff is slow to medium.

Included with this soil in the mapping were areas of Ulysses silt loam, 0 to 1 percent slopes, and of Manter fine sandy loam, 0 to 1 percent slopes. Also included were areas of Satanta soil that have a silt loam surface layer.

Most of this soil is dryfarmed, but a few areas are irrigated. The main dryland crops are wheat and grain sorghum. In dryfarmed areas, management is needed to conserve moisture and control soil blowing. Essential practices are summer fallowing and stubble mulching. Because this soil is nearly level, wind stripcropping is more effective than terracing, contour farming, contour stripcropping, or other mechanical practices. The amount of residue needed on the surface at seeding time varies according to the crop sequence and the mechanical practices used.

Suitable irrigated crops are wheat, corn, sorghums, alfalfa, pinto beans, garden crops, and grasses. Good management provides practices that maintain or improve soil fertility and tilth. Crop residue and manure help to maintain organic-matter content and tilth. The crop residue is also protection against soil blowing. Applications of commercial fertilizer increase crop growth and the amount of crop residue produced. Efficient application of water reduces the labor needed and insures even distribution of the water and no wasted water or erosion. (Capability unit IIIc-1, dryland; I-1, irrigated; Loamy Upland range site)

Spearville Series

The Spearville series consists of deep, nearly level soils on the tableland, mainly in the southeastern part of the county. These soils formed in moderately fine textured sediments.

In a typical profile, the surface layer is dark grayish-brown, noncalcareous silty clay loam about 6 inches thick. This layer has granular structure and is free of lime. The subsoil, about 16 inches thick, is dark grayish-brown, noncalcareous silty clay in the upper part and grayish-brown, calcareous silty clay loam in the lower part. It is compact and firm or very firm. The substratum is calcareous and contains concretions of lime in the upper part. It is light silty clay loam and heavy silt loam and is easily penetrated by plant roots.

Spearville soils are well drained, but they are droughty at times. They release water very slowly to plant roots, though their capacity for holding water is high. The rate of water intake is slow, and permeability is slow to very slow.

Nearly all of the acreage of Spearville soils is cultivated to dryfarmed wheat and grain sorghum. These crops are well suited, as are other dryfarmed crops and native grasses. A small acreage is irrigated.

Typical profile of Spearville silty clay loam, 0 to 1 percent slopes, 500 feet north and 100 feet east of the southwest corner of section 27, T. 30 S., R. 32 W:

Alp—0 to 6 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine to medium, granular structure; hard when dry, firm when moist; noncalcareous; abrupt, smooth boundary.

B2t—6 to 16 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) when moist; weak prismatic structure breaking to moderate, medium, subangular blocky structure; shiny faces on blocks; hard when dry, very firm when moist; noncalcareous; clear, smooth boundary.

B3—16 to 22 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; weak subangular and moderate, medium, granular structure; hard when dry, firm when moist; calcareous; gradual, smooth boundary.

Cca—22 to 32 inches, pale-brown (10YR 6/3) light silty clay loam, brown (10YR 5/3) when moist; weak granular structure; hard when dry; calcareous; soft lime concretions or films of calcium carbonate.

C—32 to 60 inches, very pale brown (10YR 7/3) heavy silt loam, brown (10YR 5/3) when moist; massive (structureless); soft to slightly hard when dry; friable when moist; calcareous.

The silty clay loam A horizon ranges from 4 to 8 inches in thickness. The B3 horizon is missing in some places. Depth to limy material ranges from 10 to 22 inches.

Spearville soils are finer textured in the surface layer and subsoil than the associated Richfield and Ulysses soils. The surface layer of the Spearville soils is less clayey than that of the Randall soils in upland depressions.

Spearville silty clay loam, 0 to 1 percent slopes (Sp).—This nearly level soil occurs on tableland, mainly in the southeastern part of the county. Areas range from 80 to 160 acres in size. Runoff is medium to slow, and the rainwater that does not soak into this soil flows into the upland depressions.

This soil is better suited to dryfarmed crops than to irrigated crops because the surface layer and subsoil contain a large amount of clay. Most areas are dryfarmed. Winter wheat and grain sorghum are the main dryfarmed crops. Good management provides control of soil blowing, a suitable cropping sequence, and minimum tillage. Practices that control soil blowing and conserve moisture are summer fallowing, stubble mulching (fig. 14), wind stripcropping, and terracing and contour farming.

Stubble helps to conserve moisture by holding snow in place until it melts. The stubble may be lightly grazed, but some stubble is needed for protection against soil blowing. The amount of residue needed on the surface at seeding time depends on the mechanical practices and the crop sequence used.

Suitable irrigated crops are wheat, corn, sorghums, and alfalfa. Good management provides practices that maintain and improve soil fertility and tilth. Among these practices are using a cropping system that includes a deep-rooted legume, applying commercial fertilizer and manure, managing irrigation water efficiently, and use of crop residue. The border, furrow, and corrugation methods of irrigation are used, but the furrow and corrugation methods are most common. Land leveling is necessary for uniform

Figure 14.—Stubble mulch on Spearville silty clay loam, 0 to 1 percent slopes.

distribution of water. It is essential that the water is applied in small streams so that there is little loss as tailwater. An irrigation takes a relatively long time. Lined ditches prevent loss of irrigation water. A drainage system is needed for removing excess runoff during heavy rainstorms. (Capability unit IIIs–1, dryland; IIs–2, irrigated; Clay Upland range site)

Tivoli Series

The Tivoli series consists of deep, loose, undulating to steep soils that are in hummocky, choppy, dunelike areas of the windblown sandhills in the northwestern part of the county. These soils are noncalcareous and are not suited to cultivated crops.

In a typical profile, the surface layer is grayish-brown fine sand about 4 inches thick. This layer is free of lime. It is underlain by pale-brown, loose, noncalcareous fine sand.

Tivoli soils absorb water rapidly, and there is little or no runoff. Internal drainage is rapid to excessive. Fertility and water-holding capacity are low. The hazard of soil blowing is high in areas not protected by vegetation.

Tivoli soils are used mostly as range. They are too sandy for use as cropland.

Typical profile of Tivoli fine sand, 1,000 feet west and 250 feet north of southeast corner of section 5, T. 27 S., R. 33 W., in native grass:

A1—0 to 4 inches, grayish-brown (10YR 5/2) fine sand, dark grayish brown (10YR 4/2) when moist; weak granular structure; noncalcareous; clear, smooth boundary.

C—4 to 50 inches, pale-brown (10YR 6/3) fine sand, brown (10YR 5/3) when moist; single grain (structureless); loose when dry or moist; noncalcareous.

The A horizon ranges from fine sand to loamy fine sand in texture and from 2 to 6 inches in thickness. Where the A horizon is loamy fine sand, an AC horizon of loamy fine sand is between the A horizon and the fine sand substratum. This AC horizon ranges from 6 to 10 inches in thickness.

Tivoli soils are more sandy and less developed than the Vona soils.

Tivoli fine sand (5 to 20 percent slopes) (Tf).—This undulating to steep soil is in dunelike areas in the northwestern part of the county. It is inextensive. Because internal drainage is rapid to excessive, much of the rain that falls is lost. The profile of this soil is the one described as typical of the Tivoli series.

Included with this soil in the mapping were small areas of Vona loamy fine sand. Small active dunes and blowouts are shown on the soil map by symbols.

Nearly all of this soil remains in native grasses and sand sagebrush. Cultivated crops are not suited. Soil blowing is always a hazard and occurs where the vegetation does not provide enough protection. (Capability unit VIIe–1, dryland; Choppy Sands range site)

Tivoli-Dune land complex (5 to 40 percent slopes) (Tx).—This complex is in areas that are more dunelike than those occupied by the Tivoli fine sand that was mapped separately. Active dunes make up 20 to 40 percent of the complex, and Tivoli fine sand makes up the rest.

The soils of this complex are suited only as range. They are particularly susceptible to damage from soil blowing and need careful grazing management for control of soil blowing. The active areas are a menace to the adjacent soils and should be fenced and then stabilized by reseeding to suitable native grasses. (Capability unit VIIe–1, dryland; Choppy Sands range site)

Tivoli-Vona loamy fine sands (0 to 15 percent slopes) (Tv).—These nearly level to strongly sloping soils occur in gently undulating to moderately hummocky topography. The complex consists of Tivoli fine sand on hummocks and small dunes and gently undulating to nearly level Vona loamy fine sand. These soils are so closely intermingled that it is not practical to map them separately. Most slopes are between 3 and 15 percent, but some slopes in the broader areas are about 2 percent. This complex occurs closely with the Tivoli fine sand that is more strongly sloping and choppy.

About 60 percent of this complex is Tivoli loamy fine sand; 35 percent, Vona loamy fine sand; and 5 percent, Tivoli fine sand. Profiles of Vona loamy fine sand and Tivoli fine sand are described as typical of the Vona and Tivoli series.

The Tivoli loamy fine sand has a grayish-brown loamy fine sand surface layer 3 to 8 inches thick. A transitional layer consisting of pale-brown loamy fine sand lies between the surface layer and the substratum of noncalcareous eolian fine sand. This transitional layer is 6 to 12 inches thick.

Tivoli-Vona loamy fine sands are not suited as cropland, and most of their acreage remains in native grasses. It is a good practice to reseed cultivated areas to adapted native grasses for use as range. The few blowouts should be fenced and then stabilized by reseeding. (Capability unit VIe–2, dryland; Sands range site)

Ulysses Series

The Ulysses series consists of deep, nearly level to moderately sloping soils that occur throughout the county on uplands. These soils formed in loess of silt loam texture and have a moderately developed profile.

In a typical profile, the plow layer is grayish-brown, noncalcareous loam or silt loam about 5 inches thick. It has weak granular structure and is easily worked. In most places, the plow layer is underlain by a grayish-brown heavy silt loam, which is transitional to the subsoil. The subsoil is brown heavy silt loam that contains a few scattered clusters of granular worm casts. It is about 5 inches thick. Underlying the subsoil is calcareous, pale-brown heavy silt loam that is about 14 inches thick. It is underlain by very pale brown silt loam about 30 inches thick.

The Ulysses soils have a medium rate of water intake, moderate permeability, and high water-holding capacity. The soils are moderately high in fertility but are susceptible to soil blowing and water erosion. In most areas, however, erosion has been slight.

Most areas of Ulysses soils are cultivated. Suitable dryland crops are wheat and grain sorghum. Some areas are in native grass. The more nearly level areas are suited to irrigated crops, and on these corn and grain sorghum are grown.

Typical profile of Ulysses silt loam, 0 to 1 percent slopes, 500 feet north and 100 feet east of southwest corner of NW¼, sec. 28, T. 27 S., R. 33 W., in a cultivated field:

Ap—0 to 5 inches, grayish-brown (10YR 5/2) heavy silt loam, very dark grayish brown when moist; weak granular structure; slightly hard when dry, friable when moist; numerous granular worm casts; noncalcareous; abrupt, smooth boundary.

AB—5 to 11 inches, grayish-brown (10YR 5/2) heavy silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine to medium, granular structure; hard when dry, friable when moist; noncalcareous; few granular worm casts; gradual, smooth boundary.

B2—11 to 16 inches, brown (10YR 5/2) heavy silt loam, dark brown (10YR 3/3) when moist; moderate, medium, granular structure; hard when dry, friable when moist; common granules from worm casts; calcareous; gradual, smooth boundary.

C1ca—16 to 30 inches, pale-brown (10YR 6/3) heavy silt loam, brown (10YR 5/3) when moist; weak granular structure; slightly hard when dry; calcareous and contains streaks of lime; gradual, smooth boundary.

C2—30 to 60 inches, very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) when moist; massive (structureless); soft when dry, friable when moist; porous; calcareous.

The A horizon ranges from loam to silt loam in texture and from 4 to 8 inches in thickness. An AB horizon occurs in most places. The B horizon ranges from 25 to 32 percent in content of clay. It is generally calcareous. The C horizon ranges from silt loam to light silty clay loam. Depth to calcareous material is variable but averages about 11 inches in nearly level, cultivated areas to about 8 inches in gently sloping areas. Under native grass, depth to calcareous material is as much as 15 inches. In some cultivated areas the surface layer is calcareous where tillage has brought up material from the subsoil. In some places, generally below a depth of 24 inches, there are remnants of dark-colored layers of a buried soil.

The Ulysses soils have a darker colored, less alkaline surface layer than the Colby soils and less distinct horizons than the Richfield soil. Ulysses soils are lighter colored and less deeply leached of lime than the Satanta soils.

Ulysses loam, 1 to 3 percent slopes (Ud).—This nearly level to gently sloping soil is in slightly concave areas of the uplands. It does not cover a large total acreage, and the areas range from 40 to 320 acres in size. It occurs with Manter fine sandy loam, 1 to 3 percent slopes, and with Satanta loam, 1 to 3 percent slopes.

In cultivated areas the surface layer of this soil is about 9 inches thick, but under grass it is about 10 inches thick. The subsoil is heavy loam or light silty clay loam, and the substratum is loamy loess. In some cultivated areas this soil is limy at the surface.

Included with this soil in the mapping were small areas of Colby loam on slopes of 1 to 3 percent, of Satanta loam that has 1 to 3 percent slopes, and of Manter fine sandy loam, 1 to 3 percent slopes. Also included were small eroded areas that are shown on the soil map by the symbol for erosion.

Most areas of this soil are dryfarmed, but native grasses remain in small areas, and some areas are in irrigated crops. Small grains and grain sorghum are well-suited dryfarmed crops, though in eroded, calcareous areas the sorghum shows signs of chlorosis during early growth. The cropping system generally followed is sorghum, summer fallow, and wheat. In dryfarmed areas intensive management is needed to control soil blowing. Suitable practices are use of an appropriate cropping system, stubble mulching, and wind stripcropping. The amount of residue needed on this soil at seeding time varies with the crop sequence and the mechanical practices used. Terraces and contour farming or contour stripcropping help to control water erosion.

Although some areas are irrigated, this gently sloping soil is not well suited to irrigation. For high efficiency, bench leveling is needed to reduce the grade and prevent the waste of water. If the grade is not altered, the methods of irrigation that can be used are border, contour furrow, contour ditch, and sprinklers. With bench leveling, the border, level border, or furrow method can be used. (Capability unit IIIe–1, dryland; IIe–1, irrigated; Loamy Upland range site)

Ulysses silt loam, 0 to 1 percent slopes (Ua).—The profile of this soil is like the one described for the Ulysses series. This nearly level soil occurs on uplands throughout the county; areas range from 5 to 160 acres in size. This soil is associated with Richfield silt loam, 0 to 1 percent slopes, and small areas of that soil were included in mapping.

The surface layer of this Ulysses soil is 10 to 12 inches thick under grass and is 4 to 10 inches thick where cultivated. The subsoil ranges from silt loam to light silty clay loam. Runoff is medium.

This is a good soil for dryfarmed and irrigated crops. Winter wheat and grain sorghum are the main dryfarmed crops. The low rainfall and the slight risk of soil blowing are the main hazards in dryfarmed areas. In bare areas that are cultivated, the soil blows because raindrops break down the clods into small particles that are easily blown away. Stubble mulching and summer fallowing are needed in dryfarmed areas so as to reduce soil blowing and to conserve moisture by increasing the rate of water intake. Terracing, contour farming, and contour stripcropping are suitable practices, but wind stripcropping generally is most effective because slopes are nearly level. The amount of residue needed at seeding time varies according to the crop sequence and the mechanical practices used.

In irrigated areas, wheat, sorghums, and corn are the most common crops and are well suited to this soil, but alfalfa, sugar beets, and garden crops are also suited. A cropping system that includes a deep-rooted legume is beneficial. Crop residue and manure are needed to maintain organic-matter content and tilth. Land leveling, laying underground pipe, applying fertilizer, and managing irrigation water are practices that reduce erosion, conserve water, help maintain fertility, encourage uniform penetration of water, and reduce labor. Nitrogen is generally deficient in this soil. (Capability unit IIIc-1, dryland; I-1, irrigated; Loamy Upland range site)

Ulysses silt loam, 1 to 3 percent slopes (Ub).—The profile of this soil is not so thick as the one described for the Ulysses series, but otherwise it is similar. The surface layer is about 8 inches thick in cultivated areas and about 10 inches thick under grass. In some cultivated areas the soil is calcareous at the surface. This gently sloping soil occurs throughout the county, mostly along upland drains.

Included with this soil in the mapping were small areas of Richfield silt loam, 1 to 3 percent slopes. Also included were small eroded areas that are shown on the map by the symbol for erosion.

This is a good soil for dryfarmed crops, but it is not well suited to irrigated crops. Suitable dryfarmed crops are wheat and grain sorghum, though in calcareous areas the grain sorghum shows signs of chlorosis during early growth. The cropping sequence generally followed is sorghum, summer fallow, and wheat. The main hazards are water erosion and lack of moisture because of the low rainfall, but soil blowing is also a hazard in bare areas. Stubble mulching is needed so that the intake of water is increased and soil blowing is reduced. Contour tillage and terraces are needed for controlling water erosion. Level terraces are suitable because this soil is moderately permeable. Stubble mulching increases the amount of water stored and helps to prevent soil blowing. The amount of crop residue needed at seeding time varies according to the crop sequence and the mechanical practices used.

Although this soil is not well suited for irrigation, irrigated crops can be grown. Suitable irrigated crops are wheat, corn, grain sorghum, and sugar beets. The irrigation methods suitable for this soil are border, corrugation, contour furrow, contour ditch, and sprinkler. If this soil is irrigated by contour ditches, the size of the siphon tubes used should be carefully selected. Practices that conserve water, control erosion, and reduce labor are furrowing or bench leveling, adding fertilizer, and managing the application of water. The use of underground pipe or gated pipe prevents loss of water by evaporation and deep percolation. (Capability unit IIIe-1, dryland; IIe-1, irrigated; Loamy Upland range site)

Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded (Ue).—This complex is 60 percent Ulysses silt loam and 40 percent Colby silt loam. Each kind of soil has a profile similar to the one described as typical of its respective series. These gently sloping soils occur with Ulysses silt loam, 1 to 3 percent slopes, in the uplands.

Nearly all of the acreage of these soils is dryfarmed, but some areas are irrigated. If management is intensive, dryfarmed crops grow fairly well in years when the rainfall is above average. Wheat is the most suitable dryfarmed crop, but grain sorghum, though susceptible to chlorosis, is also suitable. The cropping sequence most used is sorghum, summer fallow, and wheat. The medium runoff causes water erosion, and soil blowing is likely unless these soils are protected by clods, vegetation, or crop residue. In dryfarmed areas contour tillage, stubble mulching, and summer fallowing are needed to control soil washing, conserve moisture, and control soil blowing.

Wheat, corn, grain sorghum, and sugar beets are suitable irrigated crops. A deep-rooted legume or other close-growing crops are needed in the cropping sequence. Irrigation by contour furrows and contour ditches reduces erosion and increases the amount of water stored. Practices that further reduce erosion, and that increase yields, maintain fertility, and reduce labor, are bench leveling, use of underground pipe and gated pipe, applying fertilizer, and managing irrigation water. In bench-level areas suitable methods of irrigation are the border, level border, and sprinkler. (Capability unit IVe-2, dryland; IIe-1, irrigated; Limy Upland range site)

Ulysses-Colby silt loams, 3 to 5 percent slopes, eroded (Um).—This complex is 50 percent Ulysses silt loam and 50 percent Colby silt loam. Each kind of soil has a profile somewhat similar to the one described as typical of its respective series, though in soils of this complex lime is nearer the surface and the lighter colored subsoil is exposed in places.

Included with these soils in the mapping were small areas of Otero soils. Where these Ulysses and Colby soils are near sandy soils, the surface layer is loam.

Because runoff is rapid and water erosion is likely, these soils are not suited to cultivated crops. They blow readily because they are high in lime. Fertility has been reduced by the removal of the surface layer. The surface layer slickens and seals during and after rainstorms, and much soil is lost through erosion. Plants are damaged if they do not have firmly anchored roots.

Although most of the acreage of these soils is cultivated, permanent grass for range is better suited than crops. Some cultivated areas have been seeded to suitable grasses, and it is advisable to seed the remaining cultivated areas. (Both soils in capability unit VIe-1, dryland; Limy Upland range site)

Vona Series

The Vona series consists of deep, gently sloping to gently undulating sandy soils that formed in outwash sediments that have been partly reworked by wind. These soils are in a narrow belt that is transitional between the sandhills to the north and the tableland of the High Plains to the south. Tivoli soils occupy the sandhills, and Ulysses and Richfield soils occupy the tableland.

In a typical profile, Vona soils have a light brownish-gray loamy fine sand surface layer about 9 inches thick. This layer is free of lime, very friable, and structureless. The subsoil is brown fine sandy loam that has granular structure and is very friable or friable and noncalcareous. The underlying material is pale-brown, calcareous loamy fine sand that is easily penetrated by plant roots, air, and water.

Vona soils are well drained. The rate of water intake is high, and most of the rain that falls soaks into this soil; permeability is moderately rapid, and internal drainage is medium. These soils have moderate fertility but are highly susceptible to soil blowing.

Vona soils are better suited to native grass range than to field crops, though wheat and grain sorghum are dryfarmed in some areas. Irrigation is not practiced.

Typical profile of Vona loamy fine sand, 500 feet west and 500 feet north of the southeast corner of section 18, T. 27 S., R. 33 W., in a cultivated field reseeded to grass:

Ap—0 to 9 inches, light brownish-gray (10YR 6/2) loamy fine sand, dark grayish brown (10YR 4/2) when moist; massive (structureless); slightly hard when dry, very friable when moist; noncalcareous; abrupt, smooth boundary.

B2t—9 to 20 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) when moist; weak, fine, granular structure; hard when dry, friable when moist; noncalcareous; gradual, smooth boundary.

B3—20 to 24 inches, brown (10YR 5/3) light fine sandy loam, dark brown (10YR 4/3) when moist; weak granular structure; slightly hard when dry, very friable when moist; noncalcareous; gradual, smooth boundary.

C—24 to 50 inches, pale-brown (10YR 6/3) loamy fine sand, brown (10YR 5/3) when moist; massive (structureless); slightly hard when dry, very friable when moist; calcareous; few, very fine, soft concretions of lime.

The surface layer (A horizon) ranges from 6 to 12 inches in thickness and from light brownish gray to grayish brown in color. The B horizon ranges from sandy loam to light loam in texture, from 8 to 16 inches in thickness, and from brown to light brown in color. Depth to calcareous material ranges from 15 to 40 inches. In some places the underlying material is silt loam or clay loam and occurs at a depth of about 20 inches.

Vona soils are darker colored than Otero soils and are leached of lime to a greater depth. They have a more sandy surface layer than Mantér soils. Vona soils are less sandy in the subsoil than the Tivoli soils and generally are in smoother topography.

Vona loamy fine sand (0 to 5 percent slopes) (Vo).—This gently sloping soil of the uplands is inextensive in this county. Slopes generally range from 1 to 3 percent. The areas range from 40 to 320 acres in size. The profile of this soil is the one described as typical of the Vona series.

Included with this soil in the mapping were areas of Manter fine sandy loam, 1 to 3 percent slopes, that are so small that it is impractical to map them separately.

Use of this soil for crops is limited by low water-holding capacity and susceptibility to erosion, but the soil can be cultivated if crop residue is managed so that it controls soil blowing. The chief crop is sorghum, which is grown continuously. The effectiveness of summer fallow is limited by the low water-holding capacity and susceptibility to erosion. Most areas of this soil have been cultivated, but large areas have been reseeded to native grasses. (Capability unit IVe-1, dryland; IVe-1, irrigated; Sands range site)

Use and Management of the Soils

This section discusses the use and management of soils for crops and pasture, as range, for planting trees in windbreaks, as wildlife areas, and in building roads, farm ponds, and other engineering structures.

Soil Management and Predicted Yields

This subsection first provides a broad view of land use in Haskell County. Then, it describes the management generally followed, and the yields to be expected, on the soils of the county when they are dryfarmed and when they are irrigated. The last part of this subsection is a short explanation of the system of capability classification used by the Soil Conservation Service. Those who wish to know the capability classification of a soil can refer to the "Guide to Mapping Units" at the back of this publication. Those desiring detailed information about the management of soils can turn to the section "Description of the Soils."

***Figure 15.—Top,* sugar beets on nearly level irrigated Richfield and Ulysses soils. *Bottom,* an irrigated peach orchard on Richfield silt loam, 0 to 1 percent slopes. The irrigation water is from deep wells.**

Land use [2]

Fertile, nearly level soils on uplands occupy about 85 percent of Haskell County. Most of these nearly level soils are silt loams, but there are small acreages of fine sandy loams and loams. These soils are cultivated to dryfarmed or irrigated crops. They make up most of the irrigated land in the county, as they are well suited to irrigation and are in areas where irrigation water is available. Also, irrigation pumps can be powered by the abundant natural gas found in the area.

The crops suited to and grown on the irrigated soils are sorghums, wheat, corn, alfalfa, pinto beans, sugar beets (fig. 15, top), and tame grasses. Grain sorghum is the main irrigated crop. Corn is an important irrigated crop, and

[2] By Earl J. Bondy, agronomist, Soil Conservation Service.

the acreage in sugar beets is increasing. Alfalfa, a cash crop, has increased in acreage since a dehydrating plant was built at Tice. Garden crops and orchard crops are also suited (fig. 15, bottom), but marketing them is difficult.

Wheat is the most extensive dryfarmed crop, but there is some grain sorghum. A sorghum is sometimes planted when the wheat crop fails because of the dry weather or because of freezing.

The gently sloping loamy soils on the uplands make up about 6 percent of the county. They are fine sandy loams, silt loams, and loams. These soils are subject to soil blowing and water erosion but, under intensive management, are suited to wheat and sorghums.

Moderately sloping and gently sloping, sandy, eroded soils occupy about 2 percent of the county. Because these soils are eroded, they are better suited to permanent grass than to crops.

The remaining 7 percent of the county consists of moderately steep sandy loams and loams in the southeastern part, the undrained depressions in the uplands, the moderately sloping silt loams and eroded soils, and the very sandy soils of the flood plains along the Cimarron River. Most areas of these soils are in native grass, though some eroded areas need to be seeded. Under good management, these soils produce excellent forage.

Management and predicted yields on dryfarmed soils

When the soils of Haskell County were under native grass they required little management other than regulation of grazing. Rains were absorbed rapidly, and there was little runoff. Erosion and the formation of soil were in balance.

Under cultivation, especially cultivation without irrigation, the supply of organic matter was reduced and soil structure was damaged. Many areas lost valuable topsoil because they were left bare and unprotected from soil blowing and water erosion. It became apparent that soil management would have to be improved if cultivation continued.

The practices evolved and now used are based on the principle of following the way of nature and protecting the soils with growing plants or crop residue at all times. Those practices that apply to all cropland in Haskell County are (1) using a conservation cropping system, (2) managing crop residue, and (3) tilling at a minimum. Terracing (fig. 16), contour tillage, and stripcropping are additional practices that are effective in controlling soil blowing and water erosion on some soils. Conservation of soil and water is best when a combination of these practices is used. A single practice may reduce erosion and conserve some moisture, but it is seldom enough for best results.

The kind of soil and the level of management used largely determine the yields obtained on a particular soil. For this reason, yields of dryfarmed wheat and grain sorghum are given in table 2 for most of the soils in the county at two levels of management, the management most commonly used and improved management. Yields under the management most commonly used are given in columns A, and those under improved management are given in columns B. If a farmer compares the yields in the two columns, he can predict whether improving management on a soil is worthwhile.

***Figure 16.*—This level terrace on nearly level Richfield soils conserves moisture and reduces erosion.**

TABLE 2.—*Predicted average yields per acre of wheat and grain sorghum, on the arable soils under two levels of dryland management*

Soil	Wheat [1]		Grain sorghum [1]	
	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*
Lofton silty clay loam	10	14	14	18
Lubbock silty clay loam	19	22	24	32
Manter fine sandy loam, 0 to 1 percent slopes	14	18	22	30
Manter fine sandy loam, 1 to 3 percent slopes	12	16	18	28
Otero-Ulysses complex, 1 to 3 percent slopes	11	15	16	22
Richfield silt loam, 0 to 1 percent slopes	16	20	20	25
Richfield silt loam, 1 to 3 percent slopes	14	17	16	22
Satanta fine sandy loam, 0 to 1 percent slopes	15	20	24	32
Satanta fine sandy loam, 1 to 3 percent slopes	12	18	20	30
Satanta loam, 0 to 1 percent slopes	16	20	22	28
Spearville silty clay loam, 0 to 1 percent slopes	14	17	16	22
Ulysses silt loam, 0 to 1 percent slopes	15	19	20	25
Ulysses silt loam, 1 to 3 percent slopes	13	17	17	23
Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded	12	16	15	20
Ulysses loam, 1 to 3 percent slopes	14	18	18	24
Vona loamy fine sand	8	14	16	24

[1] Yields of wheat reflect the general use of summer fallow.

The yield predictions were based on data obtained from farmers, from the county agricultural agent, from members of the Agricultural Stabilization Conservation Committee, and from members of the Board of the Haskell

County Soil Conservation District. Also used was information from the Tribune and Garden City branches of the Kansas State Agricultural Experiment Station.

Predicted yields for wheat are based mostly on yield data from Ulysses and Richfield silt loams. The predicted yields for other soils are partly interpolated on basis of records of yields on the Ulysses and Richfield soils.

Under the management most commonly used for both dryfarmed wheat and grain sorghum (columns A), suitable crop varieties are seeded, and seeding is at the proper time and rate. Methods of planting and harvesting are efficient, and weeds, insects, and plant diseases are controlled to some extent. Some management of crop residue is practiced. In addition, the following practices are used for dryfarmed wheat:

1. Tillage is not on the contour but is in straight lines generally parallel to the boundaries of the field or around the field.
2. Tillage is frequent and with equipment that soon destroys the crop residue.
3. Wheat is generally alternated with fallow, but sometimes the sequence is fallow, wheat, and sorghum. Winter wheat is seeded early in fall on soils that have been left idle and kept free of weeds for one growing season. If the stand of wheat is not satisfactory, the soils are planted to sorghum or are again left fallow in summer.
4. Emergency tillage is used to control soil blowing.
5. Crop residue is grazed if it is available, and seeded and volunteer wheat are generally grazed during fall and winter.

Under prevailing management, the following practices are used for dryfarmed grain sorghum:

1. On soils that were used for wheat the previous season, sorghum is seeded after plowing with a one-way disk for the purpose of obtaining a stand of volunteer wheat for fall pasture.
2. The soils are generally tilled at least twice before about June 1, when the sorghum is seeded. The first tillage is for killing the volunteer wheat, and the second, which is shallow, is for controlling weeds and preparing the seedbed.
3. The sorghum is drilled in rows about 20 inches apart. After the plants emerge, the crop is cultivated once with a rotary hoe or with a spike tooth harrow. Later, if weeds are numerous, the field is sprayed with chemicals.
4. Grain sorghum is not harvested if the supply of moisture has been inadequate or there is an early frost. Livestock are allowed to graze the plants in those fields, as well as the residue in harvested fields.
5. Sorghum is generally grown year after year on the Manter, Vona, Otero, and Satanta soils.

The predicted yields of dryfarmed wheat and grain sorghum given in columns B were made under the assumption that—

1. Erosion is controlled by using suitable practices, and moisture is conserved by stubble-mulch tillage, stripcropping, terracing, contour tillage, and summer fallowing.
2. Tillage is at the proper time and with a suitable implement.
3. Adapted crop varieties are grown in a flexible cropping system, and seeding is at a proper rate.
4. Only the crop residue not needed for protecting the soils is grazed.

Management and predicted yields on irrigated soils

Since 1940 when two wells were drilled for irrigation purposes, irrigation has become important in Haskell County, and now about 83,000 acres is irrigated. Some land is leveled each year, and the amount of underground pipe laid is increasing. The underground pipe reduces loss of soil through erosion and loss of water through evaporation. It also reduces the labor needed for maintaining ditches and controlling weeds, and it reduces the land lost to ditches. Gated surface pipe also does away with the ditch problem.

Much of the irrigated farming is in conjunction with dryland farming. The farms are large, and only parts of them are irrigated. Irrigation helps to stabilize income and to insure feed crops for livestock. Planning the cost of obtaining a given yield is possible because a natural deficiency in moisture does not limit crop production.

Water for irrigation is pumped from deep wells that, in most places, are powered by engines burning natural gas. The gas is piped from nearby wells in the county. Some engines use liquid gas or diesel fuel, and there are a few pumps powered by electricity.

High-yielding wells can be dug throughout the county in the Pliocene and Pleistocene deposits, which are the main sources of irrigation water. The depth of the wells ranges from 200 to 500 feet, and the wells average from 1,200 to 1,800 gallons per minute.

Essential for a good irrigation system are an abundant supply of good water and soils that have high water-holding capacity, good permeability, and adequate drainage. The types of irrigation used in the county are border,

Figure 17.—**Harvesting corn for silage on irrigated Richfield and Ulysses soils.**

TABLE. 3—*Predicted average yields per acre of irrigated crops under two levels of management on the soils most commonly irrigated*

Soil	Grain sorghum		Wheat		Corn		Sorghum silage		Sugar beets		Alfalfa		Dry beans	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Ton*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*100 lbs.*	*100 lbs.*
Lubbock silty clay loam	80	115	45	55	85	120	20	25	18	22	5	6	17	22
Manter fine sandy loam, 0 to 1 percent slopes	65	100	35	45	70	105	16	21	15	19	3	6	13	16
Richfield silt loam, 0 to 1 percent slopes	75	115	40	50	80	120	19	24	16	20	4	6	16	20
Richfield silt loam, 1 to 3 percent slopes	65	100	30	45	65	100	16	21	14	18	3	5	13	16
Satanta fine sandy loam, 0 to 1 percent slopes	75	115	40	50	80	120	19	24	16	20	4	6	16	20
Satanta loam, 0 to 1 percent slopes	75	115	40	50	80	120	19	24	16	20	4	6	16	20
Spearville silty clay loam, 0 to 1 percent slopes	65	100	30	45	70	105	16	21	14	18	3	6	13	16
Ulysses silt loam, 0 to 1 percent slopes	70	115	35	50	80	120	18	23	16	20	4	6	15	19
Ulysses silt loam, 1 to 3 percent slopes	65	100	30	45	65	100	16	21	14	18	3	5	13	16
Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded	60	90	25	40	65	100	15	20	13	16	3	5	11	15

contour furrow, ditch furrow, sprinkler, and underground pipe.

The main crops grown under irrigation in this county are wheat, corn, grain sorghum, forage sorghum, sugar beets, alfalfa, and pinto beans. The soils are also suited to tomatoes, onions, lettuce, and cantaloups. Much of the irrigated acreage is used for crops that are fed to livestock (fig. 17), and some areas in tame grasses are irrigated.

Table 3 gives predicted yields of crops grown on the soils that are generally irrigated in the county. The sources used for estimating these yields were the same as those used for estimating yields of dryfarmed crops.

Because irrigation is a recent practice in this county, little information has been recorded on yields of crops grown under irrigation. Most of the information available is for crops grown on Richfield silt loam, 0 to 1 percent slopes, and on Ulysses silt loam, 0 to 1 percent slopes. The yields predicted for crops on other soils were estimated from this information.

The yields in columns A are for prevailing management, or the management ordinarily used on irrigated soils, and those in columns B are for improved management. Under prevailing management, suitable crop varieties are used and seeding is at the proper time and rate. Methods of planting and harvesting are efficient, and weeds, insects, and diseases are controlled to some extent. Some management of crop residue is practiced.

But under prevailing management, the land has not been leveled, the penetration of water may not be uniform throughout the field, and the growth of plants is neither optimum nor uniform. Erosion occurs in sloping areas that are irrigated downslope. In some years irrigation water is not adequate.

The predicted yields given in columns B are based on improved management, which consists of the following practices:

1. The irrigation system used provides uniform penetration of water and the control of erosion. Land leveling, contour furrowing, and use of gated pipes and underground pipes are among the practices applied.
2. Tillage is at the proper time.
3. An appropriate cropping system is used that provides legumes, close-growing crops, and row crops.
4. Adapted crop varieties are planted.
5. Seeding is at a rate that insures a maximum plant population.
6. Irrigation water is properly applied.
7. The amounts and kinds of fertilizer used provide the level of fertility needed for producing optimum yields of the particular crop.
8. Manure, when available, is used to maintain the content of organic matter.

Capability classification

In the "Guide to Mapping Units" at the back of this survey, the soils of Haskell County have been classified according to their suitability for most kinds of farming. This classification is based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment. The classification does not apply to most horticultural crops, or to rice or other crops that have their own special requirements. The soils are classified according to degree and kind of permanent limitation, but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soils; and without consideration of possible but unlikely major reclamation projects.

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

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

Class I soils have few limitations that restrict their use.

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

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

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

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

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

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

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

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

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

Capability Units are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIIe-2 or VIw-1. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation, and the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph. The Arabic numeral specifically identifies the capability unit within each subclass.

Range Management[3]

About 8 percent of Haskell County is range, and most of this is in the sandhills along the northern boundary. A small acreage is in the southwestern corner near the Cimarron River. These areas of range are not suitable for cultivation, though there are small tracts of range throughout the county that can be cultivated. These small areas are intermingled with larger areas of cropland.

Summer grazing of yearlings is the main livestock operation, but in some small cowherds, calves are used as feeders. Some cropland is used to produce supplemental feed for these calves.

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 different kinds and amounts of climax, or original, vegetation. The difference in rangeland must be great enough so that different grazing practices or other management is needed to maintain the climax vegetation.

Climax vegetation is the combination of plants that originally grew on a site. It is generally the most productive combination of plants that can be grown there.

Range condition can be rated by comparing the present vegetation on a site with the climax vegetation. A rating of this kind is helpful because an estimate of the deterioration that has taken place indicates the improvement possible under good management. Four condition classes have been defined. A range in *excellent* condition is one on which 76 to 100 percent of its present vegetation is characteristic of the climax vegetation; 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.

Plants growing on a range site are classed as *decreasers*, *increasers*, or *invaders*. Decreasers and increasers are climax plants. Because decreasers are generally the most heavily grazed, they are the first to be injured by grazing and they decrease. Increasers withstand grazing better or are less palatable to livestock. At first they replace the decreasers, but most of them also decrease as heavy grazing continues. Invaders are weeds that become established after the climax vegetation has been reduced by heavy grazing.

Descriptions of the range sites

The Sands, Choppy Sands, and Sandy range sites are dominant in Haskell County. Of less extent are the Sandy Lowland, Limy Upland, Loamy Lowland, Loamy Upland, and Clay Upland range sites. These range sites and their potential plant community, or climax vegetation, are described in the following paragraphs. The annual yield of air-dry herbage is estimated for each range site when the site has received average annual rainfall and is in excellent condition.

The management practices needed for maintaining or improving the condition of all range sites are proper range use and deferred grazing. A properly managed range site takes in more water and produces more forage than does a range site that is overgrazed. This increase in forage helps to control erosion, to increase organic-matter content in the surface layer, and to improve tilth.

[3] By H. Ray Brown, range conservationist, Soil Conservation Service.

Figure 18.—Tivoli-Vona loamy fine sands on the Sands range site.

SANDS RANGE SITE

This range site consists of deep, nearly level to undulating soils and soils in duny areas. These soils are on uplands. They have a loamy sand or loamy fine sand surface layer and a fine sand to loamy fine sand subsoil and substratum. The water-holding capacity depends on the texture of the subsoil and ranges from low to high. Soil blowing is the main hazard. Figure 18 shows a typical view of the Sands range site.

In the potential plant community, or climax vegetation, are sand bluestem, little bluestem, switchgrass, big sandreed, and other decreasers. These decreasers make up 65 percent of the climax vegetation, and other perennial grasses, forbs, and shrubs make up the rest. The dominant increaser grasses are blue grama, sand dropseed, and sand paspalum. They supply most of the herbage, but in places the sand dropseed and sand sagebrush appear to be dominant. Sand sagebrush is a common woody increaser. False buffalograss, purple sandgrass, and red lovegrass invade under heavy grazing.

Under customary grazing, this site is generally in poor condition. When in excellent condition, this site has a total annual yield (air-dry weight) of about 2,500 pounds per acre in average years, but yields range from 1,200 pounds in dry years to 3,000 pounds in moist years.

CHOPPY SANDS RANGE SITE

This range site consists of deep, fine sands that occupy hummocks and dunes in the sandhills. Blowouts are numerous throughout the site. The soils are rapidly permeable, are somewhat excessively drained, and have low water-holding capacity.

Decreaser grasses make up about 60 percent of the climax vegetation, and other perennial grasses, forbs, and shrubs make up the rest. The main decreasers are sand bluestem, switchgrass, little bluestem, and big sandreed. Much of the forage is sand dropseed and sand paspalum, which are the main increaser grasses. Sand sagebrush is the principal woody plant. Blowoutgrass and big sandreed are important in stabilizing the blowouts and dunes because they are the first plants to appear in active areas. Common invaders on this site are false buffalograss, purple sandgrass, and sandbur.

Under customary grazing, this site is generally in fair condition. When in excellent condition, this site has a total annual yield (air-dry weight) of about 1,400 pounds in average years, but yields range from 650 pounds in dry years to 1,750 pounds in moist years.

SANDY RANGE SITE

This range site consists of nearly level to gently sloping soils that have a fine sandy loam subsoil and a sandy loam to clay loam subsoil. These soils are on uplands. They are moderately permeable and have moderate to high water-holding capacity.

In the climax vegetation are sand bluestem, little bluestem, switchgrass, sideoats grama, and other decreasers. These decreasers make up 55 percent of the climax vegetation. Other perennial grasses, forbs, and shrubs make up the rest. The dominant increaser grasses are blue grama, sand dropseed, buffalograss, and sand paspalum;

sand dropseed carries most of the grazing. Sand sagebrush and small soapweed are the dominant woody increasers. Common invaders are windmillgrass, tumblegrass, and six-weeks fescue.

Under customary grazing, the condition of this site is generally fair. When in excellent condition, this site has a total annual yield (air-dry weight) of about 1,700 pounds per acre in average years, but yields range from 800 pounds in dry years to 2,200 pounds in moist years.

SANDY LOWLAND RANGE SITE

This range site consists of nearly level to gently sloping soils that have a calcareous surface layer and subsoil. These soils formed in alluvium along streams, and they receive extra water when the streams overflow.

Decreaser grasses make up about 70 percent of the climax vegetation, and other perennial grasses and forbs make up the rest. Important decreasers are sand bluestem, little bluestem, switchgrass, and sideoats grama. The dominant increaser grasses are blue grama, buffalograss, sand dropseed, and sand paspalum. Blue grama is the principal increaser where grazing is heavy. Sand sagebrush and small soapweed are common woody increasers. The principal invaders are windmillgrass, tumblegrass, and annuals.

Under customary grazing, this site is generally in fair condition. When in excellent condition, this site has a total annual yield (air-dry weight) of about 1,800 pounds per acre in average years, but yields range from 1,500 pounds in dry years to 3,500 pounds in moist years.

LIMY UPLAND RANGE SITE

This range site consists of nearly level to steep soils on uplands. These soils have a loamy surface layer and a loamy subsoil that is highly calcareous. They are moderately permeable and well drained.

Decreaser grasses, such as sideoats grama and little bluestem, make up about 45 percent of the climax vegetation, and other perennial grasses and forbs generally make up the rest. The increaser grasses are blue grama, buffalograss, sand dropseed, and perennial three-awn. Broom snakeweed is the principal forb that increases. The common invaders are annuals.

Under customary grazing, this range site generally is in fair or good condition, and blue grama is the dominant grass. When in excellent condition, this site has a total annual yield (air-dry weight) of about 1,700 pounds per acre, but yields range from 2,000 pounds in dry years to 2,300 pounds in moist years.

LOAMY LOWLAND RANGE SITE

This range site consists of deep, well-drained, nearly level, loamy soils in slight depressions. Water other than that from direct rain occasionally runs into these depressions.

In the climax vegetation are switchgrass, big bluestem, little bluestem, sideoats grama, Canada wildrye, and other decreasers. These decreasers make up 60 percent of the climax vegetation, and other perennial grasses and forbs make up the rest. Western wheatgrass, blue grama, and buffalograss are the dominant increasers, and the blue grama and western wheatgrass are most plentiful when the grazing is heavy. The principal invaders are annuals.

Under customary grazing, this site is generally in fair condition. When in excellent condition, this site has a total annual yield (air-dry weight) of about 3,000 pounds per acre, but yields range from 2,000 pounds in dry years to 4,000 pounds in moist years.

LOAMY UPLAND RANGE SITE

This range site consists of nearly level to gently sloping, well-drained soils that have a loam or silt loam surface layer and a loam to silty clay loam subsoil. These soils are on uplands. They are moderately permeable and have high water-holding capacity.

Decreasers make up 25 percent of the climax vegetation, and other perennial grasses and forbs make up the rest. The main decreasers are sideoats grama, western wheatgrass, switchgrass, and little bluestem. Blue grama, buffalograss, and sand dropseed are the main increaser grasses, but western ragweed, a forb, is also common. The buffalograss increases rapidly when the range is grazed heavily, and it and blue grama are generally dominant in the plant community. Little barley and annual bromes are the principal invaders.

Under customary grazing, this site is generally in good condition. When in excellent condition, this site has a total annual yield (air-dry weight) of about 1,700 pounds per acre in average years, but yields range from 800 pounds in dry years to 2,000 pounds in moist years.

CLAY UPLAND RANGE SITE

This range site consists of level to gently sloping, calcareous soils that have a clay loam or silty clay loam surface layer and a silty clay or silty clay loam subsoil. These soils are on uplands. They are slowly permeable and are very droughty.

Decreaser grasses, such as western wheatgrass and sideoats grama, make up about 20 percent of the climax vegetation, and other perennial grasses and forbs make up the rest. The dominant increaser grasses are blue grama, buffalograss, and silver bluestem. Other increasers are pricklypear and western ragweed. Buffalograss is the principal increaser in heavily grazed areas. The main invaders are little barley, annual bromes, and snow-on-the-mountain.

Under customary grazing, this site is generally in good condition. When in excellent condition, this site has a total annual yield (air-dry weight) of about 1,600 pounds per acre in average years, but yields range from 800 pounds in dry years to 2,000 pounds in moist years.

Windbreak Management [4]

A well-placed windbreak with properly spaced trees and shrubs protects farmsteads, feedlots for livestock, and some kinds of wildlife. It controls snowdrifts by reducing the velocity of the wind. In addition to the protection it gives, a well-tended windbreak is attractive and improves the esthetic setting of the farm buildings.

In Haskell County there is no native woodland, but trees and shrubs can be planted and maintained in farmstead windbreaks. Grasses and weeds must be controlled so as to prevent competition for available moisture. Cultivation controls weeds and also permits water and air to penetrate

[4] By ANDREW LONGLEY, area conservationist, Soil Conservation Service, Garden City, Kans.

Figure 19.—**Irrigated windbreak on Richfield and Ulysses soils.**

the soils easily. Extra moisture can be provided by diverting runoff from other areas, by diverting floodwaters, and by using water from irrigation and domestic wells. The trees and shrubs planted in irrigated windbreaks grow faster and provide protection much sooner than those grown on dryland (fig. 19).

In Haskell County the soils suitable for windbreaks have been placed in three windbreak suitability groups. The finer textured soils (loams, silt loams, and silty clay loams) are in group 1 or group 3, and the coarser textured soils (fine sandy loams and loamy fine sands) are in group 2. Generally, trees and shrubs have slightly faster growth on the soils in groups 2 and 3.

Table 4 lists the height, in feet, that specified planted trees and shrubs reach in 10 years in irrigated and dryland windbreaks. To identify the soils in each windbreak group, refer to the "Guide to Mapping Units" at the back of this survey. Not suitable for planting trees and not placed in windbreak suitability groups are Active dunes, Glenberg soils, Likes loamy sand, Otero gravelly complex, Randall

TABLE 4.—*Trees and shrubs suitable for soils in windbreak suitability groups and estimated height in 10 years on dryland and irrigated soils*

Suitable trees and shrubs	Windbreak suitability group 1		Windbreak suitability group 2		Windbreak suitability group 3	
	Dryland	Irrigated	Dryland	Irrigated	Dryland	Irrigated
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
Eastern redcedar	5	9	8	11	7	9
Honeylocust	12	22	14	24	16	22
Cotoneaster	6	10	5	8	8	10
Osage-orange	12	22	13	22	15	22
Ponderosa pine	6	9	8	11	8	9
Rocky Mountain juniper	5	9	8	11	7	9
Russian-olive	12	22	13	22	15	22
Siberian elm [1]	22	32	25	35	26	32
Skunkbush sumac	5	9	6	9	7	9
Tamarisk	10	20	10	15	12	20

[1] Commonly called Chinese elm.

284-091 O-68—3

clay, Tivoli fine sand, and Tivoli-Dune land complex. Lofton silty clay loam and Lubbock silty clay loam occupy positions on which extra water runs in and are therefore the most suitable soils in the county for trees. Sites on these soils, however, are not suitable for farmsteads and feedlots.

More information on planting and tending trees and shrubs in farmstead windbreaks may be obtained from the local representative of the Soil Conservation Service or from the county agent.

Wildlife Management [5]

Wildlife is affected primarily by the kinds of vegetation the soils produce and the distribution of this vegetation. Vegetation and its distribution depend on the way the soils are used. In this county farming that provides areas of cover is beneficial to pheasant, bobwhite quail, cottontail, and white-tailed deer. Other species, such as prairie chicken, may be harmed by farming.

A convenient way to discuss the wildlife in the county is by soil associations. The soil associations are described in the section "General Soil Map," and the location of each association is shown on the general soil map in figure 2, p. 3.

Table 5 rates the potential of each of the five soil associations for producing food and cover for the more important kinds of wildlife in the county. In the following paragraphs these species are discussed according to the associations in which they are most plentiful.

The pheasant is the most important game bird in the county. It lives mostly in the Richfield-Ulysses and the Richfield-Spearville-Ulysses soil associations. The lack of adequate winter cover restricts the number of pheasants in the county.

In Haskell County the prairie chicken is most plentiful in the Tivoli-Vona association. The soils in this association support grassland vegetation that includes a large amount of sagebrush. The prairie chicken feeds mainly on this vegetation in summer, but in winter it feeds mostly in crop fields adjacent to the grasslands.

Small numbers of scaled quail live in Haskell County and are primarily in the Satanta-Manter association. This bird has about the same habitat requirements as the prairie chicken.

Bobwhite quail are in small numbers in the Richfield-Ulysses and the Richfield-Spearville-Ulysses associations, mostly in the woody cover near farmsteads. The number of quail could be increased by planting shrubs and other woody plants in odd areas.

A few mule deer frequent the Otero-Colby-Likes soil association along the Cimarron River in the southwest corner of the county. Other upland wildlife in the county are the desert and eastern cottontail, black-tailed jackrabbit, fox squirrel, raccoon, badger, and spotted and striped skunk.

Only a few waterfowl nest in Haskell County, but many use the ponds, irrigation reservoirs, and potholes during their semiannual migrations through the county. Depression basins in the Richfield-Ulysses and the Richfield-Spearville-Ulysses associations attract waterfowl in spring and fall when rainwater collects in the depressions.

Fishing waters are scarce in Haskell County. Ponds can be built only where enough water is available to replace the water lost through evaporation during extended dry periods. One source of water that can be used for fish ponds is the surplus water from irrigated fields. The ponds should be deep because the rate of evaporation is high.

Further information and assistance in planning and developing wildlife habitat can be obtained at the local office of the Soil Conservation Service and from the Kansas Forestry and Game Commission, the Bureau of Sports Fisheries and Wildlife, and the county agent.

Engineering Properties of Soils [6]

This subsection describes the outstanding properties of soils, particularly in relation to highway construction and

[5] By JACK W. WALSTROM, biologist, Soil Conservation Service, Salina, Kans.

[6] CARL L. ANDERSON, civil engineer, Soil Conservation Service, assisted in the preparation of this subsection.

TABLE 5.—*Potential of the soil associations for providing habitat required by some of more important kinds of wildlife*

[Absence of entry indicates potential of soil association is not rated]

Soil association	Wildlife	Potential for producing, for kinds of wildlife named—			
		Woody cover	Herbaceous cover	Aquatic habitat	Food
Tivoli-Vona.	Prairie chicken	Good	Good		Good.
	Scaled quail	Good	Good		Fair.
Satanta-Manter.	Pheasant	Fair	Good		Good.
	Scaled quail	Fair	Good		Good.
	Bobwhite quail	Poor	Good		Good.
	Dove	Poor	Good		Good.
	Prairie chicken	Fair	Good		Good.
Richfield-Ulysses. Richfield-Spearville-Ulysses.	Pheasant	Fair	Good		Good.
	Bobwhite quail	Fair	Good		Good.
	Dove	Fair	Good		Good.
	Cottontail	Fair	Good		Good.
	Waterfowl			Good	Good.
Otero-Colby-Likes.	Deer	Fair	Good	Poor	Fair.
	Prairie chicken	Poor	Fair		Fair.
	Scaled quail	Poor	Fair		Fair.

conservation engineering. It also briefly describes the two systems of soil classification most used by engineers.

Soil properties influence design, construction, and maintenance of engineering structures. The properties most important to the engineer are permeability to water, shear strength, compaction characteristics, plasticity, and reaction. Also important are depth to unconsolidated material, depth to water table, and topography.

The information in this survey can be used to—

1. Make studies of soil and land use that will aid in selecting and developing sites for industries, businesses, residences, and recreation.
2. Make preliminary estimates of the engineering properties of soils that will help in planning agricultural drainage systems, farm ponds, terraces, waterways, dikes, diversions, irrigation canals, and irrigation systems.
3. Make preliminary evaluations of soils and ground conditions that will aid in selecting highways and airports and in planning detailed investigations of selected locations.
4. Locate probable sources of gravel, sand, and other construction material.
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 soil mapping units 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.

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

Some of the terms used by soil scientists may not be familiar to the engineer, and some terms may have a special meaning in the soil science. Several of these terms are defined in the Glossary at the back of this soil survey. Additional information useful to the engineer can be found in other sections of the survey, particularly "Descriptions of the Soils" and "Formation and Classification of Soils."

Engineering classification systems

Agricultural scientists of the U.S. Department of Agriculture (USDA) classify soils according to texture, color, and structure. This system is useful only as the initial step in making engineering classifications of soils, for additional properties important to engineering must be determined by tests or estimated. The two systems commonly used by engineers are the one adapted by the American Association of State Highway Officials (AASHO) and the Unified system. The brief explanations of these soils in the following paragraphs are taken largely from the PCA Soil Primer (*6*).[7]

AASHO classification system.—The AASHO system is based on actual performance of material used as a base for roads and highways (*1*). In this system all the soils are classified in seven groups. The soils most suitable for road subgrade are classed A–1, and the soils least suitable are classed A–7. Within rather broad limits, soils are classified numerically between these two extremes, according to their load-carrying ability. Three of the seven basic groups may also be divided into subgroups to designate within-group variations.

In the AASHO system the soil materials may be further divided into the following two major groups: (1) Granular materials in which 35 percent or less of the material passes a 200-mesh sieve, and (2) silt-clay materials in which more than 35 percent of the material passes a 200-mesh sieve. The silty part of the silt-clay materials has a plasticity index of 10 or less, and the clayey material has a plasticity index greater than 10. The plasticity index refers to the numerical difference between the liquid limit and the plastic limit. The liquid limit is the moisture content, expressed as a percent of the ovendry weight of the soil, at which the soil material passes from a plastic to a liquid state. The plastic limit is the moisture content, expressed as a percent of the ovendry weight of the soil, at which the soil material passes from a semisolid to a plastic state.

Unified soil classification system.—In the Unified system the soils are grouped on the basis of their texture and plasticity as well as on their performance when used as material for engineering structures (*10*). The soil materials are identified as coarse grained, which are gravels (G) and sands (S); fine-grained silts and clays, which are plastic (C) and nonplastic (M); and organic and highly organic (Pt). There are no highly organic soils in Haskell County. Engineers define a fine-grained soil as one in which more than half of the material will pass through a No. 200 sieve, which has openings 0.074 millimeter in size.

Under the Unified system, clean sands are identified by the symbols SW or SP; sands with fines of silt and clay are identified by the symbols SM or SC; silts and clays that have a low liquid limit are identified by the symbols ML and CL; and silts and clays that have a high liquid limit are identified by the symbols MH and CH.

After an engineer has been trained and has obtained experience, he can make approximate classification of soils, based on visual field inspection and observation. Exact classification, however, must be based on review and application of complete laboratory analysis data. Field classifications are useful in determining when and upon which soils laboratory analyses should be made.

Soil engineering interpretations

Two tables are included in this subsection. In the first, table 6, are soil classifications and estimated properties that are important in construction. The data in table 6 are based on laboratory testing of soils in Ford, Logan, and Morton Counties, on Kansas State Highway tests at construction sites, on experience with the same kind of soils in other counties, and on the information in other parts of this

[7] Italic numbers in parentheses refer to Literature Cited, p. 47.

TABLE 6.—*Estimated*

Soil and map symbols	Depth from surface	Classification		
		USDA	Unified	AASHO
	Inches			
Active dunes (Ad).	0–60	Fine sand	SM	A–1–b
Colby (Co).	0–48	Loam	CL	A–4 or A–6
Glenberg (Gb).	0–48	Sandy loam	SM	A–2
Likes (Lk).	0–24	Loamy sand	SM	A–2
	24–50	Fine sand	SP	A–3
Lofton (Lo).	0–6	Silty clay loam	CL or ML–CL	A–6 or A–4
	6–30	Silty clay	CH	A–7–6
	30–50	Silty clay loam	ML–CL	A–6 or A–7
Lubbock (Lu).	0–9	Light silty clay loam	CL	A–6
	9–42	Silty clay loam	CL	A–6
	42–68	Silt loam	ML–CL	A–4 or A–6
Manter (Ma, Mb).	0–50	Fine sandy loam	SM–SC	A–4
Otero:				
Gravelly complex (Og). (Gravelly part only; for fine sandy loam part, see Ou below.)	0–6	Gravelly sandy loam	SM–SC	A–2–6
	6–60	Loamy sand to sand	SM	A–2
Fine sandy loam (Ou). (For properties of the Ulysses soil in mapping unit Ou, refer to Ulysses silt loam.)	0–60	Fine sandy loam	SM–SC or SM	A–4
Randall (Ra).	0–36	Clay	CH or MH	A–7–5 or A–7–6
	36–60	Light silty clay loam	CL	A–6
Richfield (Rm, Rn, Ru). (For properties of the Ulysses soil in mapping unit Ru, refer to the Ulysses series.)	0–6	Silt loam	CL	A–4 or A–6
	6–42	Silty clay loam	CL	A–6 or A–7
	42–60	Heavy silt loam	ML–CL	A–6 or A–7
Satanta:				
Fine sandy loam (Sa, Sb).	0–8	Fine sandy loam	SM or ML	A–4
	8–26	Sandy clay loam	SC, CL or SM–SC	A–6
	26–60	Light silty clay loam	CL or ML–CL	A–4 or A–6
Loam (Sn).	0–12	Loam	CL	A–6
	12–24	Clay loam	CL	A–6
	24–50	Loam	ML–CL	A–6
Spearville (Sp).	0–6	Silty clay loam	CL	A–6
	6–16	Silty clay	CH or MH	A–7–5 or A–7–6
	16–60	Light silty clay loam to silt loam.	CL or ML–CL	A–6 or A–4
Tivoli:				
Fine sand (Tf, Tx).	0–50	Fine sand	SM	A–2 or A–3
Loamy fine sand (Tv). (For properties of Vona soil in mapping unit Tv, refer to the Vona soil series.)	0–16	Loamy fine sand	SM	A–2
	16–48	Fine sand	SM	A–2 or A–3
Ulysses:				
Loam (Ud).	0–30	Loam	CL	A–4 or A–6
	30–60	Light clay loam	CL or ML–CL	A–4 or A–6
Silt loam (Ua, Ub).	0–5	Silt loam	ML–CL	A–4 or A–6
	5–30	Heavy silt loam	CL or ML–CL	A–4 or A–6
	30–60	Silt loam	ML–CL	A–4 or A–6
Silt loam, eroded (Ue, Um). (For properties of the Colby soil in mapping units Ue and Um, refer to the Colby soil series.)	0–60	Silt loam	ML–CL	A–4 or A–6
Vona (Vo).	0–9	Loamy fine sand	SM	A–2
	9–24	Fine sandy loam	SM or ML	A–4
	24–50	Loamy fine sand	SM	A–2

[1] Very low.

properties of the soils

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4	No. 10	No. 200				
			Inches per hour	*Inches per inch of soil*	*pH*	
100	100	10–20	>6.30	0.04	6.6–7.3	Low.
100	100	60–75	0.20–0.63	.18	7.4–7.8	Low to moderate.
100	100	25–35	0.63–2.00	.12	7.4–8.4	Low.
100	100	15–25	2.00–6.30	.10	7.4–7.8	Low.
100	100	10–20	>6.30	.06	7.4–7.8	Very low.
100	100	90–95	0.20–0.63	.18	6.6–7.3	Moderate.
100	100	90–95	0.05–2.0	.15	6.6–7.3	High.
100	100	90–95	0.20–0.63	.18	7.4–7.8	Low to moderate.
100	100	90–95	0.20–0.63	.19	6.6–7.3	Moderate.
100	100	90–95	0.20–0.63	.19	6.6–7.8	Moderate.
100	100	70–90	0.20–0.63	.19	7.4–7.8	Moderate.
100	100	40–50	0.63–2.00	.14	6.6–7.3	Low.
100	100	25–35	0.63–2.00	.14	6.6–7.4	Low.
100	100	10–20	>6.30	(1)	7.4–7.8	Very low.
100	100	40–45	0.63–2.00	.13	7.4–7.8	Low.
100	100	75–95	< 0.05	.15	6.6–7.4	Very high.
100	100	70–80	0.20–0.63	.18	7.4–7.8	Moderate.
100	100	70–90	0.20–0.63	.19	6.6–7.3	Moderate.
100	100	90–95	0.20–0.63	.19	6.6–7.3	Moderate.
100	100	70–90	0.20–0.63	.18	7.4–7.8	Moderate.
100	100	45–60	0.63–2.00	.12	6.6–7.3	Low.
100	100	40–55	0.20–0.63	.13	6.6–7.3	Low to moderate.
100	100	90–95	0.20–0.63	.18	7.4–7.8	Low to moderate.
100	100	60–75	0.20–0.63	.19	6.6–7.3	Low.
100	100	70–80	0.20–0.63	.18	6.6–7.3	Moderate.
100	100	60–75	0.20–0.63	.18	7.4–7.8	Low.
100	100	90–95	0.20–0.63	.19	6.6–7.4	High.
100	100	90–95	0.05–0.20	.12	6.6–7.4	Very high.
100	100	90–95	0.20–0.63	.18	7.4–7.8	High.
100	100	10–20	>6.30	.05	6.6–7.3	Low.
100	100	15–25	2.00–6.30	.10	6.6–7.3	Low.
100	100	10–20	>6.30	.05	6.6–7.3	Low.
100	100	60–75	0.20–0.63	.19	6.6–7.3	Low.
100	100	70–80	0.20–0.63	.18	7.4–7.8	Moderate.
100	100	70–90	0.20–0.63	.18	6.6–7.3	Moderate.
100	100	70–90	0.20–0.63	.18	7.4–7.8	Moderate.
100	100	70–90	0.20–0.63	.18	7.4–7.8	Moderate.
100	100	70–90	0.20–0.63	.18	7.4–7.8	Low to moderate.
100	100	15–25	2.00–6.30	.10	6.6–7.3	Low.
100	100	40–55	0.63–2.00	.12	6.6–7.3	Low.
100	100	15–25	2.00–6.30	.10	7.4–8.4	Low.

284-091 O-68—4

survey. No engineering test data were available for the soils in Haskell County.

Because the properties estimated in table 6 are for a typical profile, some variation from the values given should be expected. A description of a profile representative of each series in the county is given in the section "Descriptions of the Soils."

For each soil layer significant in engineering, table 6 lists the USDA textural classification and the Unified and AASHO engineering classifications.

The columns headed "Percentage passing sieve" list percentages of material that is small and passes the opening of No. 4, No. 10, and No. 200 sieves. Material retained on the No. 200 sieve (0.08 mm.) is generally considered coarse grained.

Soil permeability is the ability of the soil to transmit water or air. It is measured in terms of the rate at which water passes through the soil. In table 6 the column that shows permeability gives, in inches per hour, the estimated rate that 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 material, of the capillary water in the soil when that soil is wet to field capacity. When the soil is air dry, this amount of water

TABLE 7.—*Interpretation of*

Soil series and map symbol	Suitability as source of—					Soil features affecting—		
	Topsoil	Sand	Gravel	Road fill [1]	Subgrade [1]	Highway location [1]	Dikes and canals	Farm ponds: Reservoir area
Colby (Co)	Good	Unsuitable.	Unsuitable.	Good	Good	Good drainage; moderate stability and erodibility.	Moderate erodibility; low to moderate shear strength and plasticity.	Deep soil material; moderate permeability; rapidly permeable sand in some stream channels.
Glenberg (Gb)	Fair	Poor in surface layer; fair in substratum.	Poor	Good	Fair	Good drainage; fair stability; low plasticity; moderate erodibility.	Well-graded soil material; moderate stability and permeability.	Few strata of sand; moderate to rapid permeability.
Likes (Lk)	Poor	Good	Fair in local areas.	Fair	Fair to good.	Good drainage; unstable slopes because of high erodibility.	Coarse-textured material; unstable banks.	Not applicable
Lofton (Lo)	Fair	Unsuitable.	Unsuitable.	Poor	Poor	Infrequent flooding by runoff during storms; depressions.	Deep soil material; slow permeability; moderate to high shrink-swell potential.	Not applicable
Lubbock (Lu)	Good	Unsuitable.	Unsuitable.	Good	Fair	Good drainage; infrequent ponding.	Deep soil material; moderately slow permeability; moderate shear strength and stability.	Not applicable
Manter (Ma, Mb)	Fair	Poor	Unsuitable.	Good	Good	Good drainage; moderate stability.	Deep soil material; moderate permeability and erodibility.	Moderate permeability.
Otero (Og, Ou) (For interpretations of the Ulysses soil in mapping unit Ou, refer to the Ulysses soil series.)	Poor	Fair in local areas.	Fair in local areas.	Good	Good	Good drainage	Deep soil material; moderate permeability; layers of sand in places.	Moderate permeability; few strata of sand.

See footnotes at end of table.

will wet the soil material to a depth of 1 inch without deeper penetration.

The acid or alkaline reaction of a soil is expressed in a pH value. A pH of 7.0 is neutral; values lower than 7.0 are acid, and values higher are alkaline. No soil in Haskell County is more acid than pH 6.6 or more alkaline than pH 8.4.

A knowledge of the pH, or reaction, of a soil is useful if pipelines are to be constructed, for the pH indicates, among other things, likelihood of corrosion. The column that shows shrink-swell potential indicates the volume change in a soil when the content of moisture changes. It is an estimate of how much a soil shrinks when it is extremely dry and how much it swells when it is extremely wet. Randall soils to a depth of 3 feet have very high shrink-swell potential, and Spearville soils to a depth of 5 feet have a high to very high shrink-swell potential. These soils shrink greatly when they are dry, and they swell when they become wet. The Glenberg, Likes, Manter, and Vona soils have a low shrink-swell potential. A knowledge of this potential is important in planning the use of soils for building roads and other engineering structures.

engineering properties of soils

Soil features affecting—Continued					Degree of limitations for—	
Farm ponds—Con. Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Waterways	Sewage filter field	Foundations for small building
Moderate shear strength, stability, and plasticity; fair to good compaction.	Good drainage; gentle to moderately steep slopes.	Deep soil material; moderate permeability; high water-holding capacity; gentle to moderately steep slopes.	Deep, friable soil material; strong to moderately steep slopes; moderate to high erodibility.	Deep, friable soil material; moderate to high erodibility; moderate stability; gentle to moderately steep slopes.	Moderate: 5 to 12 percent slopes.	Moderate: Moderate shear strength, stability, and plasticity.
Well-graded soil material; moderate shear strength, permeability, and erodibility.	Good drainage; moderate permeability.	Limited water-holding capacity; sand pockets; good drainage; moderate permeability.	Not applicable	Moderate stability and erodibility; friable soil material.	Slight	Slight.
Not applicable	Good drainage	Rapid permeability; very low water-holding capacity; gentle to moderate slopes.	Not applicable	High erodibility; low fertility; unstable banks.	Slight	Slight.
Not applicable	Outlets distant from depressional areas.	Not applicable	Not applicable	Not applicable	Severe: Slow to moderately slow permeability.[2]	Severe: Moderate to high shrink-swell potential.
Not applicable	Good drainage	Deep soil material; nearly level slopes; moderately slow permeability; high water-holding capacity.	Not applicable	Not applicable	Severe: Moderately slow permeability.[2]	Moderate: Moderate shear strength and stability.
Well-graded soil material; good compaction; slight hazard of piping.	Good drainage	Limited water-holding capacity; moderately rapid permeability.	Deep, friable soil material.	Deep, friable soil material; moderate stability and erodibility.	Slight	Slight.
Well-graded soil material.	Good drainage	Moderate permeability; limited water-holding capacity.	Steep slopes	Limited water-holding capacity; moderate to high erodibility.	Slight	Slight.

TABLE 7.—*Interpretation of engineering*

Soil series and map symbol	Suitability as source of—					Soil features affecting—		
	Topsoil	Sand	Gravel	Road fill [1]	Sub-grade [1]	Highway location [1]	Dikes and canals	Farm ponds: Reservoir area
Randall (Ra)	Poor	Unsuitable.	Unsuitable.	Poor	Poor	Flooding of depressional areas by water in runoff during storms.	Deep soil material; slow permeability; high plasticity and shrink-swell potential.	Not applicable
Richfield (Rm, Rn, Ru). (For interpretations of the Ulysses soil in mapping unit Ru, refer to the Ulysses soil series.)	Good	Unsuitable.	Unsuitable.	Fair to good.	Poor to fair.	Good drainage; stable material.	Deep soil material; moderately slow permeability.	Moderately slow permeability; may contain strata of sand and gravel.
Satanta (Sa, Sb, Sn).	Good	Unsuitable.	Unsuitable.	Good	Fair to good.	Good drainage	Deep soil material; moderately slow permeability; moderate shear strength and stability.	Moderately slow permeability.
Spearville (Sp)	Fair	Unsuitable.	Unsuitable.	Fair to good.	Poor to fair.	Good drainage	Deep soil material; slow permeability; high shrink-swell potential and plasticity.	Not applicable
Tivoli (Tf, Tv, Tx). (For interpretations of the Vona soil in mapping unit Tv, refer to the Vona series.)	Poor	Good	Poor	Good if confined.	Good if confined.	Unstable slopes because of high erodibility; good drainage.	Moderate to high permeability and erodibility; poor to moderate stability.	Not applicable
Ulysses (Ua, Ub, Ud, Ue, Um). (For interpretations of the Colby soil in mapping units Ue and Um, refer to the Colby series.)	Good	Unsuitable	Unsuitable	Good	Good	Good drainage; stable material.	Moderate stability, plasticity, and shrink-swell potential.	Moderate permeability; low to moderate shrink-swell potential; may contain strata of sand and gravel.
Vona (Vo)	Poor	Fair	Unsuitable	Good	Good	Unstable slopes because of high erodibility.	Moderately rapid permeability; moderate stability and erodibility.	Not applicable

[1] Data for road fill, subgrade, and highway location prepared with the assistance of C. W. HECKATHORN, field soil engineer, and HERBERT E. WORLEY, soils research engineer, Kansas State Highway Commission.
[2] Slight limitations to use for sewage lagoons.

properties of soils—Continued

Soil features affecting—Continued					Degree of limitations for—	
Farm ponds—Con. Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Waterways	Sewage filter field	Foundations for small building
Not applicable	Ponding; outlets distant from depressional areas.	Not applicable	Not applicable	Not applicable	Severe: Very slow permeability.[3]	Severe: High plasticity and shrink-swell potential; ponding.
Moderate shear strength and stability; low to moderate shrink-swell potential; fair compaction.	Good drainage	Deep soil material; moderately slow permeability; high water-holding capacity; nearly level slopes.	Deep soil material; moderately slow permeability; moderate stability; low to moderate erodibility.	Deep, friable soil material; low to moderate erodibility.	Severe: Moderately slow permeability.[3]	Moderate: Moderate shear strength and stability; low to moderate shrink-swell potential.
Moderate shear strength, stability, and shrink-swell potential; fair to good compaction.	Good drainage	Deep soil material; moderately slow permeability; high water-holding capacity; nearly level slopes.	Deep, friable soil material; nearly level slopes; moderate stability and erodibility.	Deep, friable soil material; moderate stability and erodibility.	Moderate: Moderately slow permeability.	Moderate: Moderate shear strength, stability, and shrink-swell potential.
Not applicable	Good drainage	Deep soil material; slow permeability; high water-holding capacity; nearly level slopes.	Deep soil material; slow permeability; nearly level slopes.	Not applicable	Severe: Slow to moderately slow permeability.[2]	Moderate: High shrink-swell potential and plasticity.
Not applicable	Good drainage	Not applicable	Not applicable	Not applicable	Slight	Slight.
Moderate permeability; low to moderate shear strength, plasticity, stability, and erodibility; fair to good compaction.	Good drainage	Deep soil material; moderate permeability; high water-holding capacity; nearly level to gentle slopes.	Deep soil material; low to moderate stability and erodibility.	Deep, friable soil material; low to moderate erodibility.	Severe: Moderately slow permeability.[3]	Moderate: Low to moderate shrink-swell potential.
Not applicable	Good drainage	Very low water-holding capacity; moderately rapid permeability.	Not applicable	Not applicable	Slight: High permeability.[4]	Slight.

[3] Slight to moderate limitations to use for sewage lagoons.
[4] Severe limitations to use for sewage lagoons.

The shrink-swell potential of the soils in this county is indicated by the relative terms *very low*, *low*, *moderate*, *high*, and *very high*. The soils that have a liquid limit of 25 or less are rated very low or low; 25 to 40, moderately low; 40 to 60, high; and more than 60, very high.

For information on depth to ground water and bedrock, refer to "Geology and Ground-Water Resources of Grant, Haskell, and Stevens Counties, Kansas" (*5*), a publication of the University of Kansas.

The suitability of the soils of this county for various engineering uses is indicated in table 7. Also given in this table are soil features that affect the use of soils for highway construction and for agricultural engineering. In addition, table 7 rates the degree of limitations to use of the soils as sewage filter fields and as foundations for small buildings. The land type Active dunes is not listed in table 7, because the dunes are so variable and unstable that rating soil properties is not practical.

The suitability of the soils as a source of topsoil is indicated by the terms *good*, *fair*, or *poor*, or if the soils are unsuitable, that fact is indicated. This information is important because topsoil is needed for growing plants that control erosion on embankments, on the shoulders of roads, in ditches, and on cut slopes. For these estimates each layer was considered as a possible source of topsoil, though only one rating is shown in table 7. The surface layer, for example, may be more sandy or more clayey than the material under it. In many areas, as on embankments and on cut slopes, part of the soil material can be used as topsoil, whether the soil is still in place or has been moved. Normally, the cut slopes on the loamy soils can be seeded without a layer of topsoil.

For a proposed highway, it is essential that the location selected is suitable for the highway. Roads located on soils that are ponded during wet periods must be constructed on embankment sections, or it is necessary to provide a good system of underdrains and surface drains. Lofton and Randall soils occur in depressions and have slow to very slow permeability and poor surface drainage. Surface runoff accumulates and floods these soils. In addition, the clayey layers shrink greatly when they dry, and they swell when they become wet. If the subgrade on these soils is too wet when the pavement is laid on it, the soil material shrinks as it dries and the pavement may crack. If the subgrade is too dry, the pavement laid warps as the soil material absorbs moisture and swells. Pavement laid over plastic soils crack and warm less if a granular base course is placed directly beneath the pavement. Adequate drainage can be provided by extending this foundation course past the shoulder of the road.

Reservoirs and pond embankments are not suitable on Lofton, Lubbock, and Randall soils, though dugouts can be constructed in these soils. These soils occur in upland areas that are depressional, have undefined drainage, and are not suitable for constructing reservoirs or farm ponds. Also, sites suitable for ponds generally do not occur on the Likes, Spearville, Tivoli, and Vona soils.

Features that affect irrigation are listed in table 7. Additional facts about the suitability of soils for irrigation are given in the subsection "Management and Predicted Yields on Irrigated Soils."

Terraces generally are not suitable on the Glenberg and Likes soils, because they occur in positions along the Cimarron River that are not suitable. Terraces also are not suitable in the depressional areas of the Lofton, Lubbock, and Randall soils.

Waterways are not suitable on several soils in the county, because of topography, or because windblown material accumulates in the waterway, smothers vegetation, and hinders the flow of water.

The degree of limitations to the use of soils as sewage filter fields and as foundations for small buildings are rated *slight*, *moderate*, and *severe* in table 7. In this county sewage filter fields are affected mostly by the slope and the permeability of the soils. The foundations of small buildings are affected by shear strength, stability, plasticity, and shrink-swell potential.

Formation and Classification of Soils

This section discusses the effects that the five factors of soil formation have had on the formation of the soils in Haskell County. Also, the current system of soil classification is explained, and the soils in the county are placed in some of the categories in that system and in the great soil groups of an older system.

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 the soil at any given point are determined by (1) the physical and mineralogical composition of the parent materials; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plant and animal life on and in 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 vegetation are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body with genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that can be formed and, in extreme instances, determines it almost entirely. Finally, time is needed for the changing of the parent material into a soil profile. It may be much or little, but some time is always required for horizon differentiation. Usually, a long time is required for the development of distinct horizons, but where precipitation and temperature are high, the time needed is less than that needed where they are low. For this reason, the soils in the western part of Kansas have not developed such strong B horizons as have the soils in the eastern part.

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

Parent material

The soils of Haskell County have developed mainly from deposits of loess and windblown sands. The loess (windblown silt) is probably Peorian loess of Wisconsin age (*4*). The sand dunes in the northern part of the county were probably laid down during the late phases of the Wisconsin glaciation and in Recent time. Some soils, however, formed in alluvial instead of windblown deposits, and others formed in partly reworked sediments of sand that were blown by wind from old, alluvial outwash of Lower Pleistocene time (*5*).

The loess was deposited in Upper Pleistocene time. This silty material was laid down over most of the area as a mantle that ranged from a few feet to many feet in thickness. The loess is more than 50 percent silt and is light gray to pale brown, calcareous, friable, and porous. In Haskell County, the Richfield, Ulysses, and Colby silt loams are the dominant soils that developed in this kind of loess. Spearville silty clay loam also formed in loess.

The depressions in the loess-capped upland are clayey. Randall clay occupies the floors of the depressions and in places receives water that runs off higher areas. Lubbock and Lofton silty clay loams are in slightly depressional areas and have a slightly thicker soil profile than other soils in the uplands.

The windblown sands in the areas of the sandhills were probably deposited after the loess. The sandhills are strongly undulating, hummocky, and choppy. They are occupied by the Tivoli soils.

The transitional area between the loessal tablelands and the sandhills contains soils that developed in sandy to loamy sediments. These sediments consist of partly reworked sandy outwash that was deposited by streams during the Pliocene and Pleistocene epochs. They are the parent material of the Manter, Satanta, Vona, and Otero soils.

Alluvial sediments consisting of a mixture of gravel, sand, silt, and clay were deposited on the flood plain of the Cimarron River and near the mouth of the upland drainageways. Glenberg soils formed in sandy alluvium on the flood plain of the river. Likes soils formed in sandy alluvium on fans.

Old deposits of sandy and gravelly sediments occur in terraces above the flood plain of the Cimarron River. The Otero gravelly complex occupies areas of these geologic materials.

The deposits of Pleistocene sediments were affected by periods of erosion, deposition by water, deposition by wind, and soil formation. During the Recent epoch, this area has undergone erosion that has shaped much of its present topography.

Climate

Haskell County has a semiarid climate that is characterized by extreme temperatures in summer and winter and by a deficiency of moisture in most seasons. Under this climate, the soils in the county developed somewhat more slowly than those in areas where rainfall is higher.

Climate affects the physical, chemical, and biological relationships in the soil. Because the amount of water that percolates through the soils is limited, large amounts of bases remain in them. Most soils are calcareous at the surface or to about the depth that moisture normally penetrates. Water dissolves small amounts of the minerals and carries them out of the soil. Other minerals, such as clay and calcium carbonate, are moved downward for only a short distance in the soil profile.

Because of the limited amount of precipitation in Haskell County, the soil minerals are only slightly weathered. Calcium carbonates have been leached to a depth of 18 to 30 inches in some of the older soils, but they are at the surface in younger soils.

The growth of organisms generally increases as temperature increases. Also increasing with a rise in temperature is the rate that chemicals react and affect the weathering of minerals and the decomposition of organic material.

The strong winds that are characteristic of this area have influenced soil formation by sorting soil materials. In some places the surface soil has been recharged with calcium carbonate that has blown and washed in from nearby areas.

Relief

Relief, or lay of the land, influences the formation of soils through its effect on drainage, erosion, temperature, and plant cover.

Soils in slight depressions in the uplands receive extra water from surrounding areas and are deep, dark colored, and well developed. Also, they are leached of lime to a depth of 20 to 36 inches. Lubbock soils are of this kind.

Richfield soils are nearly level and occur on uplands capped with loess. These soils are leached of lime to a depth of about 18 inches. Because of their relief, they have absorbed more water and are more developed than the Ulysses soils on uplands. The Ulysses soils are nearly level to sloping and slightly convex.

Lofton soils on benches around depressions are deep and moderately fine textured because the moisture they received is above normal and has promoted the weathering of silt particles to clay.

Soil formation is retarded on steep slopes by the continual loss of material through erosion. The Colby soils, for example, lose soil material through erosion almost as fast as the material forms. The gravelly Otero soils occur on steep slopes where erosion has removed the loessal cap and has exposed the moderately sandy material of the Ogallala formation.

The Randall soils are in depressions and are fine textured because silt particles have been weathered to clay, or clay particles have been washed in by water.

Plant and animal life

Animal life and vegetation are indispensable in soil development. Small burrowing animals, worms, and insects help to mix the soil, and bacteria, fungi, and other micro-organisms help to weather rock and to decompose organic material. Plant and animal life also influence the chemical and biological processes that take place in the soil. The numerous worm casts in some soils in the county are evidence of the presence of animal life. Ulysses and Colby soils contain numerous worm casts.

The type and amount of vegetation are important for soil development and are determined in part by the climate and in part by the nature of soil material. Vegetation adds organic matter to the soil and thus influences its physical and chemical characteristics. Trees, shrubs, and other plants influence the climate within the soil by providing shade and by helping the soil to retain moisture.

The soils of Haskell County have developed under grass. As a result, a soil profile typical of the county has dark-colored upper horizons that are rich in organic matter and a transitional horizon that, in many places, is slightly finer in texture and somewhat lighter in color. The underlying parent material is generally light in color and high in calcium carbonate.

Time

The length of time required for soil development depends largely on the other factors of soil formation. Soils develop more slowly in Haskell County, where the climate is dry and the vegetation is sparse, than they do in areas where the climate is moist and the vegetation is dense. As water moves downward through the soil profile, lime and fine particles are gradually leached from the surface and deposited in the subsoil. The amount of this leaching depends primarily on the length of time the soil has been in place, the permeability of the soil, and the amount of water. As the fine particles are deposited in the subsoil, a horizon of clay accumulation forms. In many areas, horizons of lime accumulation form in the subsoil where lime carbonate is deposited after it has been leached from the surface soil.

Classification of the Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us in understanding their behavior and their response to manipulation. First through classification and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

Thus in classification, soils are placed in narrow categories that are used in detailed soil surveys so that knowledge about the soils can be organized and used in managing farms, fields, and woodland; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

Two systems of classifying soil have been used in the United States in recent years. The older system was adopted in 1938 (*2*) and later revised (*9*). The system currently used was adopted for general use by the National Cooperative Soil Survey in 1965. The current system is under continual study. Therefore, readers interested in developments of the current system should search the latest literature available (*7, 8*). In table 8, the soil series of Haskell County are placed in some categories of the current system and in the great soil groups of the older system.

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped together. Most of the classes of the current system are briefly defined in the following paragraphs.

ORDER: Ten soil orders are recognized. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate in the soil orders are those that tend to give broad climatic groupings of soils. The two exceptions to this are the Entisols and Histosols, which occur in many different kinds of climate. Table 8 shows that the four soil orders in Haskell County are Entisols, Vertisols, Aridisols, and Mollisols.

Entisols are light-colored soils without natural genetic horizons or with only very weakly expressed begnnings of such horizons. These soils do not have traits that reflect soil mixing caused by shrinking and swelling. In Haskell County this order includes some soils previously classified as Alluvial soils and Regosols.

Vertisols are soils that have enough swelling clay to cause cracking, shearing, and mixing of the soil material when, because of climate and topography, there is alternate wetting and drying of the soil mass. Soils in this order were formerly called Grumusols.

Aridisols are light-colored mineral soils that are high in bases and have well-expressed mineral genetic horizons. In Haskell County this order is represented only by soils previously classified as Brown soils.

Mollisols developed under grass and have thick, dark-colored surface horizons containing colloids dominated by bivalent cations. These soils are not mixed by shrinking and swelling. Soils of this order were formerly called Chestnut soils and Alluvial soils.

TABLE 8.—*Soils classified according to the current system of classification and the 1938 system*

Series	Family	Subgroup	Order	Great soil groups in the 1938 system
Colby	Fine-silty, mixed, calacareous, mesic	Typic Ustorthents	Entisols	Regosols.
Glenberg	Coarse-loamy, mixed, calcareous, mesic	Typic Ustifluvents	Entisols	Alluvial soils.
Likes	Mixed, thermic	Typic Ustipsamments	Entisols	Alluvial soils.
Lofton	Fine, montmorillonitic, thermic	Vertic Argiustolls	Mollisols	Chestnut soils.
Lubbock	Fine, mixed, thermic	Pachic Argiustolls	Mollisols	Chestnut soils.
Manter	Coarse-loamy, mixed, mesic	Typic Argiustolls	Millisols	Chestnut soils.
Otero	Coarse-loamy, mixed, calacareous, mesic	Typic Ustorthents	Entisols	Regosols.
Randall	Fine, montmorillonitic, thermic	Udic Pellusterts	Vertisols	Grumusols.
Richfield	Fine, montmorillonitic, mesic	Typic Argiustolls	Mollisols	Chestnut soils.
Satanta	Fine-loamy, mixed, mesic	Typic Argiustolls	Mollisols	Chestnut soils.
Spearville	Fine, montmorillonitic, mesic	Vertic Argiustolls	Mollisols	Chestnut soils.
Tivoli	Mixed, thermic	Typic Ustipsamments	Entisols	Regosols.
Ulysses	Fine-silty, mixed, mesic	Typic Haplustolls	Mollisols	Chestnut soils.[1]
Vona	Coarse-loamy, mixed, mesic	Mollic Haplargids	Aridisols	Brown soils.[1]

[1] Intergrading toward Regosols.

SUBORDER: Each order has been subdivided into suborders, primarily on the basis of the characteristcs that seemed to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging or soil differences resulting from the climate or vegetation.

GREAT GROUP: Suborders are separated into great groups on basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those that have pans that interfere with growth of roots or movement of water. The features used are the self-mulching properties of clays, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like. The great group is not shown separately in table 8, because it is the last word in the name of the subgroup.

SUBGROUP: Great groups are subdivided into subgroups, one representing the central (typic) segment of the group, and others, called intergrades, that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group.

FAMILY: Families are separated within a subgroup primarily on the basis of properties important to the growth of plants or behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

General Facts About the County

This section was written mainly for those unfamiliar with Haskell County. It tells about the physiography, drainage, and water supply; the climate; the natural resources, transportation, and markets; and the agriculture of the county.

Physiography, Drainage, and Water Supply

Haskell County lies within the High Plains part of the Great Plains physiographic province. Its topography is shown in figure 20.

A nearly level to gently sloping, silty and clayey tableland that slopes generally eastward occupies all of the county except the southwestern corner, the sandhills of the northwestern part and a small area in the northeastern part, and the north-sloping silty uplands in the northern part. This silty and clayey tableland occupies about three-fourths of the county. It falls only about 10 to 20 feet per mile as it slopes eastward. The drainage pattern is poorly defined and contains many undrained depressions that collect water after heavy rains. These depressions remain ponded until the water evaporates or soaks into the ground.

The southwestern corner of the county is a fairly rough area through which the Cimarron River flows and drains the nearby uplands. The moderately sloping to steep valley wall along this river consists of sandy to loamy soils. Crooked Creek drains the east-central part of the county as it flows through the surrounding level to gently sloping silty soils of the uplands.

Sandhills occupy an area in the northwestern part of the county. These sandhills are in a continuous narrow belt of cone-shaped hills or dunes and intervening small, irregular depressions. Blowouts are common where the dunes are highest and steepest. Although intermittent streams enter this area, within a short distance they are indefinable in the hummocks and dunes. But these streams help recharge the ground water.

The northern part of the county is a silty upland that slopes generally northward, though small intermittent drainageways do empty into the sandhills to the west. In the eastern part of this tableland, drainageways empty into nearly level areas that are generally slightly depressional. These areas contain large depressions that collect water. This upland area is smooth and nearly level to gently sloping, and its drainage channels are small. The large depressional areas receive water that runs in from higher areas, and when rainfall is high, water ponds in the large depressions. Most of the water that falls in this area is collected and remains in the area.

The highest point in the county, about 3,075 feet above sea level, is in the northwestern part. The lowest point along the Cimarron River is about 2,875 feet, and the lowest point in the northeastern part of the county is about 2,800 feet. The elevation at Sublette is about 2,900 feet.

Water for domestic use is obtained from drilled wells, and most of the water for livestock is pumped from wells by windmills. Irrigation water is pumped from wells drilled deeply into the Ogallala formation. Many of the pumps are powered by gas (fig. 21).

The Ogallala formation, a deposit of gravel, sand, silt, and clay, is the principal aquifer in the county, but the Permian red beds are important in the supply of water because they form an impervious floor beneath the water-bearing sediments. Much of the water is obtained from the coarse gravel and sand in the lower part of the Ogallala formation. In parts of the county, the Dakota and Cheyenne formations yield a moderate amount of water. The ground water that is available in wells comes entirely from the rain and snow that fall within the county and in areas to the west and north.

Climate [8]

The climate of Haskell County is continental and is characterized by low annual rainfall, abundant sunshine, dry air, and large variations in temperature during the day and during the year.

Haskell County is in the southeastern part of Kansas in an area called the Short Grass Country. Elevations average 2,950 feet above sea level and are relatively uniform. The county is in the rain shadow of the Rocky Mountains, for these mountains block storms that come from the Pacific Ocean. The air from the Pacific loses its moisture as it crosses the mountains, and when it reaches Haskell County, it is warm and dry and is moved in downslope winds.

[8] By MERLE J. BROWN, State climatologist, U.S. Weather Bureau, Manhattan, Kans.

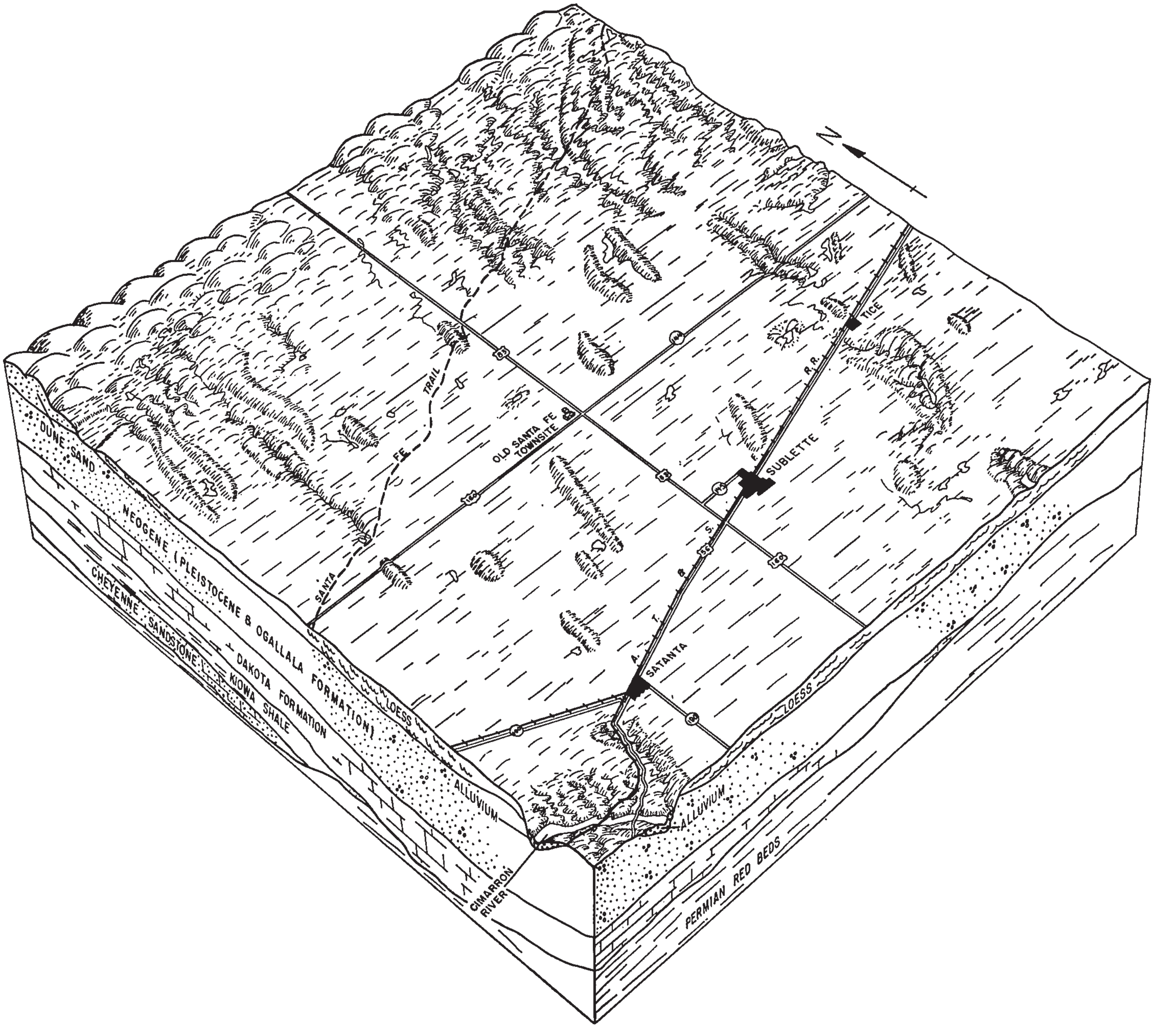

Figure 20.—**Physiography of Haskell County.**

The Gulf of Mexico is the principal source of moisture, but the county does not receive as much moisture from the gulf as do areas to the east. The average annual precipitation in the county is about 18½ inches, of which three-fourths falls in the period from April through September. Rainfall is generally greatest late in spring and early in summer. In May, the wettest month, average precipitation is about 3 inches. In January, the driest month, average precipitation is only 0.36 inch.

Most of the rain in Haskell County falls in showers or accompanies thunderstorms. Some of the thunderstorms are violent, and the strong winds and heavy downpour of rain and hailstones wash out seed crops and damage cultivated fields considerably.

Table 9 shows the average daily maximum and minimum temperatures for each month in the year and for the year. It also gives the probabilities that, 2 years in 10, specified temperatures will occur. In 1 year in every 10, on the average, each of the months from October through March will have precipitation amounting to less than 0.10 inch. On the other hand, precipitation in May and in June will exceed 6 inches in 1 year in 10. Records from 1900 through 1960 at Garden City, Kans., indicate that chances are best early in June and early in August for receiving weekly precipitation of 0.20 inch or more.

During the period from 1914 through 1964, annual precipitation at Sublette has ranged from a low of 5.29 inches in 1956 to a high of 28.18 inches in 1964. Crop-damaging droughts may continue for several years. Droughts were very serious during the 1930's and again from 1952 through 1957. During the 1930's 103 months were dry, and 55 of these months had either severe or extreme droughts.

Because the climate of Haskell County is not moderated by the effects of large bodies of water, variations in temperature are large, especially during the day but also during the year. Cloudless skies and low humidity combine to produce a strong, warming effect during the day, but there is a great loss in heat at night. A temperature range of 30 degrees is common in a 24-hour period, and at times the range is as much as 40 degrees. The range in temperature during the year is large because there is intense solar heating in summer and occasional invasions of cold arctic air in winter. Mean monthly temperatures range from 32° F. in January to about 80° in July. Temperature extremes at Sublette have ranged from 21° below zero to 112° above. Table 9 shows that, at Sublette, 2 years in 10 are likely to have at least 4 days in July with a temperature of 104° or higher.

The freeze-free period ranges from an average of about 170 days in the northwestern corner of the county to 180 days in the southeastern corner (*3*). May 22 was the latest recorded date in spring that had a temperature of 32° F. This was in 1931. The probability of the last freeze after a specified date in spring and the first before a specified date in fall are given for 5 thresholds in table 10. These probabilities were calculated from the records in Sublette. Table 10 shows that in one-half of the years, on the average, the last 32° temperature in spring occurs after April 26. Also in about one-half of the years, the first 32° freeze in fall occurs before October 18.

Surface winds are moderate to strong in all seasons. The windiest season is spring, when the average hourly speed exceeds 15 miles per hour. The prevailing wind is southerly, but northerly winds are fairly common, especially from December through March. Because of the wind and the dry weather, soil blowing is a hazard, particularly in March and April.

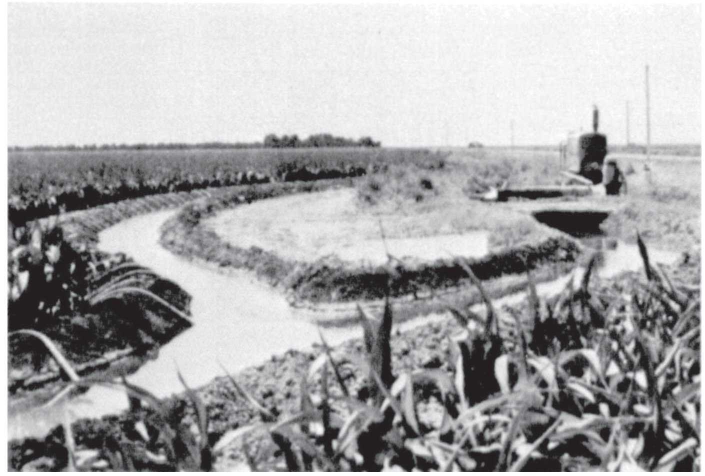

***Figure 21.*—A gas engine used to pump irrigation water from a deep well. The soil is Richfield silt loam, 0 to 1 percent slopes.**

Because of the moderate winds, the high temperature, and the dry air, the rate of evapotranspiration is high during summer. The damaging effect of loss of moisture, however, is lessened in June, July, and August because in each of these months rainfall averages more than 2 inches.

Annual snowfall averages about 20 inches in Haskell County. Several inches of snow commonly accumulates during some storms, but ordinarily the snow does not stay on the ground long. Blizzards occur, but not frequently.

Tornadoes occur occasionally in spring, summer, and early in fall, but they rarely cause loss of life or heavy damage to property.

TABLE 9.—*Temperature and precipitation*

[From records kept at Sublette]

Month	Temperature				Precipitation		
	Average daily maximum [1]	Average daily minimum [1]	Two years in 10 will have at least 4 days with— Maximum temperature equal to or higher than [2]—	Two years in 10 will have at least 4 days with— Minimum temperature equal to or lower than [2]—	Average monthly total [1]	One year in 10 will have— Monthly total less than [1]—	One year in 10 will have— Monthly total more than [1]—
	° *F.*	° *F.*	° *F.*	° *F.*	*Inches*	*Inches*	*Inches*
January	46.2	17.3	66	1	0.36	0.03	0.88
February	51.6	21.7	71	8	.56	.05	1.40
March	58.8	27.6	79	12	.91	.08	2.22
April	69.0	38.9	86	26	1.55	.29	2.69
May	77.7	49.6	93	38	2.97	.55	6.02
June	88.2	59.6	102	49	2.83	.66	6.05
July	93.9	65.0	104	58	2.47	.78	4.84
August	92.5	63.4	103	56	2.39	.51	4.38
September	84.9	54.9	98	41	1.88	.27	4.01
October	73.3	42.1	88	30	1.43	.06	3.44
November	58.1	28.4	74	13	.67	.01	1.53
December	47.9	20.1	67	7	.46	.01	.95
Year	70.2	40.7	[3] 105	[4] −8	18.48	11.25	24.55

[1] Calculated from data recorded from 1913 through 1964.
[2] Calculated from data recorded from 1913 through 1961.
[3] Average annual highest temperature from 1914 through 1964.
[4] Average annual lowest temperature from 1914 through 1964.

TABLE 10.—*Probabilities of last freezing weather in spring and first in fall*

[From records kept at Sublette, Kans.]

Probability	Dates for given probability and temperature				
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower
Spring:					
1 year in 10 later than	April 7	April 10	April 16	April 28	May 11.
2 years in 10 later than	April 1	April 4	April 11	April 23	May 6.
5 years in 10 later than	March 20	March 25	April 2	April 13	April 26.
Fall:					
1 year in 10 earlier than	December 9	November 30	November 19	November 11	November 1.
2 years in 10 earlier than	December 3	November 25	November 15	November 6	October 28.
5 years in 10 earlier than	November 21	November 14	November 5	October 28	October 18.

Natural Resources, Transportation, and Markets

Except for soil and water, the only natural resources in Haskell County are gas and oil and sand and gravel. Most of the gas wells are in the western two-thirds of the county, for the county is at the edge of the great Hugoton gasfield. The oil wells are mainly in the western third. Sand and gravel that are used locally for road construction and in concrete are dug in the alluvium along the Cimarron River and in the Ogallala formation in the southwestern part of the county.

The Atchison, Topeka and Santa Fe Railway passes through Satanta, Sublette, and Tice. In these towns are grain-handling and storage facilities for assisting in transportation of grain to the terminal elevators and markets to the east.

The three U.S. highways, three State highways, and several county roads in Haskell County form a network that is densest in the southern part. U.S. Highway No. 83 bisects the county as it runs north and south. It is joined near the center of the county by U.S. Highway No. 160, which runs in from the west. From the southwestern corner of the county, U.S. Highway No. 56 runs generally northeastward, and it passes through Satanta, Sublette, and Tice. Two of the State highways are in the southern part of the county.

Agriculture

This subsection tells about the development of agriculture in Haskell County and describes the agriculture of today.

Before 1900 native grasses covered most of Haskell County. From then until World War I, farming was mainly for producing crops for home use, though there were some large ranches. Agriculture was assisted by the building of branch lines by the Atchison, Topeka and Santa Fe Railroad.

In 1935, about 224,600 acres was cultivated. More and more grassland was plowed after the tractor was used for farm power, and wheat gained in importance. Extensive cash-grain farms were established.

Farmers became concerned about soil erosion during the drought of the 1930's and began contour tillage, stubble mulching, stripcropping, and other conservation practices. Use of these practices increased after the Haskell County Soil Conservation District was organized in 1948. By 1958 only about 33,200 acres remained in native grass range and the farmland was managed better than it had been.

Irrigation began in about 1940, when two deep wells were supplying water to irrigate about 300 acres. Irrigation increased; the U.S. Census of Agriculture reported that in 1964 about 79,700 acres, or about one-fourth of the cropland, was irrigated.

Dryland and irrigated farming today are the basic agriculture in Haskell County, though there are a few cattle ranches in the sandhills and along the Cimarron River. In 1964, cropland amounted to about 306,500 acres. Of this acreage, about 79,700 acres was irrigated, and most of the rest was dryfarmed or in summer fallow. Most of the wheat and sorghum grown is shipped out of the county. Farming is on a large scale and is highly mechanized. Many cattle and sheep are brought into the county to graze for short periods.

According to the 1964 Census of Agriculture, there were 301 farms in the county. The average size of the farms was 1,252.4 acres. Tenants operated 100 farms; part owners, 145 farms; and full owners 56 farms. Most of the farms are cash grain, but there are some general farms and a few ranches.

Crops.—Wheat and grain sorghum are practically the only dryfarmed crops in the county, though there is a small acreage of rye and barley. The wheat and grain sorghum are grown in a cropping system in which the hardland soils are summer fallowed every other year. Irrigated crops are wheat, sorghums for silage and grain, corn for silage and grain, beans, sugar beets, alfalfa, and garden crops. In 1964, according to the Kansas State Board of Agriculture, the acreages harvested were wheat, 132,000 acres; grain sorghum, 38,000 acres; silage sorghum, 1,000 acres; sugar beets, 1,010 acres; and alfalfa, 1,200 acres.

Pasture.—Approximately 20 percent of the farms in the county are livestock farms. In 1958, native pasture amounted to about 33,200 acres, most of which was on the steep loamy slopes along the Cimarron River and in the sandhills, and some was on the nearly level tableland. As irrigation expands, more of the nearly level land is being cultivated. Most of the land used for range is nonarable or marginal. The High Plains support native mid and short grasses, and the sandhills and bottom lands support taller grasses. Ranches in the county are few.

Livestock.—Beef cattle usually outnumber other kinds of livestock, but the number varies greatly from year to year and from season to season. The numbers of cattle and sheep are usually high in fall and winter, particularly when the preceding growing season was favorable. These animals are brought in from the range when wheat, pasture, or sorghum stubble is available for grazing. Farmers who have summer range keep a few cows.

The number of commercial feed yards is increasing. Also increasing are small feed yards, in which the farmer feeds and winters a few feeder cattle. According to U.S. Census of Agriculture, in 1964 there were in the county about 230 milk cows, 27,320 other cattle, 1,520 hogs and pigs, 160 sheep and lambs, and 4,930 chickens.

Literature Cited

(1) American Association of State Highway Officials.
1961. Standard specifications for highway materials and methods of sampling and testing. Ed. 8, 2 v., illus.

(2) Baldwin, Mark, Kellogg, Charles E., and Thorp, James.
1938. Soil classification. U.S. Dept. Agr. Ybk., pp. 979–1001, illus.

(3) Bark, L. Dean.
1959. When to expect late-spring and early fall freezes in Kansas. Kans. State Univ. of Agri. and Applied Sci., Kans., Agri. Expt. Sta. Bul. 415, 23 pp., illus.

(4) Gutentag, E. D.
1963. Studies of the Pleistocene and Pliocene deposits in southwest Kansas. Trans. Kans. Acad. Sci.: 66–4; pp. 606–21, illus.

(5) McLaughlin, Thad G.
1943. Geology and ground-water resources of Grant, Haskell, and Stevens Counties, Kansas. State Geol. Survey of Kans. Bul. 61, 221 pp., illus.

(6) Portland Cement Association.
1956. PCA soil primer. 86 pp., illus.

(7) Simonson, Roy W.
1962. Soil classification in the United States. Sci. 137: 1027–1034.

(8) Soil Survey Staff.
1960. Soil classification, a comprehensive system. U.S. Dept. Agri., 265 pp., illus. [Amendment issued in March 1967.]

(9) Thorp, James and Smith, Guy D.
1949. Higher categories of soil classification: order, suborder, and great soil group. Soil Sci. 67: 117–126.

(10) Waterways Experiment Station, Corps of Engineers.
1953. The unified soil classification. Tech. Memo. 3–357, 2 v. and appendix.

Glossary

Aggregate. Many fine particles of soil held in a single mass or cluster, such as a clod, crumb, block, or prism.

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

Blowout. An excavation produced by wind action in loose soil, usually sand.

Buried soil. A developed soil, once exposed but now overlain by more recently formed soil.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

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

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

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 to moderate 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; tends to stretch somewhat and pull apart, rather than pull free from other material.

Hard. When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

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

Cemented. Hard and brittle; little affected by moistening.

Gravel. Rounded or angular rock fragments that are not prominently flattened and are 2 millimeters to 3 inches in diameter. A gravelly soil is one in which fragments of this land make up 15 to 50 percent of the soil mass.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-formed processes. These are the major horizons:

O horizon. The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon. The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and it is therefore marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon. The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has (1) distinctive characteristics caused by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; (4) or by some combination of these. The combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon. The weathered rock material immediately beneath the solum. This layer, commonly called the soil parent material, is presumed to be like that from which the overlying horizons were formed in most soils. If the underlying material is known to be different from that in the solum, a Roman numeral precedes the letter, C.

R layer. Consolidated rock beneath the soil. The rock usually underlies C horizon but may be immediately beneath an A or B horizon.

Ground water. Water that fills all the unblocked pores of underlying material below the water table, which is the upper limit of saturation.

Leaching. The removal of soluble materials from soil or other material by percolating water.

Loam. Soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand.

Loess. A fine-grained eolian deposit consisting dominantly of silt-sized particles.

Parent material (soil). The horizon of weathered rock or partly weathered soil material from which soil has formed; horizon C in the soil profile.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

pH. A numerical means for designating relatively weak acidity and alkalinity, as in soils and other biological systems. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

Reaction, soil. The degree of acidity or alkalinity of a soil expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction, because it is neither acid nor alkaline. In words the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Sand. Individual rock or mineral fragments in soils having diameters 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.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying parent 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).

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. (See also Clay, Sand, and Silt.) The basic textural classes, in order of increasing proportions of fine particles are as follows: sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

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.

Weathering. All physical and chemical changes produced in rocks at or near the earth's surface by atmospheric agents. These changes result in more or less complete disintegration and decomposition of the rock.

Wind stripcropping. Growing wind-resisting crops in long, relatively narrow strips that are placed crosswise to the direction of the prevailing wind without regard to the contour of the land.

GUIDE TO MAPPING UNITS

[For a full description of a mapping unit, read both the description of the mapping unit and the description of the soil series to which the mapping unit belongs]

[See table 1, p. 10, for approximate acreage and proportionate extent of the soils; table 2, p. 25, for predicted yields on dryfarmed soils; and table 3, p. 27, for predicted yields on irrigated soils. Table 4, p. 31, lists growth of trees and shrubs in windbreaks on the soils in the three windbreak suitability groups in the county. For facts about engineering uses of soils, turn to the subsection on engineering beginning on p. 32]

			Capability unit		*Range site*		*Windbreak suitability group*
			Dryland	*Irrigated*			
Map symbol	*Mapping unit*	*Page*	*Symbol*	*Symbol*	*Name*	*Page*	*Number*
Ad	Active dunes	9	VIIe-1	-------	Choppy Sands	29	-------
Co	Colby loam, 5 to 12 percent slopes	10	VIe-1	-------	Limy Upland	30	1
Gb	Glenberg soils	11	VIw-1	-------	Sandy Lowland	30	-------
Lk	Likes loamy sand	11	VIe-2	-------	Sands	29	-------
Lo	Lofton silty clay loam	12	IVw-1	-------	Clay Upland	30	3
Lu	Lubbock silty clay loam	13	IIIe-2	I-1	Loamy Lowland	30	3
Ma	Manter fine sandy loam, 0 to 1 percent slopes.	14	IIIe-3	IIs-1	Sandy	29	2
Mb	Manter fine sandy loam, 1 to 3 percent slopes.	14	IIIe-2	IIe-2	Sandy	29	2
Og	Otero gravelly complex	15	VIe-3	-------	Sandy	29	-------
Ou	Otero-Ulysses complex, 1 to 3 percent slopes.	15					
	Otero soil	----	IVe-3	-------	Sandy	29	2
	Ulysses soil	----	IVe-3	-------	Loamy Upland	30	1
Ra	Randall clay	16	VIw-2	-------	-------	----	-------
Rm	Richfield silt loam, 0 to 1 percent slopes	17	IIIe-1	I-1	Loamy Upland	30	1
Rn	Richfield silt loam, 1 to 3 percent slopes	17	IIIe-1	IIe-1	Loamy Upland	30	1
Ru	Richfield and Ulysses complexes, bench leveled.	18	IIIe-1	I-1	Loamy Upland	30	1
Sa	Satanta fine sandy loam, 0 to 1 percent slopes.	19	IIIe-3	I-2	Sandy	29	2
Sb	Satanta fine sandy loam, 1 to 3 percent slopes.	19	IIIe-2	IIe-2	Sandy	29	2
Sn	Satanta loam, 0 to 1 percent slopes	20	IIIe-1	I-1	Loamy Upland	30	1
Sp	Spearville silty clay loam, 0 to 1 percent slopes.	20	IIIs-1	IIs-2	Clay Upland	30	1
Tf	Tivoli fine sand	21	VIIe-1	-------	Choppy Sands	29	-------
Tv	Tivoli-Vona loamy fine sands	21					
	Tivoli soil	----	VIe-2	-------	Sands	29	-------
	Vona soil	----	VIe-2	-------	Sands	29	2
Tx	Tivoli-Dune land complex	21	VIIe-1	-------	Choppy Sands	29	-------
Ua	Ulysses silt loam, 0 to 1 percent slopes	22	IIIe-1	I-1	Loamy Upland	30	1
Ub	Ulysses silt loam, 1 to 3 percent slopes	23	IIIe-1	IIe-1	Loamy Upland	30	1
Ud	Ulysses loam, 1 to 3 percent slopes	22	IIIe-1	IIe-1	Loamy Upland	30	1
Ue	Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded.	23	IVe-2	IIe-1	Limy Upland	30	1
Um	Ulysses-Colby silt loams, 3 to 5 percent slopes, eroded.	23	VIe-1	-------	Limy Upland	30	1
Vo	Vona loamy fine sand	24	IVe-1	IVe-1	Sands	29	2

U.S. GOVERNMENT PRINTING OFFICE : 1968 O—284-091

Accessibility Statement

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at (800) 457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.

Nondiscrimination Statement

Nondiscrimination Policy

The U.S. Department of Agriculture (USDA) prohibits discrimination against its customers, employees, and applicants for employment on the basis of race, color, national origin, age, disability, sex, gender identity, religion, reprisal, and where applicable, political beliefs, marital status, familial or parental status, sexual orientation, whether all or part of an individual's income is derived from any public assistance program, or protected genetic information. The Department prohibits discrimination in employment or in any program or activity conducted or funded by the Department. (Not all prohibited bases apply to all programs and/or employment activities.)

To File an Employment Complaint

If you wish to file an employment complaint, you must contact your agency's EEO Counselor (http://directives.sc.egov.usda.gov/33081.wba) within 45 days of the date of the alleged discriminatory act, event, or personnel action. Additional information can be found online at http://www.ascr.usda.gov/complaint_filing_file.html.

To File a Program Complaint

If you wish to file a Civil Rights program complaint of discrimination, complete the USDA Program Discrimination Complaint Form, found online at http://www.ascr.usda.gov/complaint_filing_cust.html or at any USDA office, or call (866) 632-9992 to request the form. You may also write a letter containing all of the information requested in the form. Send your completed complaint form or letter by mail to U.S. Department of Agriculture; Director, Office of Adjudication; 1400 Independence Avenue, S.W.; Washington, D.C. 20250-9419; by fax to (202) 690-7442; or by email to program.intake@usda.gov.

Persons with Disabilities

If you are deaf, are hard of hearing, or have speech disabilities and you wish to file either an EEO or program complaint, please contact USDA through the Federal Relay Service at (800) 877-8339 or (800) 845-6136 (in Spanish).

If you have other disabilities and wish to file a program complaint, please see the contact information above. If you require alternative means of communication for program information (e.g., Braille, large print, audiotape, etc.), please contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

Supplemental Nutrition Assistance Program

For additional information dealing with Supplemental Nutrition Assistance Program (SNAP) issues, call either the USDA SNAP Hotline Number at (800) 221-5689, which is also in Spanish, or the State Information/Hotline Numbers (http://directives.sc.egov.usda.gov/33085.wba).

All Other Inquiries

For information not pertaining to civil rights, please refer to the listing of the USDA Agencies and Offices (http://directives.sc.egov.usda.gov/33086.wba).