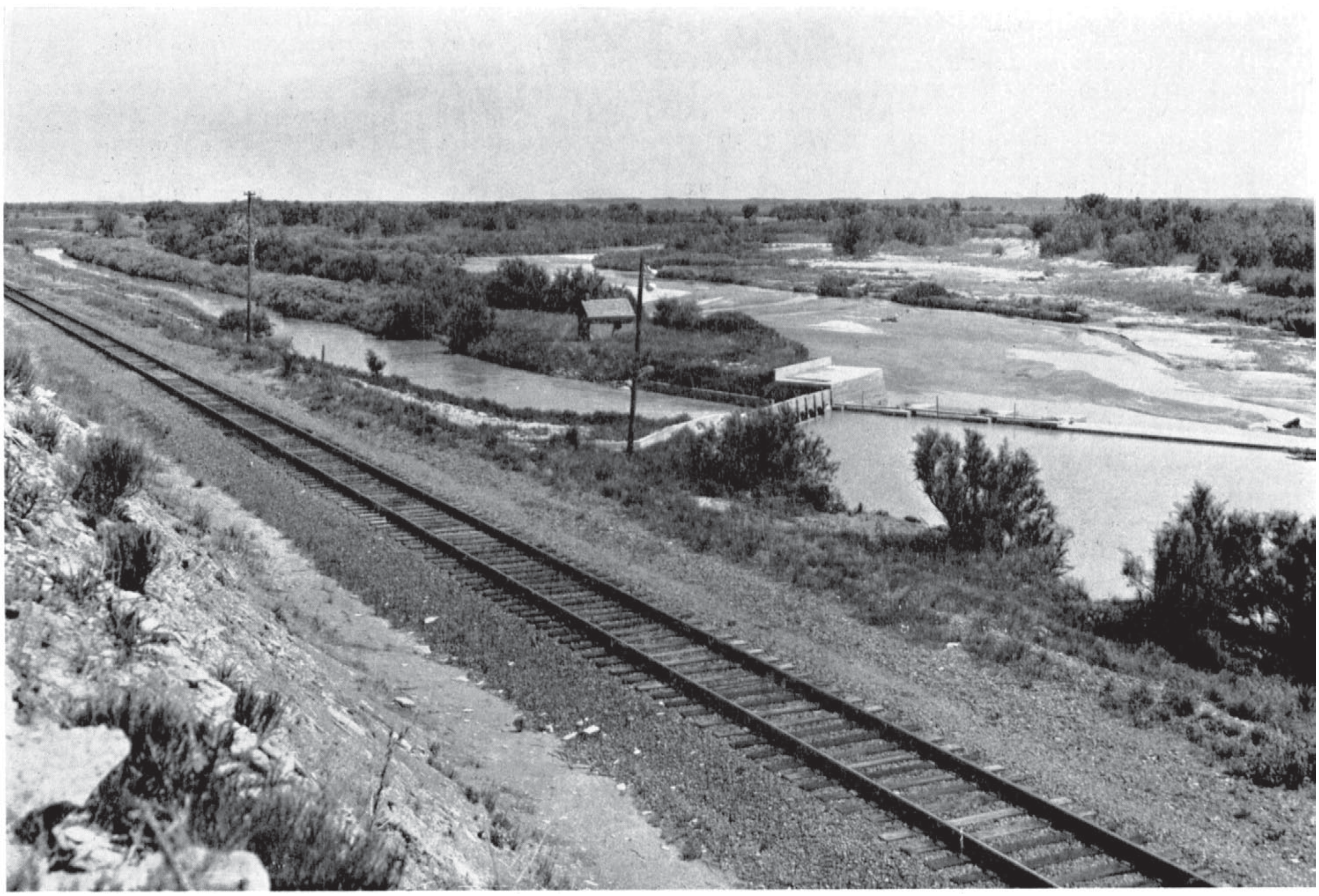
Series 1959, No. 32

Issued November 1963

SOIL SURVEY
KEARNY COUNTY
Kansas



UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
Kansas Agricultural Experiment Station

HOW TO USE THE SOIL SURVEY REPORT

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

Locating the soils

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

Finding information

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

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

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

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

Students, teachers, and other users will find information about soils and their management in various parts of the report, depending on their particular interest.

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

* * * * *

Fieldwork for this survey was completed in 1959. Unless otherwise indicated, all statements in the report refer to conditions in the county at that time. This cooperative survey of Kearny County was made by the United States Department of Agriculture and the Kansas Agricultural Experiment Station as part of the technical assistance furnished by the Soil Conservation Service to the Kearny County Soil Conservation District.

Cover picture
A concrete diversion dam diverting water from the Arkansas River into the Amazon Ditch.

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

Contents

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SOIL SURVEY OF KEARNY COUNTY, KANSAS

BY KENNETH H. SALLEE, VERNON L. HAMILTON, CHARLES W. McBEE, AND EDWARD L. FLEMING, SOIL SCIENTISTS, SOIL CONSERVATION SERVICE

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

KEARNY COUNTY, located in southwestern Kansas, (fig. 1), has a land area of 853 square miles, or 545,920 acres. It extends about 36 miles from north to south and 24 miles from east to west. Lakin, the county seat, is in the southeastern part of the county along the Arkansas River.

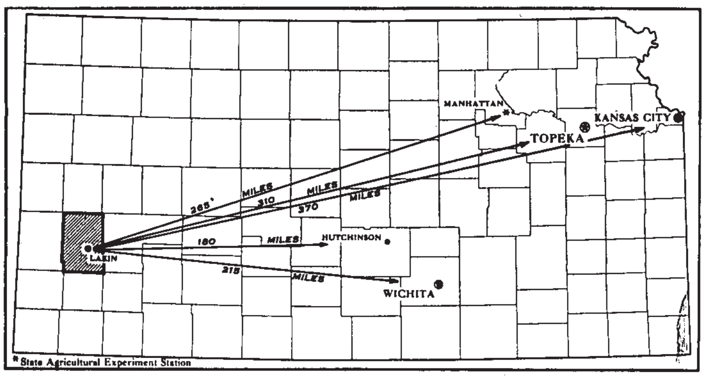

Figure 1.—**Location of Kearny County in Kansas.**

Agriculture is the principal enterprise, and wheat, grain sorghum, and cattle are the main sources of income. Most of the crops are grown under dryland farming, but, during the past 60 years, irrigation has been practiced along the Arkansas River. The production of natural gas is the leading industry.

How This Soil Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Kearny 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 or bored many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down to the rock material that has not been changed much by leaching or by roots of plants.

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

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Colby 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 natural characteristics.

Many soil series contain soils that are alike except for the texture of their surface layer. According to this difference 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. Las Animas sandy loam and Las Animas clay loam are two soil types in the Las Animas series. The difference in the texture of their surface layers is apparent from their names.

Some soil types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into soil phases. The name of a soil phase indicates a feature that affects management. For example, Colby silt loam, 5 to 15 percent slopes, is one of several phases of Colby silt loam, a soil type that ranges from nearly level to steep.

After a fairly detailed guide for classifying and naming the soils had been worked out, the soil scientists drew soil boundaries on aerial photographs. They used photographs for their base map because they show areas of woodland, buildings, field borders, trees, and similar detail that greatly help in drawing boundaries accurately. The soil map in the back of this report was prepared from the aerial photographs.

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

In preparing some detailed maps, the soil scientist has 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, he shows this mixture of soils as one mapping unit and calls it a soil complex. Ordinarily, a soil complex is named for the major soil series in it, for example, the Richfield-Mansic complex. Also, in most mapping, there are areas to be shown that are so rocky, so shallow, or so frequently worked by wind and water that they cannot be called soils. These areas are shown on a soil map like other mapping units, but they are given descriptive names, such as Active dunes or Broken land, and are called land types rather than soils.

Only part of the soil survey was done when the soil scientist had named and described the soil series and mapping units, and had shown the location of the mapping units on the soil map. The mass of detailed information he had recorded then needed to be presented in different ways for different groups of users, among them farmers, managers of woodland and rangeland, and engineers.

To do this efficiently, he had to consult with persons in other fields of work and jointly prepare with them groupings that would be of practical value to different users. Such groupings are the capability classes, subclasses, and units, designed primarily for those interested in producing short-lived crops and tame pasture; range sites, for those using large tracts of native grass; woodland suitability groups, for those who need to manage wooded tracts; and the classifications used by engineers, who build highways or structures to conserve soil and water.

General Soil Map

After study of the soils in a locality and the way they are arranged, it is possible to make a general map that shows several main patterns of soils, called soil associations. Such a map is the colored general soil map in the back of this report. Each association, as a rule, contains a few major soils and several minor soils, in a pattern that is characteristic although not strictly uniform.

The soils within any one association are likely to differ from each other in some or in many properties; for example, slope, depth, stoniness, or natural drainage. Thus, the general soil map shows, not the kind of soil at any particular place, but patterns of soils, in each of which there are several different kinds of soils.

The six soil associations in Kearny County are shown on the general soil map in the back of the report. Each soil association is named for the major soil series in it, but, as already noted, soils of other series may also be present. The major soils of one soil association may also be present in another association, but in a different pattern.

The general map showing patterns of soils is useful to people who want a general idea of the soils, who want to compare different parts of a county, or who want to know the possible location of good-sized areas suitable for a certain kind of farming or other land use.

1. Richfield-Ulysses Association

Soils of the High Plains tableland

Nearly level or gently sloping soils in broad, continuous areas on the summit of the High Plains tableland make up most of this association. The association also includes soils along narrow, intermittent drainageways and on the narrow, nearly level floors of swales in the uplands. It is the most extensive association in the county, and it is made up mainly of Richfield and Ulysses soils. These soils formed in loess or in similar silty sediments.

Richfield soils make up the major part of this association. They occupy broad, continuous areas that are mainly nearly level and have no clearly defined drainageways. The Ulysses soils, which have gentle, convex slopes, are mainly along the margin of the nearly level tableland where the slope is steeper.

Colby, Goshen, Manter, Mansic, and Lofton soils occupy a minor acreage in the association. The Colby soils are along the narrow, intermittent drainageways that have cut through the loess; the Goshen soils are on the narrow floors of upland swales that have an indefinite channel or no channel, and they occur throughout the association; the Manter soils are in a few places on small knolls and ridges; the Mansic soils occur in concave areas slightly below the level of the High Plains (fig. 2) ; and the Lofton soils are in a few small, enclosed depressions, or potholes, mainly within the areas of Richfield soils.

The soils of this association are used mainly to grow wheat and grain sorghum. Erosion by wind is a hazard in the nearly level areas, and erosion by both wind and water is a hazard on the sloping soils. Conserving water is important if profitable yields are to be obtained.

2. Goshen-Ulysses Association

Soils of the High Plains drainageways

This association consists of nearly level soils on the floors, in the deep, wide channels, and on the side slopes of the two large drainageways that dissect the northern part of the county.

The Goshen and Ulysses soils are dominant in this association, but a smaller acreage is occupied by areas of Broken land and Alluvial land and by the Colby, Lofton, and Manter soils. There is also a small acreage of soils of the Otero gravelly complex and of the Richfield-Mansic complex.

The Goshen soils are nearly level and formed in colluvial and alluvial sediments. They are on the broad floors of the large drainageways and in the small, narrow swales of side drainageways.

The Ulysses soils are gently sloping and are in areas that border the alluvial valleys. Broken land, a miscellaneous land type, occupies the broken areas and is in the deep, wide channels of the drainageways within the areas of Goshen soils. Alluvial land occurs on the narrow floors of the drainageways and in the incised, winding channels bordered by steep slopes or areas of Broken land. The Colby soils are on the steeper side slopes and knobs. The Lofton soils are in depressions, or potholes, where there is no definite channel.

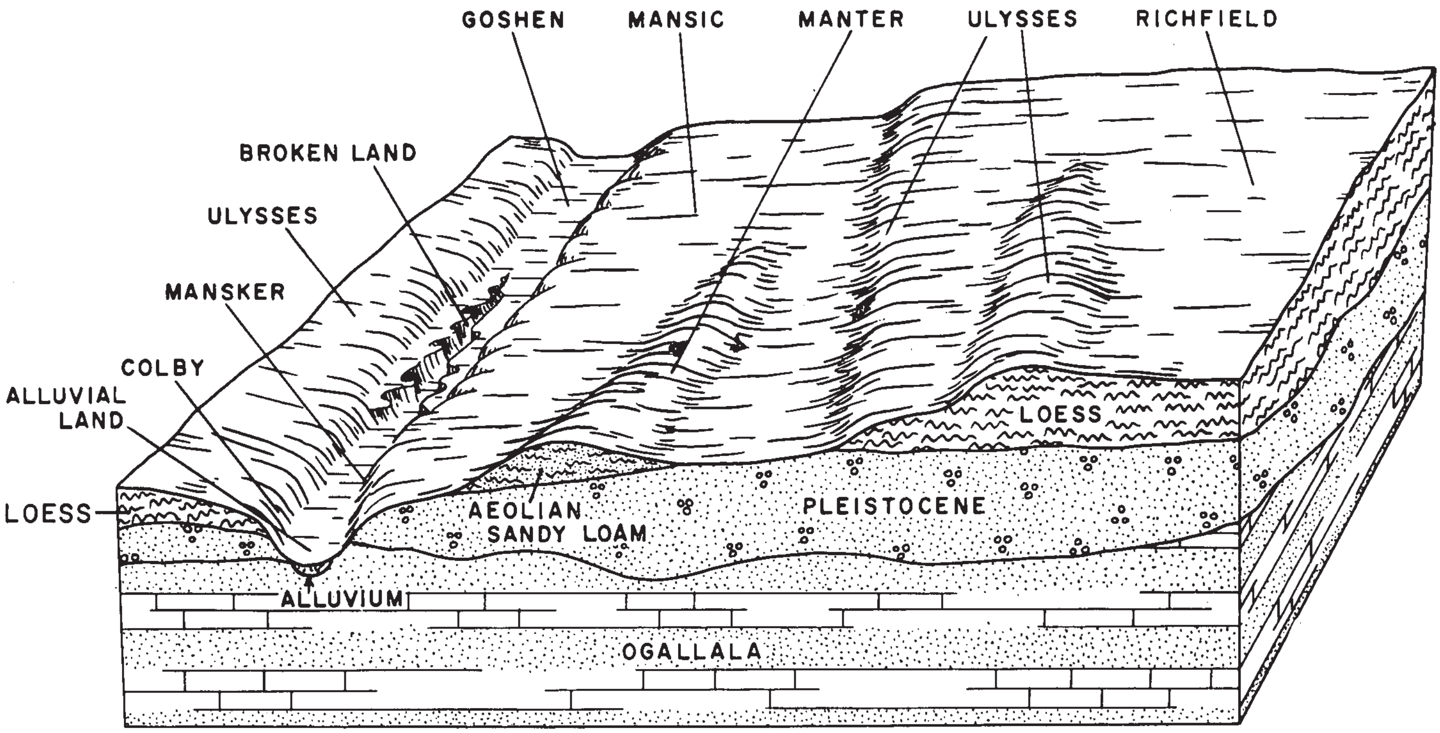

Figure 2.—**Cross section of the county showing the relationship of some of the soils of the uplands to the parent material and topography.**

The Manter soils and the soils of the Otero gravelly complex are on a few small, isolated knobs and ridges. Soils of the Richfield-Mansic complex occupy part of the sloping area along the drainageways. The Richfield soils of this complex formed in loess or in similar silty sediments, and they have a well-developed profile. The Mansic soils formed in highly calcareous outwash material, and they have only weak profile development.

Most of the soils in this association are used to grow wheat and grain sorghum, but the steeper and more broken areas are in native grass and are used for grazing. Erosion by wind and water is a serious hazard in the sloping areas, and erosion by wind is a serious hazard on the more sandy soils.

3. Colby-Ulysses Association

Sloping soils of the High Plains

Sloping soils of the High Plains make up most of this association, but some of the areas are nearly level to moderately sloping. Some of the soils are on the steep side slopes of deep valleys formed as the result of erosion, or in sandy, steep, and rough areas. The nearly level or moderately sloping soils are in the uplands adjacent to the nearly level tableland. Most of this association is north of the valley of the Arkansas River.

The Colby soils are more extensive than the other soils in this association, but the Ulysses soils are also extensive. The Colby soils are moderately steep or steep, and the Ulysses soils are nearly level or gently sloping. These soils formed in loess that mantles most of the slopes.

Soils of the Otero gravelly complex, Lincoln soils, soils of the Tivoli-Vona complex, and small areas of Potter and Goshen soils occupy a minor acreage in the association. The soils of the Otero gravelly complex are in the more sandy, steep, and rough areas. Within the areas of Otero gravelly complex are areas of Lincoln soils and of the Tivoli-Vona complex. The Lincoln soils are in the channels of the broad, sandy drainageways. The soils of the Tivoli-Vona complex are on the sandy benches and side slopes along the drainageways. The acreage of Potter soils is small, and these soils are in the broken areas adjacent to the valley of the Arkansas River. They are shallow over caliche or over limestone and chalk. The Goshen soils occupy a minor, but important, part of the association. They are in narrow, nearly level swales in the uplands and in drainageways that have no channel or only an indefinite channel.

Most of the acreage of nearly level to moderately sloping soils in this association is under cultivation. The steeper and more broken areas are in native grass and are used for grazing. Wheat and sorghum are the main crops. Crop failures are common, and profitable yields are obtained only during years of high rainfall. It is necessary to conserve water carefully, and, because the soils are susceptible to erosion by wind and water, management should include practices to help control erosion.

4. Bridgeport-Las-Las Animas Association

Soils in the valleys of the Arkansas River and Bear Creek

This association consists mainly of soils on alluvial fans, or aprons, and on flood plains. It includes all of the Arkansas River Valley, which extends from west to east across the county. The association also includes the soils in the valley of Bear Creek in the southern part of the county.

The Arkansas River Valley, which consists of the flood plains and the alluvial fans along the northern border of the flood plains, ranges from less than 1 mile to 5 miles or more in width. It is bordered on the north by bluffs and by the sloping soils of the High Plains. On the south it is bordered by the sandhills.

The Bridgeport, Las, and Las Animas soils are dominant in this association, but a smaller acreage is occupied by Bayard, Bowdoin, Sweetwater, and Lincoln soils. There are also small areas of soils of the Tivoli-Vona complex and of a dark variant of the Church soils.

The Bridgeport and Bayard soils occupy the alluvial fans, or aprons, along the northern margin of the flood plain north of the Arkansas River. These soils are friable, well drained, and productive, and they are cultivated under irrigation. The Las, Las Animas, and Bowdoin soils occur throughout the flood plains. They have a moderately high water table and are slightly to moderately saline. Most of their acreage is irrigated and used to grow cultivated crops. The Sweetwater soils have a fairly high, stable water table. They support good stands of native grasses (fig. 3) and are used as range or meadow. The Lincoln soils are in areas where sandy alluvium has been deposited recently along the Arkansas River, and they are of value only for grazing and wildlife. The soils of the Tivoli-Vona complex are on sand dunes in the valley south of the Arkansas River.

***Figure 3.*—Native grasses growing on an area of Sweetwater clay loam that is used for range.**

Soils in the valley of Bear Creek, in the southern part of the county, make up only a minor part of the association. This valley is occupied mainly by Bridgeport soils and by a dark variant of the Church soils. The dark variant of the Church soils is deep, moderately dark colored, and fine textured, and it developed in calcareous sediments. It is on the floor of the valley. The Bridgeport soils are on a slightly higher part of the valley floor than the dark variant of the Church soils, and they are more friable than those soils. Most soils in the valley of Bear Creek are cultivated, and part of the acreage is irrigated.

5. Tivoli Association

Soils of the sandhills

Soils of the sandhills south of the Arkansas River Valley make up this association. Most of the area is strongly undulating, hummocky, and choppy. It is gently undulating or billowy in the southern part, however, and the eastern part contains some nearly level and gently undulating areas. The sandhills cover an area that is about 5 miles wide at the western boundary of the county. The area broadens to about 15 miles along the eastern side of the county.

Nearly all of the acreage in the sandhills consists of Tivoli soils. Tivoli fine sand occupies the areas of hummocky and choppy dunes. Within these areas are small, irregularly shaped basins. There are also nearly bare areas of loose, actively blowing sand, or Active dunes. The dunes, mostly in the rougher areas, have been formed by wind erosion on the Tivoli soils (fig. 4). The gently undulating areas are occupied by soils of the Tivoli-Vona complex.

***Figure 4.*—Giant sandreedgrass that is beginning to stabilize an area of Tivoli fine sand.**

Except for a small, nearly level area in the eastern part of the association, all of the soils are nonarable and are used as range. Under good management, mixed stands of tall and mid grasses produce enough forage for grazing, and they protect the soils from wind erosion.

6. Manter-Vona Association

Soils transitional between the sandhills and the High Plains tableland

This association consists of gently sloping or slightly undulating soils in narrow areas between the sandhills and the High Plains tableland south of the sandhills. The area is a transitional zone where the soils are moderately sandy or sandy. The moderately sandy soils grade to the silty soils of the uplands to the south, and the sandy soils grade to the soils of the sandhills to the north. The amount of sand decreases as the distance from the sandhills increases.

The association consists mainly of Manter and Vona soils. The Manter soils are nearly level or gently sloping and are adjacent to the High Plains tableland. The Vona soils are in billowy or slightly undulating areas adjacent to the sandhills.

The Colby soils and the soils of the Otero gravelly complex make up a minor acreage in this association. These soils are moderately sloping to steep. They are along drainageways that extend into the sandhills and toward the Arkansas River.

Most of the soils in this association are cultivated without irrigation. Sorghum is the main crop on the sandy soils, and wheat is predominant on the less sandy soils. Wind erosion is a hazard throughout the area. It is especially serious on the more sandy soils, and erosion by water is an additional hazard on the gently sloping, more silty soils. Careful management is needed to help control erosion and to conserve water for plants.

Descriptions of the Soils

In the following pages the soils of Kearny County are arranged alphabetically by soil series, and the characteristics of each series are described. Then, a brief description of a soil profile considered to be typical of the series is given, and other mapping units are described by comparing their profile to the one described as typical of the series. Also, in the description of each mapping unit is a reference to the capability unit and range site to which the soil belongs.

The location and distribution of the individual mapping units are shown on the soil map at the back of this report. The "Guide to Mapping Units, Capability Units, and Range Sites," also at the back of this report, lists the map symbol of each mapping unit and the page where that mapping unit is described. In addition, it lists for each mapping unit the capability unit and range site and the pages where each of these is described. Table 1 shows the approximate acreage and proportionate extent of the soils mapped in Kearny County. Some terms that may be unfamiliar to the reader are defined in the Glossary at the back of the report.

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

Soil	Area	Extent
	Acres	*Percent*
Active dunes	1, 740	0. 3
Alluvial land	510	. 1
Bayard fine sandy loam	1, 290	. 2
Bowdoin clay loam	710	. 1
Bridgeport clay loam	9, 420	1. 7
Broken land	2, 880	. 5
Church clay, dark variant	1, 210	. 2
Colby silt loam, 1 to 3 percent slopes	15, 390	2. 8
Colby silt loam, 3 to 5 percent slopes	8, 070	1. 5
Colby silt loam, 5 to 15 percent slopes	6, 840	1. 3
Dalhart-Vona loamy fine sands, 0 to 1 percent slopes	3, 310	. 6
Goshen silt loam	20, 190	3. 7
Gravelly broken land	1, 440	. 3
Las clay loam, deep	8, 860	1. 6
Las clay loam, moderately deep	6, 040	1. 1
Las-Las Animas complex	1, 840	. 3
Las Animas clay loam	1, 180	. 2
Las Animas loamy sand	3, 610	. 7
Las Animas sandy loam	1, 600	. 3
Lincoln sand	2, 050	. 4
Lofton silty clay loam	1, 310	. 2
Mansic clay loam, 0 to 1 percent slopes	2, 110	. 4
Mansker loam, 0 to 3 percent slopes	220	(1)
Manter fine sandy loam, 0 to 1 percent slopes	2, 590	. 5
Manter fine sandy loam, 1 to 3 percent slopes	3, 850	. 7
Manter fine sandy loam, 3 to 5 percent slopes	610	. 1
Otero gravelly complex	4, 810	. 9
Potter soils	360	. 1
Richfield silt loam, 0 to 1 percent slopes	161, 940	29. 7
Richfield-Mansic complex, 1 to 3 percent slopes	3, 900	. 7
Sweetwater clay loam	3, 610	. 7
Tivoli fine sand	76, 660	14. 1
Tivoli-Dune land complex	13, 140	2. 4
Tivoli-Vona loamy fine sands	32, 880	6. 0
Ulysses silt loam, 0 to 1 percent slopes	85, 940	15. 8
Ulysses silt loam, 1 to 3 percent slopes	30, 050	5. 5
Ulysses silt loam, 3 to 5 percent slopes	610	. 1
Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded	3, 810	. 7
Ulysses-Colby silt loams, 3 to 5 percent slopes, eroded	680	. 1
Ulysses and Richfield soils, silted, 0 to 1 percent slopes	10, 490	1. 9
Vona loamy fine sand	4, 510	. 8
Arkansas River	1, 020	. 2
Gravel pits	140	(1)
Intermittent lakes	160	(1)
Lake McKinney	2, 340	. 4
Total	545, 920	100. 0

[1] Less than 0.1 percent.

Active Dunes

This miscellaneous land type consists of fine sand on hills and ridges and in cone-shaped dunes. The loose sand is continually shifted by the wind.

Active dunes (Ad).—This land type is closely associated with the Tivoli soils. In fact, severe wind erosion on the Tivoli soils has formed the loose, actively shifting dunes. The land type consists of areas, 20 acres or more in size, where 80 percent or more of the acreage is bare of vegetation. In some places there is a cover of giant sandreed or blowoutgrass, but this cover is too sparse to keep the sand from blowing.

This land should be fenced from livestock, protected by a cover of weeds or sorghum, and then seeded to the native grasses that commonly grow in the area. (Capability unit VIIe-1; Choppy Sands range site)

Alluvial Land

This miscellaneous land type consists of areas along intermittent streams in the uplands. It is grayish-brown, calcareous loam to sandy loam to a depth of 2 feet. Below this is weakly stratified, loamy, sandy, and gravelly material.

Alluvial land (An).—This miscellaneous land type generally is not suited to cultivation. Winding channels of streams cut into the narrow flood plains it occupies, and the soils on adjoining slopes are generally unsuitable for cultivated crops. Also, the areas are flooded occasionally.

The areas of this land type are at least 200 feet wide. They are continuous enough to be suitable for separate grazing management. Most of the acreage is in range. (Capability unit VIw–1; Loamy Lowland range site)

Bayard Series

The Bayard series consists of calcareous, well-drained, grayish-brown fine sandy loams over moderately sandy alluvium. These soils are in rather narrow areas along present and abandoned channels of upland streams that cross the alluvial fans, or aprons, bordering the Arkansas River Valley.

The soils are porous and permeable, and their water-holding capacity is moderate. The water table is well below the root zone, generally at a depth of more than 10 feet.

The surface layer of these soils is 4 to 10 inches of grayish-brown, friable fine sandy loam. This surface layer generally is underlain by loam and sandy loam that is somewhat stratified. In a few places, however, it is underlain by thin strata of loamy fine sand. The subsoil is grayish brown to pale brown and is 8 to 20 inches thick. At a depth of more than 20 inches, the soil material is somewhat lighter colored, is strongly calcareous, and contains small, soft concretions of lime. Coarse sand and gravel is 30 to 60 inches or more from the surface. Small pebbles are scattered throughout the profile.

The Bayard soils are associated with the Bridgeport soils, but they are at slightly higher elevations, are more sloping, and have more sand throughout the profile.

Bayard fine sandy loam (Ba).—This is the only Bayard soil mapped in Kearny County. Mapped with it are small areas of a shallow, very sandy soil that are too small to be mapped separately.

Many areas of Bayard fine sandy loam are in native vegetation because they are on slightly higher ridges that cannot be reached by irrigation water. The cultivated areas generally are irrigated with the adjacent Bridgeport soils.

Wind erosion is a hazard when this soil is dry and is not adequately protected. Flash floods from the uplands sometimes damage crops and irrigation systems. (Capability unit IVe–4 (dryland); capability unit IIs–1 (irrigated); Sandy range site)

Bowdoin Series

The Bowdoin series consists of dark grayish-brown soils that are calcareous and generally saline. These soils formed in clayey alluvium deposited in nearly level to depressed areas on bottom lands along the Arkansas River and around Lake McKinney. They are somewhat poorly drained, and their subsoil is slowly permeable. Most of the time the water table is 5 to 10 feet from the surface, but it may be higher when rainfall is above average.

The surface layer and subsurface layer combined consist of 5 to 20 inches of grayish-brown to dark grayish-brown clay loam. This clay loam is of moderate, medium, granular structure and is slightly firm when moist. The subsoil consists of layers of gray clay and clay loam. Coarse sand generally is more than 40 inches from the surface, and the average depth is 50 inches.

In places the profile contains thin strata of material ranging from sand to clay in texture; these thin layers may occur in any part of the profile. Also, to a depth of about 40 inches, the layers may be mottled, especially the layers of clay.

Bowdoin soils are similar to the Las soils, but they have a subsoil of clay instead of clay loam.

Bowdoin clay loam (Bd).—This is the only Bowdoin soil mapped in Kearny County. A large acreage of this soil is in irregularly shaped areas that are managed with the surrounding Las and Las Animas soils. There are also many long, narrow areas along old channels of streams.

Much of this soil is irrigated. Wheat and forage sorghum are the main crops. The soil is not highly productive, and careful management is necessary because it is saline, slowly permeable, and poorly drained. Growing deep-rooted crops and returning large quantities of crop residues to the soil will increase the permeability and improve the soil structure. (Capability unit IVw–2 (dryland); capability unit IVw–3 (irrigated); Saline Subirrigated range site)

Bridgeport Series

The Bridgeport series consists of moderately dark colored, calcareous soils that are deep and well drained. The soils formed in alluvium that streams have brought down from the uplands and deposited in the valleys. Many areas of these soils are on the nearly level, alluvial fans, or aprons, above the flood plain north of the Arkansas River Valley. A few areas are along Bear Creek.

The surface layer and subsurface layer are dark grayish-brown clay loam. The material under these layers is similar, but it is lighter colored. Sand and gravel are at a depth of more than 5 feet in most places. The ground water table lies well below the root zone.

In most places there is no variation in the profile. To a depth of 40 inches, there may be strata of sandy material, but these are not prominent.

The Bridgeport soils are lighter colored than the Goshen soils and are calcareous nearer the surface. They are less sandy than the Bayard soils. They are deeper to sand and gravel than the associated Las soils, and they are also better drained. Bridgeport soils are more porous and permeable and are better drained than the Bowdoin and Church soils, and their subsoil is less clayey.

Bridgeport clay loam (Bp).—This is the only Bridgeport soil mapped in Kearny County. It is a porous and permeable soil that has a high water-holding capacity. Crops grown on this soil produce the highest yields of any crops grown on the soils of the Arkansas River Valley. This soil is well suited to field crops, and much of it is irrigated.

Wheat and sorghum are grown under dryland farming and under irrigation. Alfalfa is grown only under irrigation. Dryland wheat and sorghum generally make satisfactory yields if they are grown in fields that are fallowed.

Limitations are few, but, if this soil is cultivated and not irrigated, the hazard of wind erosion is serious. Flash floods that come down streams draining the uplands sometimes damage crops. Some areas of this soil are nonarable, because this flooding is so frequent and extensive. (Capability unit IIIc–1 (dryland); capability unit I–1 (irrigated); Loamy Upland range site)

Broken Land

This miscellaneous land type consists of steep, nonarable, alluvial sandy loams to clay loams. It shows little or no profile development.

Broken land (Bx).—This mapping unit is along intermittent streams of the uplands and in the Arkansas River Valley. It is not suitable for cultivation and has little value for grazing. The areas are at least 150 feet wide, however, and are continuous enough to be considered separately for use and management. (Capability unit VIIw–1 (dryland); Unstable range site)

Church Series

No typical Church soils are mapped in this county, but a dark variant, which has some characteristics like those of Church soils has been mapped. The dark variant of the Church series consists of deep, moderately dark colored, strongly calcareous, clayey soils. It occurs in the lower part of the Bear Creek depression.

The surface layer, about 6 inches thick, is grayish-brown, calcareous light clay that has a weak, granular structure. It is hard when dry, which makes a seedbed difficult to prepare.

The subsurface layer is about 20 inches thick. It is dark grayish-brown, calcareous clay and has a blocky structure.

The parent material is brown, calcareous, massive clay.

Variations in the profile are few, but the texture of the surface layer ranges from heavy silty clay loam to clay, and the color, from grayish brown to brown.

These soils are associated with the Bridgeport soils, but they are more clayey throughout the profile. They are deeper over sand, are less dark, and are less stratified than the Bowdoin soils, and they contain no mottles.

Church clay, dark variant (Ca).—This nearly level soil occurs in the lower part of the Bear Creek depression. It is not suited to field crops under dryland farming, and it is only moderately well suited to irrigated crops. About half of this soil is cultivated under irrigation, and half is in native grass range.

There are limitations on the kinds of crops that can be grown. It is difficult to prepare an adequate seedbed in the clayey surface layer. Also, this soil is slowly permeable and has poor surface drainage. Floods sometimes damage crops and irrigation systems. Satisfactory yields are obtained only when water, fertility, and tillage are carefully managed. (Capability unit VIs–4 (dryland); capability unit IVw–5 (irrigated); Clay Lowland range site)

Colby Series

The Colby series consists of friable, light-colored soils that are deep and calcareous. The soils have formed in deep loess and in similar silty sediments in the more sloping parts of the county.

The surface layer is 4 to 7 inches of grayish-brown, calcareous silt loam. It is underlain by slightly lighter colored, porous, massive silt loam. Free lime occurs throughout the profile.

Variations in the profile are few. The surface layer and the underlying material range from silt loam to light silty clay loam. In some places under grass, the surface layer is noncalcareous, somewhat darker colored, and less than 6 inches thick.

The surface layer of the Colby soils is lighter colored and thinner than that of the Ulysses and the Richfield soils. The underlying material is less clayey than that of the Richfield soils. The C_{ca} horizon, a layer of accumulated lime, is less prominent in the Colby soils than in the Mansic and Mansker soils.

Included with the mapping units of Colby soils are small areas of Ulysses silt loams.

Colby silt loam, 1 to 3 percent slopes (Cb).—Most of this soil is on gentle, convex slopes adjacent to upland drainageways north of the Arkansas River Valley. The average slope is 2 percent.

Nearly level areas of this soil are closely associated with Ulysses soils, which are darker colored. The more sloping areas occur with areas of Colby silt loam, 3 to 5 percent slopes, and Colby silt loam, 5 to 15 percent slopes.

This sloping soil is not well suited to field crops, but much of it is cultivated. The hazard of water erosion is serious. The soil tends to seal over during rainstorms, and runoff is rapid. Wind erosion is also a hazard when the soil is not adequately protected by plant cover or plant residues. (Capability unit IVe–2 (dryland); capability unit IIe–4 (irrigated); Loamy Upland range site)

Colby silt loam, 3 to 5 percent slopes (Cc).—This soil is similar to Colby silt loam, 1 to 3 percent slopes, but its surface layer is thinner, or only 3 to 5 inches thick. Gravel and outcrops of caliche occur in a few places.

Most of this soil is adjacent to large drainageways and is used mainly for native range. Some of it is cultivated, but it is not well suited to field crops. Excessive runoff damages crops if it comes before the plants have put down strong roots.

Erosion by water and wind is a hazard. This sloping soil should be protected by leaving crop residues on it or by keeping it under growing vegetation. (Capability unit VIe–1 (dryland); Loamy Upland range site)

Colby silt loam, 5 to 15 percent slopes (Cd).—Except for its stronger slopes, this soil is similar to the other Colby silt loams. The surface layer is mainly silt loam, but in places it is loam.

Soils other than the Colby soil make up about 15 percent of this mapping unit. These inclusions consist of (1) grayish-brown, calcareous, loamy soils formed in alluvium on narrow valley floors of minor drainageways, and (2) Potter soils that occur in a few small areas, generally less than 20 acres in size. These areas of included soils are too small to have special significance in range planning and management.

Nearly all of this soil is covered with native short grasses and is used for range. A few small areas have been cultivated because they are within large fields of arable soils. Erosion on these cultivated areas has been so severe that most of them are no longer used for field crops. Cultivated areas should be seeded to the grasses commonly grown in the area and used as range. (Capability unit VIe–1 (dryland); Limy Upland range site)

Dalhart Series

The Dalhart series consists of deep, noncalcareous loamy fine sands. The soils are well drained and dark colored.

In most places the surface layer is 5 to 18 inches of dark grayish-brown to brown loamy fine sand that is only slightly coherent. In a few places it is 2 inches or less of friable loam. The surface layer is massive or has weak, thin, platy structure. The subsoil ranges from 15 to 26 inches in thickness. The upper part is brown, friable fine sandy loam and has weak, coarse, prismatic to weak, fine, granular structure. The lower part is brown, friable sandy clay loam that has weak, coarse, prismatic to weak, medium, granular structure. At a depth of more than 24 to 30 inches is lighter colored sandy clay loam to loamy fine sand that is calcareous in places. Also, below a depth of 24 inches, there is a buried soil in places.

In this county the Dalhart soils are mapped with the Vona soils. The subsoil of the Dalhart soils is less sandy and more coherent than that of the Vona soils. The Dalhart soils are more sandy throughout the profile than the Richfield and Ulysses soils. They have a less silty subsoil and substratum than the Manter soils.

Dalhart-Vona loamy fine sands, 0 to 1 percent slopes (Dx).—About 60 percent of this complex, or mixture of soils, is Dalhart loamy fine sand, and 40 percent is Vona loamy fine sand. These soils are nearly level to gently sloping. They occur on isolated flats in the sandhills, surrounded by slightly undulating to choppy and hummocky, dunelike areas that are occupied by Tivoli-Vona loamy fine sands.

The Dalhart soils have a surface layer of noncalcareous, dark grayish-brown to brown loamy fine sand over heavy sandy loam to sandy clay loam. The underlying material is somewhat variable. The Vona soils consist of 5 to 24 inches of noncalcareous loamy fine sand over a subsoil of sandy loam. The color and texture of the underlying material and depth to calcareous material are somewhat variable.

Included with these soils are very small areas, generally less than 1 acre in size, that resemble the Tivoli loamy fine sands.

All of the soils in this complex are used as range. They are not well suited to field crops, because of their low water-holding capacity and high susceptibility to soil blowing. The low water-holding capacity and susceptibility to soil blowing also limit the effectiveness of summer fallow. If these soils are cultivated, they should be managed carefully to control soil blowing. Growing sorghum continuously and restricting grazing and tillage will provide a vegetative cover and crop residues that will adequately protect the soils. (Capability unit IVe–1 (dryland); capability unit IVe–7 (irrigated); Sands range site)

Goshen Series

The Goshen series consists of deep, dark-colored, friable, nearly level soils in swales and along intermittent drainageways in the uplands. The soils have formed in silty material washed down from higher slopes nearby. The dominant slope is less than 1 percent, but this is enough for good surface drainage. These soils are porous and permeable, absorb water readily, and have good internal drainage.

The surface layer is 8 to 20 inches of dark grayish-brown, granular silt loam. The subsoil is 8 to 14 inches of grayish-brown silty clay loam of moderate, fine, subangular blocky structure. It overlies a pale-brown, massive silt loam that is strongly calcareous, contains a few, small, soft lime concretions, and extends to a depth of 44 inches. Below a depth of 44 inches is the parent material of massive, strongly calcareous silt loam.

Goshen soils are associated with Colby, Ulysses, and Richfield soils, but their surface layer is darker and thicker than the surface layer of the associated soils. Also, they are darker colored than the Bridgeport soils and are noncalcareous to a greater depth.

These soils are well suited to the crops commonly grown in the area. Flooding is sometimes a hazard during thunderstorms.

Goshen silt loam (Go).—This is the only Goshen soil mapped in Kearny County. It is important for agriculture because of its high natural productivity. Most of it is cultivated along with other soils, and it is used mainly to grow wheat and sorghum. These crops generally benefit from the extra moisture accumulated through runoff from adjacent areas. As a result, yields are generally higher than on most of the other cultivated soils. Water erosion is negligible, but wind erosion is a hazard whenever the soil is bare of vegetation. (Capability unit IIIc–2 (dryland); capability unit I–1 (irrigated); Loamy Lowland range site)

Gravelly Broken Land

This miscellaneous land type consists of nonarable, moderately sandy, sandy, and gravelly soils that have steep and broken slopes of 15 to 40 percent. Geologic erosion has stripped away the mantle of loamy sediments and has exposed highly calcareous, sandy and gravelly material. Gravel and outcrops of caliche are on the more broken areas. Thin, noncalcareous, moderately dark colored, moderately sandy and sandy material is on the smoother areas and is at the base of the slopes.

Gravelly broken land (Gr).—This mapping unit is northeast of Hartland. It is associated with areas of Otero gravelly complex that have slopes of 5 to 15 percent, but its slopes are steeper than those of the soils in that complex and it contains more gravel. This soil supports sparse stands of native grasses, mainly sand dropseed, side-oats grama, blue grama, and little bluestem, and it is suitable only for limited grazing. Careful grazing management is necessary to keep the land productive. (Capability unit VIIs–4 (dryland); Gravelly Hills range site)

Las Series

The Las series consists of light-colored, nearly level soils that are slightly to moderately saline. These soils formed in alluvium of calcareous clay loam and are on flood plains of the Arkansas River. They are somewhat poorly drained because the water table is 3 to 6 feet below the surface most of the time.

The surface layer is 8 to 12 inches of grayish-brown, slightly firm, calcareous clay loam; it is underlain by 6 to 10 inches of slightly lighter colored clay loam. The subsoil is massive, pale-brown clay loam or sandy loam to a depth of 36 to 60 inches. It is underlain by stratified layers of loamy sand, sand, and gravel that are distinctly mottled. In places the profile contains thin layers of sand, silt, or clay that occur in various parts of the profile. These layers are mottled in places at a depth of 16 to 50 inches.

Mapped with these soils are long, narrow, irregularly shaped areas along old, winding channels or oxbows of streams. These areas are occupied by a soil that contains layers of clay or that is gravelly near the surface.

The Las soils are moderately productive under irrigation. Salt in the irrigation water limits yields, however, in some areas, especially if the soil is underlain by clay.

Las clay loam, deep (Lb).—Depth to sand or gravel ranges from 38 to 60 inches; in most places it is about 46 inches. The subsoil has yellowish-brown mottles at a depth of 20 to 50 inches.

This soil is not well suited to dryland farming, and most of it is cultivated under irrigation. Wheat, sorghum, and alfalfa are the main crops. During periods of high rainfall, yields may be reduced on areas where the root zone is shallow and the water table is near the surface. If this soil is used as range, abundant forage is obtained from grasses commonly grown in the area. (Capability unit IVw–2 (dryland); capability unit IIw–1 (irrigated); Saline Subirrigated range site)

Las clay loam, moderately deep (La).—This soil is not so deep over sand as Las clay loam, deep, and it contains more stratified sandy material. Sand is at a depth of 24 to 36 inches, or deeper than in Las Animas clay loam. The subsoil is more clayey and more coherent than that of the Las Animas soils, and it is less clayey and more permeable than that of the Bowdoin soil.

Mapped with this soil are small areas of Las clay loam, deep, and of Las Animas clay loam, Bowdoin clay loam, and Las Animas sandy loam.

Most of Las clay loam, moderately deep, is cultivated under irrigation, and sorghum and wheat are the main crops. Growing alfalfa is uncertain, because of the high water table, but yields are good if an adequate stand is maintained. Salinity is slight to moderate, but it has had little effect on the crops that are commonly grown. (Capability unit IVw–2 (dryland); capability unit IIIw–1 (irrigated); Saline Subirrigated range site)

Las-Las Animas complex (Ld).—About 35 percent of this complex, or mixture, of alluvial soils consists of Las clay loam, moderately deep; 35 percent is Las Animas sandy loam; 10 percent is Las clay loam, deep; 5 percent is Las Animas clay loam; and 5 percent is Las Animas loamy sand. An additional 10 percent consists of Bowdoin clay loam, Lincoln sand, and long, narrow gravel bars.

The soils of this complex are mainly nearly level to gently undulating and are along old, winding stream channels and along the oxbows of streams. Because of their position, these soils are not well suited to field crops. Also, in places they are too sandy or too shallow for crops. Some of the areas, however, are used to grow dry-farmed crops, and some are used to grow irrigated crops. The cultivated areas are along channels that wind across large cultivated fields. Cutting into large pockets of coarse sand or gravel is a hazard when leveling these soils. If these soils are used as range, abundant forage is obtained from grasses commonly grown in the area. (Capability unit IVw–2 (dryland); capability unit IVw–4 (irrigated); Saline Subirrigated range site)

Las Animas Series

The Las Animas series consists of light-colored soils formed in stratified, calcareous, sandy alluvium on bottom lands of the Arkansas River. The soils are somewhat poorly drained; the water table is 2 to 10 feet below the surface. Also, the soils are flooded when the river overflows. In most places they are only slightly saline, but in some small areas they are moderately to strongly saline.

The surface layer ranges from grayish-brown loamy fine sand to clay loam, and the subsoil and substratum are sandy loam or loamy sand. The soils are mottled below a depth of 15 to 40 inches. In most places coarse sand and gravel are at a depth of more than 20 inches.

Variations are common in the profile of these soils. In places the profile contains layers of sandy, silty, or clayey material. Although these layers occur in various parts of the profile, they are commonly 24 or more inches from the surface. In places a complete range of texture occurs within short distances and between points where differences in elevation are 12 inches or less.

The Las Animas soils have a coarser textured subsoil than the Las, Bowdoin, and Sweetwater soils, but their subsoil is finer textured than that of the Lincoln soils and is more coherent. The Las Animas soils are more poorly drained than the Bridgeport and Bayard soils, but they are better drained than the Sweetwater soils.

Las Animas clay loam (Lg).—This soil consists of clay loam or loam over sandy loam or loamy sand. Its profile ranges from 10 to 20 inches in thickness, but in most places it is about 15 inches thick. The surface layer and subsoil contain more clay and less sand than those of Las Animas loamy sand and Las Animas sandy loam. The soil generally occupies lower areas on the flood plains than Las clay loam, moderately deep, and Las clay loam, deep, and it is shallower over coarse sand and gravel. The sand and gravel are only 18 to 26 inches from the surface. This soil lacks the dark-colored, granular surface layer that is typical of the Sweetwater soil, and it is better drained than that soil.

Most of this soil is covered with native short and mid grasses. The soil is not well suited to cultivated crops grown under dryland farming or under irrigation, because its shallow root zone and high water table limit the kinds of crops that can be grown. Salinity is slight to moderate. In places salinity causes the yields to be somewhat lower than average for this soil, but it has little effect over large areas. When this soil is used as range, yields of native grasses are abundant. (Capability unit IVw–2 (dryland); capability unit IVw–4 (irrigated); Saline Subirrigated range site)

Las Animas loamy sand (Lh).—Most of this soil is in low areas on the flood plains. In places, however, it occupies higher areas along old stream channels that wind through areas of Las soils and other Las Animas soils.

The soil is closely associated with Lincoln sand and with Sweetwater clay loam. It is more sandy than the Las soils and Las Animas sandy loam, and its subsoil is more coherent and less sandy than that of Lincoln sand.

Variations in the profile are common. Thin strata of sand, silt, and clay occur in various parts of the profile, and in places the surface layer consists of 3 to 6 inches of dark-colored clay loam or loam. Coarse sand and gravel are at a depth of 15 to 36 inches.

Mapped with this soil are small areas of Las Animas sandy loam, Lincoln sand, and Sweetwater clay loam. These included soils make up about 12 percent of the total acreage mapped as Las Animas loamy sand.

Roots, water, and air can readily penetrate Las Animas loamy sand, but the water-holding capacity is low. Most of this soil is covered with native tall and mid grasses. The soil is well suited to these native grasses, and yields of forage are generally moderate to high. The soil is not well suited to field crops, because of droughtiness and the restricted root zone, high water table, and susceptibility to wind erosion. (Capability unit VIs–2 (dryland); Saline Subirrigated range site)

Las Animas sandy loam (Lk).—This soil occurs in areas where the relief is somewhat irregular. It is closely associated with Las Animas loamy sand, but it is less sandy than that soil. The texture of the surface layer ranges from sandy loam to loam. The subsoil is more sandy than that of the Las soils, but it is less sandy than that of the Bridgeport soil. This soil is more poorly drained than the Bridgeport or Bayard soils.

Mapped with this soil are areas of Las Animas loamy sand, Las clay loam, and Sweetwater clay loam. These areas generally have an odd shape and are too small to be mapped separately.

Most of Las Animas sandy loam is cultivated. It is not well suited to crops grown under dryland farming, and it is only moderately well suited to crops grown under irrigation. Wheat and sorghum are the main crops grown on it. Some alfalfa is grown, but the stand is difficult to maintain because of the high water table. Abundant yields of forage are obtained, both when the soil is used for irrigated pasture and when it is used as native grass range or meadow.

This soil is susceptible to soil blowing and wind erosion. It should be adequately protected by leaving crop residues on it or by keeping it under growing vegetation. (Capability unit IVw–2 (dryland); capability unit IIIw–2 (irrigated); Saline Subirrigated range site)

Lincoln Series

The Lincoln series consists of soils made up of only slightly altered, very sandy and gravelly alluvium. These soils occupy the lower flood plains of the Arkansas River and are subject to recurrent flooding. They receive fresh deposits of material each time the river overflows. The water table is at about the same height as the level of the river.

The surface layer is 3 to 6 inches of grayish-brown, calcareous, loos and structureless fine sand to loamy fine sand. The subsoil is mainly stratified loamy fine sand and sand, but it contains thin layers of loamy to clayey material.

The texture of the profile ranges from loam in the thin layers to fine sand in the thick layers. Coarse sand is at a depth ranging from 10 to 30 inches, but in most places it is at a depth of less than 24 inches. In places the thin strata of loam or clay loam contain yellowish-brown or reddish-brown mottles.

The Lincoln soils are closely associated with the Sweetwater soils and are also associated with the Las Animas soils. They are sandier and somewhat lighter colored than the Sweetwater soils. The Lincoln soils are also sandier than the Las Animas soils, and they lack the mottled colors in the subsoil.

Lincoln sand (Ln).—This is the only Lincoln soil mapped in Kearny County. It is in areas adjacent to the Arkansas River and on the floors of some drainageways in the uplands.

Mapped with this soil are small areas of Sweetwater, Las, and Las Animas soils, which together make up about 10 percent of the total acreage mapped as Lincoln sand.

Lincoln sand is not well suited to field crops and is used mainly as range. It has not been placed in a range site, however, because of the unstable soil and variable vegetation. It supports groves of cottonwoods, scattered willows, and a sparse growth of tall and mid grasses. Where the water table is highest, it also supports a dense growth of tamarisk. (Capability unit VIIw–1 (dryland); Unstable range site)

Lofton Series

The Lofton series consists of deep, noncalcareous, fine-textured soils in shallow depressions in the uplands. The depressions, locally called potholes, have no outlets; water is ponded in them for as long as a week or more before it either passes through the soil or evaporates into the air.

The surface layer is 4 to 8 inches of grayish-brown, massive silty clay loam. The subsurface layer is 3 to 10 inches of gray, firm silty clay loam. It is underlain by 8 to 16 inches of gray, firm heavy silty clay loam that has moderate, medium, subangular blocky structure. Below a depth of 30 inches is somewhat lighter colored material that ranges from silt loam to clay loam in texture.

The characteristics of these soils vary greatly from one depression to another. The principal variations are in the texture of the surface layer and the subsoil and in depth to calcareous material. The texture of the surface layer and of the subsoil ranges from heavy silt loam to light clay. Depth to calcareous material ranges from 18 to more than 60 inches.

The Lofton soils occur in association with the Richfield soils, which occur in broad, nearly level areas, where the pattern of surface drainage is not well defined; and with the Goshen soils, which are in swales that do not have a definite channel. Their surface layer and subsoil are darker colored and more clayey than those of the Richfield, Goshen, and Ulysses soils, and they are darker colored, but less clayey, than those of the Church soils.

Lofton silty clay loam (Lo).—This is the only Lofton soil mapped in Kearny County. Most of it is cultivated with the surrounding areas. Planting or harvesting is sometimes delayed because the soil is covered by water, and crops are frequently drowned out. Wind erosion is a hazard whenever the soil is not adequately protected by a cover of plants or by plant residues. (Capability unit IVw–1 (dryland); Clay Upland range site)

Mansic Series

The Mansic series consists of moderately dark colored soils formed in highly calcareous outwash sediments of the High Plains. The soils are in slightly concave or nearly level areas in the northwestern part of the county.

The combined surface and subsurface layers consist of 8 to 24 inches of weakly calcareous, grayish-brown to dark grayish-brown clay loam that is massive or has granular structure. Below this is a slightly lighter colored transitional layer, which overlies white, massive clay loam. The clay loam is slightly hard and is strongly calcareous, for 20 to 40 percent of its volume is calcium carbonate. In places this layer contains small, hard concretions.

Variations in the profile are common. The texture of the surface layer ranges from heavy loam to clay loam. The strongly calcareous layer is at a depth between 12 and 26 inches. The material below this calcareous layer is 40 to 60 inches from the surface and generally contains an appreciable amount of coarse sand.

The Mansic soils differ from the Mansker soils in that the layer in which calcium carbonate has accumulated is less clearly defined. They differ from the Colby and Ulysses soils by having a surface layer of clay loam and a more clearly evident layer in which calcium carbonate has accumulated. The Mansic soils are less strongly developed than the Richfield soils.

Mansic clay loam, 0 to 1 percent slopes (Ma).—Most of this soil is cultivated, and wheat and sorghum are the main crops. There is little runoff because the soil is nearly level and most of the rainfall soaks in. Erosion by water is not a serious hazard, but the hazard of wind erosion is serious when the soil is not adequately protected by a cover of plants or plant residues. (Capability unit IIIc-1 (dryland); capability unit I-1 (irrigated); Loamy Upland range site)

Mansker Series

The Mansker series consists of grayish-brown, calcareous soils that are moderately deep over medium-textured to fine-textured, strongly calcareous sediments. These soils occupy gently sloping areas in the northwestern part of the county.

The surface layer is 6 to 12 inches of grayish-brown, massive, strongly calcareous loam. The subsoil is light grayish-brown, friable loam that has weak, granular structure. It is underlain at a depth between 10 and 20 inches by a well-defined layer of massive clay loam in which calcium carbonate has accumulated. From 30 to 60 percent of this layer of clay loam consists of calcium carbonate, and 10 to 40 percent is soft, partly cemented concretions. Below that layer is white, massive, strongly calcareous clay loam or silt loam that in some places contains partly weathered, hard caliche. In many places small rocks and fragments of hard caliche are scattered over the surface.

The Mansker soils are near the Mansic soils. The layer in which calcium carbonate has accumulated is more clearly defined in the Mansker than in the Mansic soils. The profile of the Mansker soils is thicker and more strongly developed than that of the Potter soils.

Mansker loam, 0 to 3 percent slopes (Mb).—This is the only Mansker soil mapped in Kearny County. The soil is not well suited to field crops, but much of it is used to grow wheat and sorghum. These crops are grown under a system where crops and fallow are alternated. Erosion by wind and water is a serious hazard. Wind erosion occurs when the soil is not protected by a cover of plants or of plant residues. On the more sloping areas runoff is rapid, and the soil tends to seal over during rainstorms. (Capability unit IVe-2 (dryland); Limy Upland range site)

Manter Series

The Manter series consists of deep, moderately dark colored, well-drained soils of uplands. The soils are moderately sandy, noncalcareous, and nearly level to moderately sloping. They formed in calcareous, moderately sandy outwash sediments of the High Plains. The sediments have been reworked to some extent. The soils are porous and permeable, and their water-holding capacity is moderate.

In most places the surface layer is 5 to 10 inches of dark grayish-brown to dark-brown, friable sandy loam. In many areas in cultivated fields, however, the surface layer consists of 2 to 4 inches of loamy fine sand because the soil material has been winnowed by wind. The subsoil consists of 17 to 30 inches of brown, friable fine sandy loam. It is underlain by a transitional layer of pale-brown sandy loam to loam that is strongly calcareous and contains films and small, soft lime concretions. The underlying parent material is calcareous, massive loam or sandy loam.

In places these soils are silty below a depth of 18 inches or more. Depth to calcareous material ranges from 10 to 30 inches, but in most places it is about 18 inches.

The Manter soils have more sand throughout the profile than the associated Ulysses soils. They are darker and less sandy than the associated Vona loamy fine sand.

Manter fine sandy loam, 0 to 1 percent slopes (Mf).—The surface layer of this soil is somewhat more loamy near areas of Ulysses silt loam than in other areas.

Mapped with this soil are areas in which the surface layer is sandy loam to loam and the soil has some characteristics of the Ulysses soils as well as of the Manter soils.

A large part of the acreage of Manter fine sandy loam, 0 to 1 percent slopes, is cultivated. Sorghum is the main crop, but some wheat is grown. The moderate water-holding capacity and susceptibility to wind erosion make this soil difficult to use and manage. Soil blowing is a serious hazard, especially when the soil is fallowed without adequate protective cover, but water erosion is negligible because the soil is nearly level. Keeping crop residues on the surface helps to control soil blowing. (Capability unit IIIe-3 (dryland); capability unit IIs-1 (irrigated); Sandy range site)

Manter fine sandy loam, 1 to 3 percent slopes (Mh).—This is the most extensive Manter soil mapped in the county. Much of it is cultivated. If it is fallowed without adequate protective cover, soil blowing is a serious hazard and erosion by water is a hazard. Keeping a cover of crop residues on the surface helps to conserve moisture and to control erosion by wind and water. (Capability unit IIIe-2 (dryland); capability unit IIe-2 (irrigated); Sandy range site)

Manter fine sandy loam, 3 to 5 percent slopes (Mk).—Most of this soil is on sandy knolls and ridges adjacent to large drainageways. Its profile is similar to that of Manter fine sandy loam, 1 to 3 percent slopes, but the sand grains are coarser and in most places the underlying material is less silty.

Many small areas of this soil are cultivated with the surrounding soils. Sorghum and wheat are the main crops. The hazard of erosion is serious, however, and a large part of the acreage is no longer used for field crops, because it is slightly or moderately eroded. The soil is better suited to native grasses than to field crops. Erosion has been only slight on areas used for pasture. (Capability unit IVe-4 (dryland) ; Sandy range site)

Otero Series

The Otero series consists of deep, light-colored, calcareous sandy loams that have formed in strongly calcareous, moderately sandy material that has been reworked by wind to some extent. Most of the Otero soils have steep slopes. They are mainly along drainageways in the uplands.

The surface layer is 4 to 10 inches of grayish-brown, calcareous, friable sandy loam that has weak, granular structure. The subsoil consists of about 10 inches of grayish-brown to pale-brown, strongly calcareous sandy loam. It is underlain by the parent material consisting of sandy and loamy outwash. A mixture of sand and gravel that is partly coated with lime is 36 inches or more below the surface. These soils are friable throughout.

Otero gravelly complex (Ox).—This complex, or mixture of soils, consists of Otero sandy loams, Manter sandy loams, and of gravelly sandy loams or gravelly sands that are nonarable and are shallow or moderately deep over sand, gravel, or cobblestones. The sand, gravel, and cobblestones are white and are partly coated with lime.

Otero soils make up about 25 percent of the acreage in this mapping unit. In the Otero soils, gravel is 20 to 60 inches below the surface. The Manter sandy loams, which also occupy about 25 percent of the acreage, are moderately dark colored, noncalcareous, and moderately deep. The other soils in this complex are variable. Gravel and caliche outcrop in some places. This complex, for the most part, occurs along drainageways in the uplands on the north side of the Arkansas River Valley. The slopes range from 5 to 15 percent. Areas of similar soils in other parts of the county contain less gravel than these soils.

These soils are not suitable for field crops, but a large acreage is in native grass (fig. 5). The hazard of erosion is serious if the soils are cultivated. Areas under cultivation should be reseeded to the grasses commonly grown in the area. (Capability unit VIe-6 (dryland) ; Gravelly Hills range site)

Figure 5.—**A large area of Otero gravelly complex in native grass. Ulysses silt loam is in the background.**

Potter Series

The Potter series consists of light-colored, strongly calcareous soils that are shallow over slightly hard caliche. The caliche is less than 12 inches below the surface. These soils have steep slopes. They are in broken areas along intermittent streams, well below the level of the High Plains. In these areas geologic erosion has stripped away the mantle of silty and loamy sediments and has exposed the caliche, limestone, and shale. There are outcrops of caliche, limestone, and shale on the steeper slopes.

The surface layer is 4 to 6 inches of light grayish-brown to grayish-brown, friable loam. It is underlain by 3 to 6 inches of white, mixed soil material and soft caliche. Below this is hard, white caliche.

Variations in the profile are common. In some places the caliche is near the surface, and in others it is at a depth of as much as 12 inches. In most places it is at a depth of about 9 inches. The texture of the surface layer ranges from sandy loam to loam.

Mapped with this soil are small areas, bare of vegetation, that contain outcrops of caliche and are underlain by limestone and shale.

The Potter soils are more sloping, somewhat less dark, and shallower than the Mansker soils. They are in more broken areas than the associated Colby soils, and they are less sandy and gravelly than Gravelly broken land.

Potter soils (Po).—The Potter soils in this county are mapped as one unit. They are shallow soils and have steep slopes. These soils are suitable only for grazing. They support a sparse stand of native grasses (fig. 6), mainly side-oats grama, and little bluestem. Careful grazing management is necessary to keep the soils productive. (Capability unit VIIs-1 (dryland) ; Rough Breaks range site)

Figure 6.—**Sparse stand of native grass on Potter soils.**

Richfield Series

The Richfield series consists of dark-colored soils that are deep and well drained. The soils formed in deep loess on the broad, nearly level tableland north and south of the Arkansas River Valley.

The surface layer of these soils is 4 to 6 inches of dark grayish-brown, noncalcareous, friable silt loam that has weak, granular structure. The subsoil is 6 to 14 inches of dark grayish-brown to dark-brown, slightly firm silty clay loam. It has moderate, medium, prismatic structure that breaks to moderate, medium, subangular blocky structure. At a depth below 13 to 22 inches or more, the material in the subsoil grades to pale-brown, slightly firm, strongly calcareous silty clay loam that contains many small, soft lime concretions. The underlying parent material is loess consisting of calcareous silt loam.

Variations in the profile are few. Depth to calcareous material ranges from 10 to 22 inches, but in most places it is about 14 inches. In places a darkened layer that is the surface layer of an old, buried soil is at a depth of 24 to 48 inches or more below the surface.

The Richfield soils are closely associated with the Ulysses soils, but their subsoil is more strongly developed and more clayey, and they are noncalcareous to a greater depth. Their surface layer is darker colored than that of the Colby soils, and their subsoil is darker colored and more clayey. The Richfield soils are more clayey and less sandy than the Manter soils, and they are less deep and less dark than the Goshen soils.

Richfield silt loam, 0 to 1 percent slopes (Rm).—This is the most extensive soil in the county. It is among the most important for agriculture.

Mapped with this soil are small areas of Ulysses silt loam, which generally cover less than 5 acres, and small areas in which the soil material is calcareous. The included areas make up about 5 percent of the total acreage.

Richfield silt loam, 0 to 1 percent slopes, is well suited to field crops, and much of it is cultivated. Dryland wheat and sorghum generally make satisfactory yields if they are grown in fields that are fallowed (fig. 7). Alfalfa, sugarbeets, vegetables, wheat, corn, and sorghum are grown in areas under irrigation. The hazard of wind erosion is serious when this soil is dry and clods have not been left on the surface, or if the soil is not protected by a cover of plants or plant residues. (Capability unit IIIc-1 (dryland); capability unit I-1 (irrigated); Loamy Upland range site)

Figure 7.—**Harvesting wheat on a field of Richfield silt loam, 0 to 1 percent slopes.**

Richfield-Mansic complex, 1 to 3 percent slopes (Rx).—About 40 percent of this complex, or mixture of soils, is Richfield silt loam, 20 percent is Mansic clay loam, and 30 percent is a soil similar to the Richfield soil. The rest of the complex consists of Ulysses, Colby, and Manter soils. These gently sloping soils occupy areas near the center of the county and are closely associated with Ulysses soils and with the Richfield soil that is mapped separately.

The Richfield soil has a surface layer of silt loam, and it formed in loess or in similar silty sediments. The Mansic soil has a surface layer of clay loam. The Mansic soil is shallow over highly calcareous outwash material of the High Plains. The Mansic soil and the soil similar to the Richfield soil formed in areas where geologic erosion has stripped away the mantle of loess and exposed the outwash sediments.

In the soil that resembles the Richfield soil, the surface layer is 3 to 6 inches of dark grayish-brown clay loam. The subsoil is 5 to 14 inches of brown, slightly firm clay loam that has moderate, medium, subangular blocky structure. At a depth of 10 to 18 inches or more, the material in the subsoil grades to brown, or pale-brown, slightly firm, strongly calcareous clay loam. This calcareous clay loam contains many splotches and small, soft lime concretions. The underlying material is strongly calcareous, stratified sandy to clayey outwash material.

Variations in the profile are common. The texture of the surface layer ranges from loam to clay loam. Calcareous material is at a depth of 6 to 18 inches or more below the surface. In places where this soil grades to the true Richfield soil, a thin cap of loess overlies the outwash material.

Erosion by wind and water and the lack of adequate moisture are problems when the soils of this complex are cultivated. A large acreage, however, is used to grow wheat and sorghum. These crops generally make satisfactory yields if they are grown in fields that are fallowed in summer. (Capability unit IIIe-1 (dryland); capability unit IIe-4 (irrigated); Loamy Upland range site).

Sweetwater Series

The Sweetwater series consists of dark-colored soils that are wet and poorly drained. The soils formed in calcareous, sandy and clayey alluvium on the flood plains of the Arkansas River. They occupy low areas where the water table is 16 to 36 inches below the surface.

The surface layer of these soils is 4 to 10 inches of grayish-brown, firm clay loam. It is underlain by friable, dark-colored material that is high in organic matter and has strong, granular structure. In places this material is part of the surface layer. Below this is 8 to 14 inches of gray, friable clay loam of strong, medium, granular structure. The substratum is at a depth of 12 to 24 inches. The upper part of the substratum is grayish-brown, friable clay loam with prominent mottles of yellowish brown and reddish brown. The lower part is a thin layer of sandy loam or loamy sand over pale-brown, stratified sand and gravel, which is at a depth of 30 to 36 inches or more.

Variations in the profile are common. Below the layer of organic accumulation, the alluvium is extremely variable. In places the profile contains thin layers of sand or clay; these layers may occur in any part of the profile.

The Sweetwater soils are associated with Lincoln sand and with the Las Animas and Las soils. They are darker colored, wetter, and less sandy than Lincoln sand and the Las Animas soils, and they are darker colored and more poorly drained than the Las soils.

Sweetwater clay loam (Sw).—This is the only Sweetwater soil mapped in Kearny County. It is nearly level and is along the Arkansas River. A large part of the acreage is in native tall and mid grasses and is used as range or meadow. Abundant yields of forage are obtained if grazing is properly managed. Slight to moderate salinity and a restricted root zone limit the suitability of this soil for field crops. (Capability unit Vw-1 (dryland); Saline Subirrigated range site)

Tivoli Series

The Tivoli series consists of loose, light-colored, noncalcareous soils that are nonarable. These soils have formed in deep, windblown sand on hummocky, strongly undulating to choppy areas in the sandhills south of the Arkansas River Valley.

The Tivoli soils have a slightly darkened, weak A_1 horizon, or surface layer, that overlies lighter colored fine sand. In most places the surface layer is 2 to 8 inches of grayish-brown loamy fine sand or fine sand. In places where finer textured sediments have been recently deposited, however, it is loam to sandy loam to a depth of 1 to 3 inches. A transitional layer that consists of 3 to 10 inches of pale-brown, single-grain loamy fine sand or fine sand lies between the surface layer and the parent material of fine sand.

These soils absorb water readily, and there is little or no runoff. Their water-holding capacity is low, and the hazard of wind erosion is serious in areas that are not protected by perennial vegetation.

Tivoli fine sand (Tf).—This is the most extensive sandy soil in the sandhills. Mapped with it are small areas of Tivoli-Vona loamy fine sands and of Active dunes.

The surface layer of Tivoli fine sand is thin, grayish-brown fine sand over pale-brown fine sand. Light yellowish-brown to very pale brown fine sand is at a depth of 6 to 8 inches.

This soil is closely associated with Tivoli-Vona loamy fine sands, but it is in areas that are more choppy, and its surface layer contains less loam and is less coherent.

This soil is not suitable for cultivation. Nearly all of it is under native grasses and sand sagebrush. Limiting grazing, stabilizing the blowouts, and reseeding native grasses are important practices that will help to protect and to improve the cover of grass. If this soil is not adequately protected by a cover of plants, the hazard of wind erosion is serious. (Capability unit VIIe-1 (dryland); Choppy Sands range site)

Tivoli-Dune land complex (Tx).—This complex, or mixture of soils, consists of Tivoli fine sand and areas of active dunes. The soils are in areas that are more dunelike than the areas occupied by Tivoli fine sand. Between 20 and 80 percent of the acreage is made up of loose sand, blowouts, and dunes.

The soils in this complex are particularly susceptible to wind erosion. They are suitable only for range and need careful management that will control soil blowing. Because these actively blowing areas are a menace to adjacent land, they should be seeded to native grasses and fenced off from livestock. (Capability unit VIIe-1 (dryland); Choppy Sands range site)

Tivoli-Vona loamy fine sands (Tv).—About 60 percent of this complex, or mixture of soils, is Tivoli loamy fine sand, and 35 percent is Vona loamy fine sand. The rest of the complex consists of areas of Tivoli fine sand that are too small to be mapped separately. In most places the slope is between 3 and 15 percent, but in some places it is only 2 percent. The soils occupy slightly undulating and hummocky, dunelike areas, and they are closely associated with Tivoli fine sand.

The surface layer of Tivoli loamy fine sand is 3 to 8 inches of grayish-brown to brown loamy fine sand. A transitional layer of pale-brown loamy fine sand that is 6 to 12 inches thick lies between the surface layer and the parent material of noncalcareous, windblown fine sand.

The soils in this complex are not well suited to field crops, because they are susceptible to soil blowing. Most of the acreage is used as range. Areas that have been cultivated should be reseeded to native grasses. Also, isolated blowouts should be reseeded and fenced off from livestock. Satisfactory yields of forage are obtained if grazing is properly managed. (Capability unit VIe-2 (dryland); Sands range site)

Ulysses Series

The Ulysses series consists of moderately dark colored, deep, well-drained soils of the uplands. The soils are nearly level to moderately sloping. They have formed in loess or in similar silty sediments.

The surface layer is 4 to 8 inches of dark grayish-brown, friable silt loam. The uppermost 3 to 8 inches of the subsoil is light silty clay loam that is slightly darker colored and slightly finer textured than the surface layer. It has a weak, medium, prismatic structure that breaks to moderate, medium, granular or, in places, to weak, fine, subangular blocky. At a depth between 8 and 16 inches, the subsoil is strongly calcareous, pale-brown silty clay loam that contains small, soft, white lime concretions. Below a depth of 20 inches is the parent material of very pale brown, massive silt loam.

Variations in the profile of these soils are common. In areas under native vegetation, depth to calcareous material is as much as 15 inches in places, but in some areas that have been cultivated, the soil is calcareous throughout. In places the profile contains a weak, textural B horizon. Also, remnants of a buried soil occur in places at various depths.

The Ulysses soils are associated with the Colby and Richfield soils and are somewhat similar to those soils. The surface layer of the Ulysses soils is darker and thicker, however, than that of the Colby soils, and the subsoil is less clayey and more friable than that of the Richfield soils. The Ulysses soils are less sandy than the associated Manter soils. Both the surface layer and subsoil are less clayey than those of the Mansic soil, and the

C_{ca} horizon, or layer of accumulated lime, is less prominent.

Ulysses soils are moderately permeable, and their water-holding capacity is high. They are susceptible to erosion by both wind and water, but erosion has been slight on most areas that have been cultivated.

Ulysses silt loam, 0 to 1 percent slopes (Ua).—This is the most extensive Ulysses soil mapped in the county. It is in areas that border the sloping High Plains.

Most of this soil is cultivated. Wheat and sorghum generally make satisfactory yields if they are planted on summer-fallowed fields. Wind erosion is a hazard whenever the soil is dry and clods have not been left on the surface. It is also a hazard where the soil is not protected by a cover of plants or plant residues. (Capability unit IIIc–1 (dryland); capability unit I–1 (irrigated); Loamy Upland range site)

Ulysses silt loam, 1 to 3 percent slopes (Ub).—This soil is similar to Ulysses silt loam, 0 to 1 percent slopes, but it is slightly undulating to gently sloping. The depth to calcareous material is slightly less, and, in most areas that have been cultivated, the surface layer is calcareous. In many places the surface layer consists of 2 to 4 inches of loam because the soil material has been winnowed by wind. The finer soil particles have been sifted out and blown away, and the coarser, sandier particles are left.

Mapped with this soil are small areas of a Richfield silt loam, a Mansic clay loam, and a Manter fine sandy loam. This mapping unit also includes small areas of soils that are eroded. In addition, a soil that has a surface layer of brownish clay loam occurs on knolls and ridges in a few places. All of these small areas make up less than 10 percent of the total acreage.

Much of Ulysses silt loam, 1 to 3 percent slopes, is used to grow wheat and sorghum. When the soil is cultivated, however, it needs careful management because it is susceptible to erosion by both wind and water. Conservation of moisture is also a problem. (Capability unit IIIe–1 (dryland); capability unit IIe–4 (irrigated); Loamy Upland range site)

Ulysses silt loam, 3 to 5 percent slopes (Uc).—Except for stronger slopes and, in most places, a thinner surface layer, this soil is similar to Ulysses silt loam, 1 to 3 percent slopes. It is associated with that soil and occupies areas along large drainageways.

The soil is used mainly as range. It is not well suited to field crops, although some of it is under cultivation. Because of its strong slope, water erosion is a serious hazard. Wind erosion and soil blowing are also hazards whenever this soil is not adequately protected by growing vegetation. (Capability unit IVe–2 (dryland); Loamy Upland range site)

Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded (Ue).—This complex, or mixture of soils, consists of Ulysses and Colby silt loams. The entire acreage is cultivated or has been cultivated, and much of it is actively eroding. Erosion has caused the surface layer of the Ulysses soil to be lighter colored than the original one, and this surface layer is less than 6 inches thick. Eroded areas that occupy about 40 percent of this complex cannot be distinguished from the Colby silt loams.

The soils of this complex are not well suited to field crops. They tend to seal over during rainstorms. As a result, runoff is rapid and erosion is excessive. Also wind erosion and soil blowing are serious hazards whenever the soils are not adequately protected by growing vegetation or by crop residues. (Capability unit IVe–2 (dryland); capability unit IIe–4 (irrigated); Limy Upland range site)

Ulysses-Colby silt loams, 3 to 5 percent slopes, eroded (Um).—These soils are similar to Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded, except for having stronger slopes. They occur mainly along drainageways in the uplands. In some places their slope is as much as 6 percent, but in most places it is about 4 percent.

Except in small areas near the edges of drainageways, these soils are cultivated or have been cultivated and are now eroded. Areas that have not been cultivated are not eroded. The areas of uneroded soils are too small to be mapped separately.

Ulysses-Colby silt loams, 3 to 5 percent slopes, eroded, is not suitable for field crops. The soils seal over during rainstorms. As a result, runoff is rapid and erosion is excessive. Crops are damaged if the rainstorms come before the plants have put down strong roots. These soils are also susceptible to wind erosion. (Capability unit VIe–1 (dryland); Limy Upland range site)

Ulysses and Richfield soils, silted, 0 to 1 percent slopes (Ux).—This undifferentiated unit consists mainly of Ulysses and Richfield soils, but it includes small areas of Manter and Goshen soils. The soils are covered by 5 to 13 inches of grayish-brown, massive, compacted silty clay loam or light silty clay that is calcareous. This silty material consists of sediments from the muddy waters of the Arkansas River that have been used to irrigate the areas for more than 50 years. The soils occur on a broad flat near Deerfield, below the Amazon irrigation canal and north of the Arkansas River Valley.

About 60 percent of the acreage consists of Ulysses soils, and 35 percent, of Richfield soils. The rest consists of Manter and Goshen soils, but the proportions of the different soils vary from place to place.

Mapped with this unit are areas that have had little or no deposition, but that are too small to be mapped separately.

Variations in the profiles of Ulysses and Richfield soils, silted, 0 to 1 percent slopes, are common because the fields have been leveled and the upper and lower ends of the irrigation runs have been silted. The texture of the surface layer ranges from light silty clay loam to light silty clay. The amount of clay and of the heavy, silty deposit vary from one end of a field to the other. The structure of the silty surface layer is generally complex. This layer is granular, platy, subangular blocky to blocky, or it is a dense, compacted mass that breaks into blocks that have slick sides and sharp edges.

In most places the Ulysses soils are calcareous throughout the profile, but the Richfield soils have only a weakly calcareous A horizon and a noncalcareous B horizon. Below the silty surface layer, the profile is similar to the one described for the Ulysses or Richfield series.

All of the acreage in this undifferentiated unit is used to grow cultivated crops under irrigation. Wheat, alfalfa, sorghum, and sugar beets are the main crops. Wind erosion is a hazard whenever the soils are dry and clods have not been left on the surface, or if the soils are not protected by a cover of plants or plant residues. Also, because of

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the slow permeability, the movement of water and air is restricted. Careful management is necessary to maintain the structure of the soils and to improve their permeability. (Capability unit IIIc-1 (dryland); capability unit IIs-2 (irrigated); Clay Upland range site)

Vona Series

The Vona series consists of gently undulating to gently sloping, light-colored soils that are deep and well drained. The soils formed in deposits of moderately sandy outwash that has been partly reworked by wind. They are in a narrow, transitional belt between the sandhills to the north, occupied by the Tivoli soils, and the High Plains tableland to the south, which is occupied by Richfield and Ulysses soils. The slope ranges from 0 to 5 percent.

The surface layer of these soils is 6 to 20 inches of grayish-brown, structureless, only slightly coherent, very friable loamy fine sand. The subsoil is at a depth between 15 and 44 inches, and it is commonly a brown, very friable, noncalcareous fine sandy loam. Below the subsoil is pale-brown, structureless, calcareous loamy fine sand. Depth to the calcareous material ranges from 15 to 46 inches.

The Vona soils are more sandy throughout the profile than the Manter soils with which they are associated. Their subsoil is less sandy than that of the Tivoli soils, and they generally occur in less hummocky areas.

Vona loamy fine sand (Vo).—This soil is not well suited to cultivated crops, because it has low water-holding capacity and is susceptible to blowing. Nevertheless, much of it is cultivated. Sorghum, the main crop, is grown year after year, but the soil is not well suited to wheat. The low water-holding capacity and susceptibility to soil blowing limit the effectiveness of summer fallow. When the soil is cultivated, it should be managed carefully to control soil blowing. (Capability unit IVe-1 (dryland); capability unit IVe-7 (irrigated); Sands range site)

Effects of Erosion

Erosion is a process in which soil and geologic materials are moved by natural agencies, mainly wind, running water, and gravity. This discussion deals with accelerated soil erosion in Kearny County. Accelerated erosion is more rapid than the gradual, normal process of soil removal known as geologic erosion. Geologic erosion takes place under natural conditions in an undisturbed environment, but accelerated erosion is brought about by changes in the natural cover or condition of the soil caused by the activities of man (fig. 8).

Wind and water are the principal active forces that cause soil erosion in Kearny County. Wind erosion is always a hazard and is serious during recurring periods of drought. The limited growth of plants and the high velocity of the wind, which are characteristic during periods of drought on the High Plains, are conducive to widespread soil blowing.

Erosion by water is a hazard on all sloping soils that are cultivated. The rate of erosion is affected by the gradient of the slope, by the texture of the soils, by the use of the land, and by the intensity of the rainfall. Runoff occurs 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 removes thin layers of soil material more or less evenly from the entire surface and causes sheet erosion. If the soils are cultivated, the evidence of sheet erosion may be obliterated and little evidence of destructive erosion may be apparent until the material in the subsoil or other underlying material is exposed.

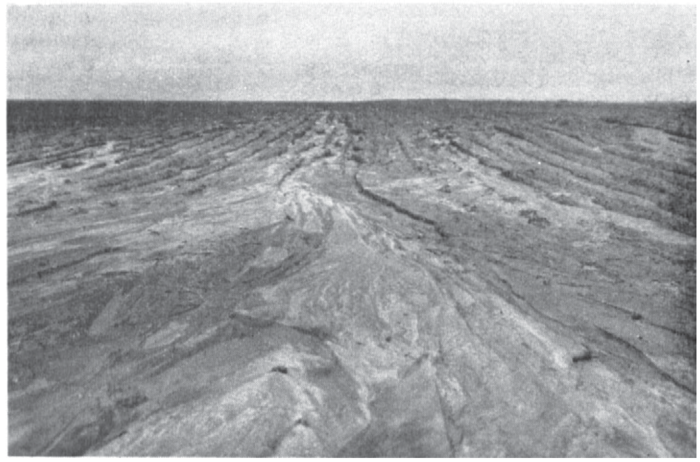

Figure 8.—An unprotected field of winter wheat where erosion has been caused by the water from snowmelt. The field was planted up and down the slope, and the soils were not protected by terraces or other devices.

Practices that slow down or decrease runoff will conserve valuable moisture and help control water erosion. These include stubble mulching, keeping tillage to a minimum, terracing, contouring, stripcropping, seeding the severely eroded and nonarable areas to suitable native grasses, and managing the range so that the areas will not be overgrazed. In most places several of these practices are necessary to protect the soils.

Some effects of erosion are permanent; the soil is damaged to the extent that it requires a change in its use and management. Other effects of erosion are transitory, but they may impair the use of the land until restorative measures are taken.

During the course of fieldwork on this soil survey, the soils in about 20 thousand acres where erosion is moderate to severe were mapped as eroded soils. The following are some of the conditions observed as having resulted from wind erosion:

1. Slight erosion has occurred on a large acreage of nearly level to level soils of the tableland. On these soils wind erosion is a hazard when the soils are dry and clods are not left on the surface, or if the soils are not protected by a cover of plants or plant residues. When active soil blowing is in progress, small, low hummocks and drifts of soil material form along fence rows, along the edges of cultivated fields in stubble fields, and in areas of native range adjacent to cultivated fields. The drifts may damage or even destroy the native vegetation on the range so that grasses have to be reestablished by reseeding or by deferred grazing. The hummocks and drifts continue to be a menace and will blow again unless they are smoothed out and unless the soils are tilled to provide a

roughened surface that will resist erosion. Full use of an area may be restored and no permanent soil damage sustained if the surface is roughened, as needed, by additional tillage.

2. Within the undulating tableland of the High Plains, the tops of ridges and knolls are more vulnerable to the action of wind than the adjacent areas of nearly level soils. The soils on these exposed areas tend to blow more often than those in areas that are protected; consequently, much of the soil material has been removed and deposited nearby on smoother areas. Some of the finer textured soil particles that were removed have been transported long distances by the wind. Much of the silt and sand deposited on the adjacent areas is calcareous. Calcareous silty and sandy soils blow readily; thus, wind erosion may occur after this material has been deposited on a field that would otherwise be stable.

   During seasons when they are not protected by a cover of plants or plant residues, these undulating soils are also susceptible to erosion by water. The sloping, calcareous silty soils are especially susceptible to erosion because they tend to seal over during rainstorms. Unless such soils are protected by vegetation or by other means, runoff will cause serious erosion. The degree of slope and the type and amount of plant cover are highly important in helping to control erosion. Bare, overgrazed, or cleanly cultivated areas are more easily eroded than areas that are adequately protected by vegetation.

3. During droughts, some of the very sandy, nonarable soils in range may be grazed to the extent that the protective vegetation is lost and severe wind erosion occurs. The soils are permanently damaged, and their value for grazing is greatly reduced. The drifting sand from these eroded areas damages cultivated crops and grass on adjacent areas and increases the hazard of wind erosion on soils where the sandy sediments are deposited.

4. The soil material that is removed by water erosion is carried by streams, which deposit it on low-lying areas, on nearly level alluvial fans, or on the flood plains of the Arkansas River. The coarse-textured sediments are deposited on the flood plains along the lower reaches of the river. Lincoln sand consists of this recently deposited material.

In Kearny County eroded soils are mapped as separate soil units only if erosion has modified some important characteristic or quality of the soil that is significant to its use and management. Many of the soils have been eroded to some extent and are subject to further erosion; the hazard of erosion on all the soils is described in the sections "Management by Capability Units (Dryland)" and "Management by Capability Units (Irrigated)." An eroded soil is designated as an eroded phase of a soil type if the eroded soil still retains many characteristics of the soil type. For example, in 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 have lost their original identity through severe erosion are designated as land types. For example, the land type, Active dunes, was probably Tivoli fine sand at one time. This land type consists of shifting fine sand on hills and ridges and in cone-shaped dunes, and it lacks a definable soil profile. Active dunes occupies a fairly large acreage, and 80 percent or more of the acreage is bare of vegetation. In this report, areas less than 20 acres in size are shown by a blowout symbol on the soil map; each symbol represents an area of 10 acres or less.

The seriousness of erosion lies not only in the permanent damage to the soils, but also in the cost of repairing the damage caused by erosion. Replanting crops, reseeding rangeland, smoothing the soils, and using emergency tillage may remove most of the temporary effects of erosion and restore the full use of the soils, but these operations are time consuming and costly.

Loamy fine sands and fine sands show the most drastic effects of erosion. In areas of these soils that have been cultivated, dunes as high as 8 feet are common along fence rows. Farmers often have to replant as many as two to four times because shifting sand destroys their crops. At times, farm buildings are nearly surrounded by dunes of loose sand. One severe windstorm may cause the county roads to be closed.

Practices needed to control erosion on a given site are discussed under the capability units in the sections "Management by Capability Units (Dryland)" and "Management by Capability Units (Irrigated)." For more specific and detailed information about the control of erosion, consult a technician of the Soil Conservation Service.

Use and Management of the Soils

This section has several main parts. In the first, principles of dryland management are discussed. In the second, the nationwide system of capability classification is explained and the capability units for dryland farming are described. The third part gives the estimated yields of the principal crops grown in the county under dryland farming. In the next part, the principles of irrigation management are discussed and the capability units for irrigation farming are described. After that, range management, wildlife management, and management of woodland are discussed, and facts are given about soil engineering.

Management of Dryland Soils

Originally the soils of Kearny County were covered by grass. The roots of the grass penetrated the soils and gave them a desirable, granular structure. They also helped to hold the soil material in place and protected the surface from wind and from beating rain. Rainfall was absorbed rapidly, and wind had little chance to disturb the soils. Erosion was a natural, gradual process. Soil formed rapidly enough to balance the amount of soil removed by erosion. Each kind of soil maintained its identity, and the natural fertility of the soils was the principal source of plant nutrients for growing crops.

During the last 50 years, more and more of the grassland has been cultivated and used to grow cereal crops. Under cultivation the soils have lost much of their supply of organic matter and their structure has deteriorated. Because they were left bare and unprotected, accelerated erosion removed much, or all, of the surface layer in many places. When the soils were bare, water that was needed by crops was lost in runoff.

Improved management practices are needed to restore a good supply of organic matter to the soils, to maintain fertility and good tilth, and to reduce the hazard of erosion. If the soils are to be managed properly, each soil should be used for the crop or purpose to which it is agriculturally and economically suited.

Using and managing the soils efficiently will result in a good income over a period of years without lessening the productivity of the soils. To conserve the soils that are used for crops, it is necessary to protect them with a cover of plants at all times. This keeps the soils receptive to moisture. Restoring the native grasses is not necessary. A suitable cropping system, minimum tillage, and proper management of crop residues keep a cover on the surface, increase the permeability, and improve the structure and tilth of the soils. Contouring, terracing, and stripcropping protect the soils, help to conserve moisture, and minimize the risk of erosion. Good management may consist of one or a combination of these practices. Each practice is discussed in the following pages.

Cropping system.—A cropping system consists of growing crops in a given sequence on a given area of soils over a period of time. It may consist of a regular rotation of different crops grown in a definite order, or of the same crop, grown year after year. Still another kind of cropping system, commonly called a flexible cropping system, consists of growing different crops, but the crops are not grown in a definite and planned order.

Besides choosing a suitable cropping system, good management consists of keeping crop residues on the surface at all times or of plowing them into the surface layer, using minimum tillage, tilling on the contour, stripcropping, and terracing where feasible. These practices are needed to minimize the risk of erosion by wind and water and to maintain or increase the productivity of the soils.

If the soils have been used for continuous cropping, they will be too low in available moisture during many seasons for yields to be worth while. They will then need to be fallowed, or left idle, after harvest so that a supply of moisture can accumulate before another crop is planted. During this fallow period, known as summer fallow, the growth of plants and erosion by wind and water need to be controlled. To be practical, summer fallowing should increase yields materially, because there is no return during the time the land is in fallow. A good plan is to combine summer fallow with stubble-mulch tillage. This can be done by using undercutting equipment that destroys the weeds and only slightly disturbs the protective cover of stubble.

The flexible cropping system shown in table 2 can be used as a guide to obtain more stable production. June 1, July 15, and September 1 have been selected as the approximate dates for measuring depth of moist soil to determine whether or not the cover on the field is adequate.

If the depth of moist soil is less than 24 inches at planting time, crops are planted primarily to provide a protective cover that will help to conserve moisture. The cover is considered adequate if it consists of enough plants, crop residues, or clods to protect the soils from erosion or if the surface of the soil is rough enough to provide protection (fig. 9).

Tillage.—In dryland farming, tillage has many objectives. It is used to manage crop residues, control weeds, maintain tilth, and minimize the risk of erosion, and it is also used to conserve moisture. Managing the crop residues and controlling weeds help prepare the soils for the next crop. The crop residues do the most good when they are left on the surface (fig. 10) to protect the soils from the splashing action of raindrops. They break up the rain-

TABLE 2.—*A flexible cropping system in which wheat is the principal crop and needed conservation practices are applied* [1]

Date	Depth of moist soil	Adequate cover on field	Inadequate cover on field
	Inches		
June 1	Less than 24	Manage the soil until the depth of moist soil is 24 inches; then plant sorghum or manage until July 15.	Manage the soil until the depth of moist soil is 24 inches; then plant sorghum or roughen the surface and manage until July 15.
	More than 24	Plant sorghum or manage for wheat.	Plant sorghum or roughen the surface and manage for wheat.
July 15	Less than 30	Manage the soil for wheat, and expect to seed wheat primarily for a cover crop, but possibly for a grain crop.	Plant sorghum for a cover crop, or plant early maturing grain sorghum.
	More than 30	Manage the soil for wheat with the expectancy of harvesting the crop for grain.	Manage the soil for wheat, and expect to seed wheat primarily for a cover crop, but possibly for a grain crop.
Sept. 1	Less than 36	Plant wheat with the expectancy of harvesting the crop for grain (the soil should be moist to a depth of at least 24 inches at the time of seeding); if there is not enough moisture for seeding wheat, manage for crop production in the next year.	Plant wheat for a cover crop, but possibly for a grain crop; if there is not enough moisture for seeding wheat, roughen the surface and manage for sorghum or wheat to be grown in the next year.
	More than 36	Plant wheat with the expectancy of harvesting the crop for grain; if there is not enough moisture in the surface layer for seeding wheat, manage for crop production in the next year.	Plant wheat for a cover crop, but possibly for a grain crop; if there is not enough moisture for seeding wheat, roughen the surface and manage for sorghum to be grown in the next year.

[1] Prepared by FRED MEYER, JR., work unit conservationist, Syracuse, Kans.

drops, allow more water to soak into the soil, and thus reduce erosion and protect the structure of the soil.

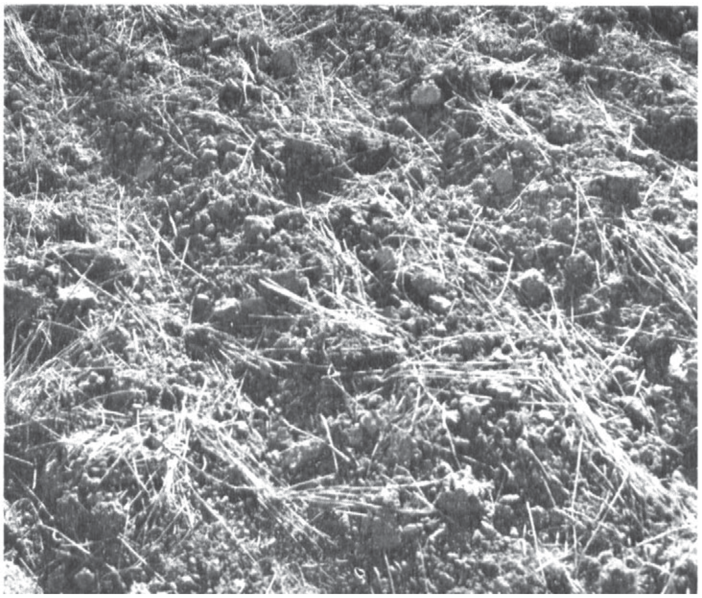

Figure 9.—**A field where clods and plant residues provide a protective cover for the soils.**

Figure 10.—**Subsurface tillage keeps protective wheat stubble on the surface.**

Whenever soils lack a protective cover of plants, they are susceptible to wind erosion. Therefore, the surface should be roughened by tillage (fig. 11). Roughening the surface is also sometimes necessary in fields of growing crops. It minimizes danger from soil blowing, provided the clods are large enough to resist blowing.

In areas where there is not enough vegetation to protect the soils, listing and chiseling make the surface layer cloddy. Deep listing is commonly used on sandy soils, and the rows are run crosswise to the direction of prevailing winds. Chiseling also helps to control erosion on the silty and clayey soils. Strongly calcareous soils are much more susceptible to wind erosion than noncalcareous soils of similar texture. The free calcium carbonate in these soils is only a weak cementing agent; consequently, the clods that form are fragile and are easily broken. Therefore, preserving the structure in the surface layer helps to control erosion.

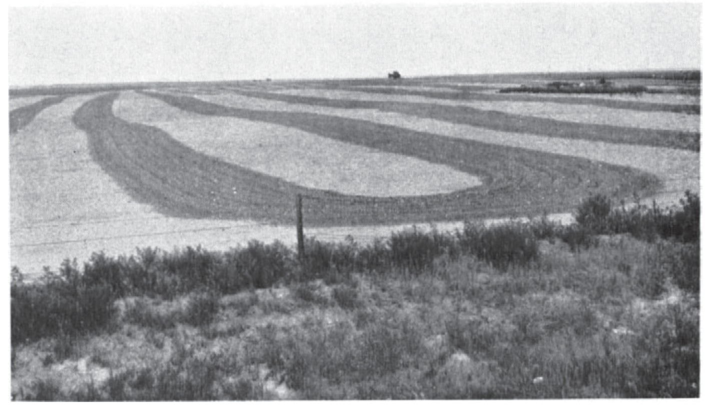

Figure 11.—**Surface roughening to stop soil blowing on land that will be used for wheat.**

A desirable structure is one in which the aggregates are stable enough to resist blowing. If the stable aggregates are large enough, tillage is needed only to kill weeds and to manage the crop residues. The minimum amount of tillage that will meet these needs should be used because excessive tillage breaks down the aggregates and leaves the soil material susceptible to crusting and blowing.

Minimum tillage, as used in this report, is the least amount of tillage that can be used to prepare an adequate seedbed and to control weeds and volunteer wheat. Tilling when the soils are neither too wet nor too dry is important. When the soils are dry, excessive tillage breaks down the soil aggregates. When they are wet, a compact layer, or tillage pan, is likely to form, especially in soils that have a surface layer of loam or silt loam.

On most soils used for field crops, tillage is required at least once or twice a year to control weeds and to prepare a seedbed. Tillage also helps to control erosion if an adequate cover of plant residues is left on the surface or if ridges are left that will help prevent soil blowing (fig. 12). If the ridges will interfere with subsequent planting, crop residues need to be left on the surface to protect the soils.

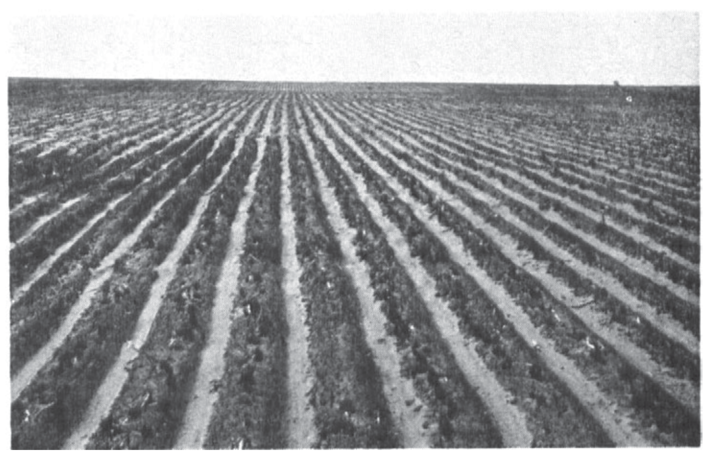

Figure 12.—**A field where the soils have been plowed into ridges that help to prevent soil blowing.**

Managing crop residues.—Managing crop residues properly helps protect the soils from erosion and conserves moisture. It consists of tilling, planting, and harvesting in such a way that an adequate cover of crop residues is left on the surface until the next crop is large enough to provide protection. To do this requires the use of subsurface tillage equipment, such as sweeps, blades, and rodweeders.

Crop residues help control water erosion. They can be conserved by controlling grazing, using minimum tillage, and protecting the areas from burning. If properly managed, crop residues protect the soils from beating raindrops, which break down the aggregates in the surface layer and cause the surface to seal over. By protecting the soils, they allow more water to soak in and thus reduce runoff. The result is more moisture for plants and less water erosion.

Crop residues on the surface also help protect the soils from wind erosion. Soils that are not protected are likely to be unsuitable for cultivation after only one season of windstorms. Soil material blown from unprotected fields will damage the soils on adjacent fields (fig. 13). This is most likely to occur in winter and spring, but soil blowing is a hazard at any time during periods of drought.

Figure 13.—Soil blown from the reseeded wheatfield on the right has drifted along the edge of the adjacent field. The soils in both fields are Manter fine sandy loams.

Stubble mulching is needed on all soils used for field crops, especially in the Great Plains. The methods used depend on the kind and amount of stubble, on the texture, structure, and tilth of the soils, on the cropping system, and on the season of the year.

The amount of residues needed depends on the kind and height of the stubble, on the number and size of clods, and on the texture of the soils. Standing wheat stubble gives more protection from wind erosion than standing sorghum stubble; therefore, only about half as much is needed. Soils that have a surface layer of sandy loam or loamy sand need more residues on the surface than silt loams or other fine-textured soils.

Crop residues can be left on the surface or plowed under depending on whether the soils are irrigated or dryfarmed, the cropping system, and the texture of the soils.

Although stubble mulching is a basic practice, it should be used with other practices for good management. For example, a combination of stubble mulching and stripcropping gives better protection against wind erosion than stubble mulching used alone. Frequently, soils blow from an exposed knoll or bare area in a field. Stripcropping confines the area to only one strip where it can be controlled by tillage or some other practice before it spreads over the entire field.

Contouring.—In contour farming the soils are tilled and planted parallel to the terraces or to contour guidelines. Furrows, ridges, and wheel tracks are then approximately at right angles to the slope. The furrows and ridges hold much of the water where it falls, and in this way runoff and erosion are decreased and moisture is more evenly distributed. Yields of crops increase because more water is absorbed by the soil and made available to crops. Also, somewhat less power is needed for contouring than for cultivating up and down the slope.

Contouring is most effective when it is used with stubble mulching, terracing, and stripcropping. Contour tillage alone checks runoff and erosion only on gently sloping soils during periods of gentle rainfall. On stronger slopes, where runoff is more rapid, terracing and other practices are needed to conserve moisture and to help control erosion. Contour furrows, terraces, and diversion dams or waterspreaders on long slopes help to distribute the water uniformly and to reduce runoff and the risk of erosion.

Terracing.—This practice consists of constructing ridges across the slope to intercept runoff water. The distance between the terraces depends upon the slope and on the texture of the soils. The ridges or terraces reduce the risk of water erosion and help to conserve moisture. Because much of the precipitation falls during storms of high intensity, the terraces act as a safety valve for such practices as contouring, stubble mulching, and contour stripcropping.

Two kinds of terraces, gradient terraces and level terraces, are used in this county. The gradient terrace has a channel that slopes toward an outlet, and it helps to control erosion. A level terrace is run on the exact contour, or across the slope, and is used mainly to conserve moisture. In Kearny County most of the terraces need to be built on the exact contour to help conserve moisture.

Contouring and other practices to help control erosion should be used with the terraces. Each row planted on the contour between the terraces acts as a miniature terrace that holds back some water and allows it to soak into the soil. Increased yields and decreased losses of soil material and water result when terracing and contouring are used together.

Stripcropping.—This practice consists of growing suitable crops in narrow strips in the same field. Strips of crops or crop residues that protect the soils from erosion are alternated with strips of other crops or with strips that are being fallowed. Good stands of wheat or sorghum and the thick, heavy stubble from these crops after harvest can be used in the strips that are used to protect the soils from erosion. Stripcropping shortens the distance that loose soil can move and, therefore, helps to control wind erosion. It reduces the hazard of erosion from water by providing a barrier of growing crops.

Stripcropping is of two types, contour stripcropping and wind stripcropping. Contour stripcropping is used on sloping soils mainly to help control erosion from water, but it also reduces the risk of erosion from wind. Wind stripcropping is used on nearly level areas where erosion from water is not a severe hazard. It is also used on stronger slopes so complex that cultivating on the contour is impractical. In wind stripcropping, the strips are uniformly wide, generally straight, and arranged across the direction of the prevailing northerly and southerly winds. The width of strips necessary to help control soil blowing varies according to the kind of soils. Strips need to be narrower on sandy soils than on soils that have a surface layer of silt loam or clay loam.

Wind stripcropping alone helps to control soil blowing. It is much more effective, however, when combined with good residue management, minimum tillage, and other needed practices.

Capability Groups of Soils for Dryland Farming

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

In this system all the kinds of soil are grouped at three levels—the capability class, subclass, and unit. The eight capability classes in the broadest grouping are designated by Roman numerals I through VIII. In class I are the soils that have few limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products.

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

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

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

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

In Kearny County different groupings are made for dryland farming and for irrigation farming. The names of the soils in each capability unit and a description of the management needed for the soils of each unit are given in the section "Management by Capability Units (Dryland)" and in the section "Management by Capability Units (Irrigated)." The capability classes, subclasses, and units for dryland farming are described in the list that follows.

Class I.—Soils that have few limitations that restrict their use. (None in dryland.)

Class II.—Soils that have some limitations that reduce the choice of plants or that require moderate conservation practices. (None in dryland.)

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

- Subclass IIIe.—Soils subject to severe erosion if they are cultivated and not protected.
  - Unit IIIe-1.—Gently sloping, silty soils of uplands.
  - Unit IIIe-2.—Gently sloping or gently undulating, moderately sandy soil of uplands.
  - Unit IIIe-3.—Nearly level, moderately sandy soil of uplands.
- Subclass IIIc.—Soils that have moderate limitations because of climate.
  - Unit IIIc-1.—Nearly level, silty soils of uplands.
  - Unit IIIc-2.—Dark, fertile soil in swales.

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

- Subclass IVe.—Soils subject to very severe erosion if they are cultivated and not protected.
  - Unit IVe-1.—Nearly level to undulating, sandy soils of the uplands.
  - Unit IVe-2.—Gently sloping to moderately sloping, calcareous, silty soils of the uplands.
  - Unit IVe-4.—Gently undulating to moderately sloping soils that have a surface layer of fine sandy loam.
- Subclass IVw.—Soils that have very severe limitations for cultivation because of excess water.
  - Unit IVw-1.—Soil in upland depressions.
  - Unit IVw-2.—Somewhat poorly drained, loamy to clayey soils of bottom lands.

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

- Subclass Vw.—Soils too wet for cultivation; drainage or protection not feasible.
  - Unit Vw-1.—Wet soil of bottom lands.

Class VI.—Soils that 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.
- Subclass VIe.—Soils severely limited, chiefly by risk of erosion if protective cover is not maintained.
  - Unit VIe–1.—Moderately steep to steep, calcareous, silty soils of the uplands.
  - Unit VIe–2.—Moderately undulating to hummocky, sandy soils of the uplands.
  - Unit VIe–6.—Steep, calcareous, sandy and gravelly soils.
- Subclass VIw.—Soils severely limited by excess water and generally unsuited to cultivation.
  - Unit VIw–1.—Loamy soil of bottom lands.
- Subclass VIs.—Soils generally unsuited to cultivation and limited for other uses by their moisture capacity or other soil features.
  - Unit VIs–2.—Saline, somewhat poorly drained, sandy soil of flood plains.
  - Unit VIs–4.—Deep, calcareous, clayey soil.

Class VII.—Soils that have very severe limitations that make them unsuited to cultivation and that restrict their use largely to grazing, woodland, or wildlife.
- Subclass VIIe.—Soils very severely limited, chiefly by risk of erosion if protective cover is not maintained.
  - Unit VIIe–1.—Hummocky soils of the sandhills.
- Subclass VIIw.—Soils very severely limited by excess water.
  - Unit VIIw–1.—Soils on the lower parts of flood plains.
- Subclass VIIs.—Soils very severely limited by moisture capacity or other soil features.
  - Unit VIIs–1.—Very shallow, loamy soils on steep, broken slopes.
  - Unit VIIs–4.—Steep, broken, gravelly soil.

Class VIII.—Soils and landforms having limitations that preclude their use for commercial production of plants and restrict their use to recreation, wildlife, water supply, or esthetic purposes. (None in Kearny County.)

Management by capability units (dryland)

In this section the soils of Kearny County are listed in capability units for dryland farming. Each capability unit is described, and suggestions for the use and management of the soils are given.

CAPABILITY UNIT IIIe–1

In this capability unit are gently sloping, silty soils of uplands. The soils are deep, moderately dark colored, and fertile, and they have a surface layer and subsoil of silt loam or clay loam. The subsoil is easily penetrated by roots, air, and water and is high in water-holding capacity.

The small amount of precipitation, recurrent droughts, and high winds are limitations to the use of these soils for crops. Wind erosion occurs when the soils are dry and clods have not been left on the surface or if the soils are not protected by a cover of plants or plant residues. The soils are also susceptible to water erosion because the surface tends to seal over during rainstorms, which causes excessive runoff. The following soils are in this unit:

Richfield-Mansic complex, 1 to 3 percent slopes (Rx).
Ulysses silt loam, 1 to 3 percent slopes (Ub).

These soils are suited to wheat and sorghum, but practices are needed to conserve moisture and to help control erosion. Planting suitable crops in a flexible cropping system, managing crop residues properly, terracing, using minimum tillage, and tilling on the contour are all practices that are needed. Also, contour stripcropping helps to control erosion.

CAPABILITY UNIT IIIe–2

Only one soil—Manter fine sandy loam, 1 to 3 percent slopes (Mh)—is in this capability unit. This gently sloping to gently undulating, moderately sandy soil of uplands is deep, moderately dark colored, and fertile. Its surface layer is fine sandy loam, and its subsoil is sandy loam to light sandy clay loam. This soil is easily penetrated by roots, air, and water, and it has moderate water-holding capacity.

This soil is well suited to sorghum and broomcorn. Wheat can also be grown if crop residues are left on the surface to keep the soil from blowing. During extended droughts, crops should be planted to protect the soil from wind erosion, although no harvest can be expected.

Practices are needed to conserve moisture and to help control erosion. Some of these practices consist of planting suitable crops in a flexible cropping system, managing crop residues properly, using minimum tillage, and tilling on the contour. Terracing and contour stripcropping are also good practices to use to help control erosion. It is important to restrict grazing of the crop residues so that enough stubble remains to protect the soil.

CAPABILITY UNIT IIIe–3

Only one soil—Manter fine sandy loam, 0 to 1 percent slopes (Mf)—is in this capability unit. This nearly level, moderately sandy soil of uplands is deep, moderately dark colored, and fertile. The surface layer is fine sandy loam, and the subsoil is sandy loam to light sandy clay loam. The soil is easily penetrated by roots, air, and water, and it has moderate water-holding capacity.

Because of the semiarid climate, practices to conserve moisture and to help control erosion are necessary in managing this soil. During extended droughts, crops should be planted to protect the soil from wind erosion, although no harvest can be expected.

This soil is well suited to sorghum. Wheat can be grown if crop residues are left on the surface to keep the soil from blowing. Practices that are suitable consist of planting suitable crops in a flexible cropping system, managing crop residues properly, and using a minimum amount of tillage.

Runoff is less rapid on this soil than on Manter fine sandy loam, 1 to 3 percent slopes, and the hazard of erosion is less serious. Contouring, terracing, and stripcropping are all practices that will help control erosion caused by runoff. Grazing of the crop residues should be limited so that enough stubble remains to protect the soil.

CAPABILITY UNIT IIIc–1

This unit consists of nearly level, silty soils of uplands. These deep, dark, fertile soils are high in water-holding capacity and are easily penetrated by roots, air, and water. Their surface layer is silt loam or clay loam, and their subsoil is silt loam and silty clay loam.

The small amount of precipitation and recurrent droughts limit the suitability of these soils for most crops. The following soils are in this unit:

Bridgeport clay loam (Bp).
Mansic clay loam, 0 to 1 percent slopes (Mo).
Richfield silt loam, 0 to 1 percent slopes (Rm).
Ulysses silt loam, 0 to 1 percent slopes (Ua).
Ulysses and Richfield soils, silted, 0 to 1 percent slopes (Ux).

These soils are suited to wheat and sorghum, but they need practices that conserve moisture and help control wind erosion. Some of these practices consist of planting suitable crops in a flexible cropping system, managing crop residues properly, and using minimum tillage. Where they are needed, contouring, terracing, and stripcropping are other practices that help control erosion. It is also important to restrict grazing of the crop residues so that enough stubble remains to protect the soils.

CAPABILITY UNIT IIIc-2

Only one soil—Goshen silt loam (Go)—is in this capability unit. This deep, dark, fertile soil is in nearly level swales and on valley benches in the uplands. It is easily penetrated by roots, air, and water and has high water-holding capacity. The surface layer of this soil is silt loam or clay loam, and the subsoil is silt loam to silty clay loam.

Crops grown on this soil generally benefit from the extra moisture received through runoff from adjacent areas, but they are sometimes damaged by flash floods from higher areas. The soil is limited in its use for most crops by the small amount of precipitation and recurrent droughts, but it is well suited to wheat and sorghum.

Practices to conserve moisture and to help control wind erosion consist of planting suitable crops in a flexible cropping system, managing crop residues properly, and using minimum tillage. Stripcropping, contouring, and terracing also help to reduce the risk of erosion.

CAPABILITY UNIT IVe-1

In this unit are nearly level to undulating, sandy soils of the uplands. The soils are deep, moderately dark colored, and fertile, and they have moderately rapid permeability and a moderately low water-holding capacity. Their surface layer is loamy fine sand, and their subsoil is sandy loam to sandy clay loam.

There is little runoff on these soils, and water erosion is negligible, but wind erosion is a serious hazard. The following soils are in this unit:

Dalhart-Vona loamy fine sands, 0 to 1 percent slopes (Dx).
Vona loamy fine sand (Vo).

Because of the risk of erosion by wind, these soils are not well suited to field crops, nor are they suited to summer fallowing. If the soils are used for field crops, minimum tillage, sorghum grown year after year, and proper management of the crop residues are the practices needed to control blowing. These soils are suitable for growing native grasses and for use as range.

CAPABILITY UNIT IVe-2

This unit consists of gently sloping to moderately sloping, calcareous, silty soils of the uplands. The soils are deep and friable. Their surface layer is moderately dark colored to light-colored silt loam or loam, and their subsoil is calcareous silt loam or loam. The subsoil is high in available water-holding capacity and can be penetrated easily by roots, water, and air. The soils contain little organic matter.

The small amount of precipitation, recurrent droughts, and high winds limit the use of these soils for crops. The soils are susceptible to wind erosion if they are not protected by a cover of plants or plant residues. They are also susceptible to water erosion if they are not protected, because the surface tends to seal over during rainstorms, and excessive runoff is a result. Because of the risk of erosion by wind and water, these soils need protection at all times. During periods of drought, crops should be planted to prevent soil blowing, although no harvest can be expected. The following soils are in this unit:

Colby silt loam, 1 to 3 percent slopes (Cb).
Mansker loam, 0 to 3 percent slopes (Mb).
Ulysses silt loam, 3 to 5 percent slopes (Uc).
Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded (Ue).

Although these soils can be cultivated, they are not well suited to field crops. Satisfactory yields from wheat and sorghum are obtained only during years of more than average rainfall. If the soils are used for cultivated crops, they require such practices as planting suitable crops in a flexible cropping system, managing crop residues, using minimum tillage, terracing, contouring, and stripcropping. In places where slopes are too complex and no satisfactory system of terraces or contour lines can be laid out, wind stripcropping can be used.

The soils are well suited to native grasses and to use as range. Management practices for range are given in the section "Range Management."

CAPABILITY UNIT IVe-4

In this unit are deep, moderately fertile, gently undulating to moderately sloping soils that are easily penetrated by roots, air, and water. Their surface layer is moderately dark colored fine sandy loam, and their subsoil is sandy loam to fine sandy clay loam. Their subsoil is moderate in water-holding capacity.

There is little runoff on these soils. Water erosion is negligible, but wind erosion is a serious hazard. The following soils are in this unit:

Bayard fine sandy loam (Ba).
Manter fine sandy loam, 3 to 5 percent slopes (Mk).

Because these soils are susceptible to wind erosion, they are not well suited to field crops, nor are they suited to summer fallowing. If they are used for cultivated crops, good management consists of using minimum tillage, growing sorghum year after year, and managing the crop residues properly. Wheat may be grown, however, if crop residues are left on the surface to protect the soils from blowing.

The soils are well suited to native grasses. Management practices for range are given in the section "Range Management."

CAPABILITY UNIT IVw-1

Only one soil—Lofton silty clay loam (Lo)—is in this capability unit. This deep, dark, slowly permeable soil is in shallow depressions in the uplands. Water is ponded in these depressions for several days after a rainstorm. The surface layer and subsoil are silty clay loam or clay loam.

Planting or harvesting is sometimes delayed because this soil is covered by water, and crops frequently drown out. Wind erosion is a hazard whenever crops have been lost and no protective cover remains on the soil.

Most of this soil is cultivated and managed with the surrounding areas. Such practices as terracing, contouring, and managing crop residues on the adjacent soils control runoff to some extent and help to keep water out of the depressions. In some places surface drainage is feasible.

CAPABILITY UNIT IVw-2

In this unit are somewhat poorly drained, loamy to clayey alluvial soils on the bottom lands of the Arkansas River. The soils are clay loams and sandy loams, and they vary in depth.

The fluctuating water table is 3 to 10 feet below the surface. The soils are subject to flooding and receive fresh deposits of material when they are covered by floodwaters. Poor drainage and flooding limit the suitability of these soils for crops, and the soils are also slightly to moderately saline. The following soils are in this unit:

Bowdoin clay loam (Bd).
Las clay loam, deep (Lb).
Las clay loam, moderately deep (La).
Las Animas clay loam (Lg).
Las Animas sandy loam (Lk).
Las-Las Animas complex (Ld).

These soils are susceptible to erosion. They are not well suited to field crops, but wheat and sorghum can be grown.

The soils require management practices to conserve moisture and to help control erosion. If they are used for field crops, practices should include minimum tillage, proper management of the crop residues, and use of a cropping system that consists of wheat and sorghum alternated with summer fallow. Fallowing is necessary during dry years if satisfactory yields are to be obtained the following year.

The soils are well suited to native grasses. Management practices for range are given in the section "Range Management."

CAPABILITY UNIT Vw-1

Only one soil—Sweetwater clay loam (Sw)—is in this this capability unit. This wet soil is on bottom lands along the Arkansas River, and it is shallow to moderately deep over sand and gravel.

This soil is poorly drained because the water table is only 16 to 36 inches below the surface. It is subject to recurrent flooding and receives fresh deposits of material each time it is flooded. Moderate to high salinity, excessive wetness, and a restricted root zone limit the suitability of this soil for field crops.

This soil is well suited to native grasses. Nearly all of it is used as range or meadow.

CAPABILITY UNIT VIe-1

This unit consists of moderately steep to steep, calcareous, silty soils of the uplands. The soils are deep, light-colored silt loams and have a subsoil that is easily penetrated by roots. They also have a high available water-holding capacity.

These soils are susceptible to severe wind erosion if they are cultivated and not protected by a cover of plants. They are also susceptible to water erosion because runoff is very rapid. The following soils are in this unit:

Colby silt loam, 3 to 5 percent slopes (Cc).
Colby silt loam, 5 to 15 percent slopes (Cd).
Ulysses-Colby silt loams, 3 to 5 percent slopes, eroded (Um).

These soils are suitable only for range, and the acreage under cultivation should be planted to native grasses. Management needed to produce adequate yields of forage and to provide a protective cover consists of proper use of the range, including deferred grazing or deferred rotation grazing. More information about the use of the soils for grazing is given in the section "Range Management."

CAPABILITY UNIT VIe-2

Only Tivoli-Vona loamy fine sands (Tv) is in this capability unit. These moderately undulating to hummocky, sandy soils of the uplands absorb rainfall rapidly, but their water-holding capacity is low. Their surface layer is loamy fine sand, and it is underlain by fine sandy loam, loamy fine sand, and fine sand.

These soils are susceptible to blowing when they are not adequately protected. Because of their low water-holding capacity and susceptibility to drifting, the soils are suitable only for permanent pasture.

Satisfactory yields of forage are obtained on these soils if grazing is properly managed. Practices consist of restricted or deferred grazing and seeding native grasses to stabilize blowouts and other areas bare of vegetation. Additional information about use of the soils for grazing is given in the section "Range Management."

CAPABILITY UNIT VIe-6

Soils of the Otero gravelly complex (Ox) are in this unit. These steep, calcareous, sandy and gravelly soils are along drainageways in the uplands. In most places they have a surface layer of light-colored, calcareous sandy loam that is underlain by a sandy and gravelly subsoil. The soils can be penetrated easily by roots, water, and air, and they are moderate to low in water-holding capacity.

The hazard of wind erosion is serious if these soils are cultivated and not protected by a cover of plants. There is also a moderate hazard of water erosion during thunderstorms when the soils are not adequately protected.

The soils of this complex are poorly suited to field crops, although some of the acreage is used for that purpose. A large acreage is in native grass, and the acreage under cultivation should be reseeded to native grasses. On the soils used as range, grazing should be restricted or deferred, and other practices need to be used to reduce damage from erosion. More information about the use of the soils for grazing is given in the section "Range Management."

CAPABILITY UNIT VIw-1

One miscellaneous land type—Alluvial land (An)—is in this capability unit. It consists of loamy alluvial material on bottom lands along the intermittent streams in the uplands. This land is mostly nonarable, because winding channels of streams cut into the narrow flood plains it occupies and because the soils on adjoining slopes are not suitable for cultivated crops. It is subject to flooding; fresh material is deposited when the areas are covered by floodwaters. It is also susceptible to erosion.

This land type is well suited to range. The valley floors where it occurs are at least 200 feet wide. They are continuous enough to be considered separately for grazing management and are nearly covered with native grasses. More information about the use of this land type for grazing is given in the section "Range Management."

CAPABILITY UNIT VIs-2

Only one soil—Las Animas loamy sand (Lh)—is in this capability unit. This somewhat poorly drained, sandy, saline soil is on flood plains of the Arkansas River. It varies greatly in depth. The water table is only 16 to 36 inches below the surface. This soil is subject to recurrent flooding, and it receives fresh deposits of material when the areas are flooded.

A restricted root zone, excessive wetness, low moisture-holding capacity, and moderate to high salinity limit the suitability of this soil for field crops. The soil is well suited to native grasses, however, and to use as range. Proper management should include practices to restrict and defer grazing. More information about the use of this soil for grazing is given in the section "Range Management."

CAPABILITY UNIT VIs-4

Only one soil—Church clay, dark variant (Ca)—is in this capability unit. This soil is deep, moderately dark colored, clayey, and calcareous, and it is very slowly permeable. This soil is in the lower part of the Bear Creek depression. It is nearly level, but the areas in native grass have strong gilgai microrelief and contain many small ridges and basins.

The small amount of precipitation, recurrent droughts, and occasional flooding make this soil unsuitable for dryland farming and only poorly suited to irrigated crops. The soil is well suited to native grasses, however, and should be used as range. Proper range management includes restricting grazing so that the range will not be overgrazed. More information about the use of this soil for grazing is given in the section "Range Management."

CAPABILITY UNIT VIIe-1

This unit consists of deep, light-colored, sandy soils of the sandhills. The soils occupy hummocky and choppy areas that resemble dunes. Active dunes and the Dune land in the complex consist of actively shifting sand on hills or ridges and in cone-shaped dunes.

These sandy soils are susceptible to blowing unless they are protected by a cover of plants. The following soils are in this unit:

Active dunes (Ad).
Tivoli fine sand (Tf).
Tivoli-Dune land complex (Tx).

These soils are not suitable for field crops, and nearly all of the acreage is in native grass and sand sagebrush. Important practices that will protect and improve the grass cover consist of restricting grazing, stabilizing blowouts, and, in some areas, reseeding suitable native grasses. The areas of active dunes should be fenced off from livestock, protected by a cover of weeds or sorghum, and then seeded to native grasses.

CAPABILITY UNIT VIIw-1

Soils on the lower parts of flood plains of the Arkansas River and of intermittent streams make up this capability unit. The following soils are in this unit:

Broken land (Bx).
Lincoln sand (Ln).

Broken land consists of steep areas of nonarable, alluvial sandy loam or clay loam and occurs along intermittent streams in the uplands. Lincoln sand consists of only slightly altered sand over coarse sand and gravel. It is on the lower parts of flood plains of the Arkansas River.

Both of these soils are subject to recurrent flooding and receive fresh deposits of material each time they are flooded. They are not suitable for cultivated crops and have little value for grazing. The soils support a sparse growth of tall, mid, and short grasses. In addition, Lincoln sand has groves of cottonwoods and scattered willows growing on it. Where the water table is highest, the soil also supports a dense growth of tamarisk.

Because of the rough topography and the trees and trash on the areas, most areas of these soils cannot be seeded. Careful management is necessary to protect the present vegetation.

CAPABILITY UNIT VIIs-1

This capability unit consists only of Potter soils (Po). The soils are loamy, light colored, and strongly calcareous, and they are very shallow over caliche, limestone, shale, and gravel. In many places there are rock outcrops. The soils are on steep, broken slopes along the broad channels of intermittent streams in the uplands and along escarpments north of the Arkansas River Valley. Their surface layer is loam or sandy loam and is 5 to 12 inches thick.

Runoff is rapid on these soils, and the soils are highly susceptible to erosion by water and wind. Also, a restricted root zone and low water-holding capacity are limitations to use.

These soils are suitable only for grazing. Because of the serious hazard of erosion, they need to be protected by vegetation at all times. Little can be done to protect them, however, except to restrict grazing so as to maintain a cover of grass. Additional information about managing these soils is given in the section "Range Management."

CAPABILITY UNIT VIIs-4

One miscellaneous land type—Gravelly broken land (Gr)—is in this unit. It consists of steep and broken slopes of calcareous, sandy and gravelly land. In places there are outcrops of basal gravel and caliche.

A restricted root zone and low water-holding capacity are limitations to the use of this soil for crops. The soil is suitable only for grazing. Because it is highly susceptible to erosion by wind and water when it is not protected, it is important to limit grazing so that a protective cover of grass will be maintained. Additional information about managing this soil is given in the section "Range Management."

Estimated Yields

Table 3 gives estimated average acre yields of seeded wheat and grain sorghum to be expected over a long period on the soils of Kearny County that are arable. Yields under the prevailing, or most common, system of management are shown in columns A, and yields that may be obtained by using an improved system of management are shown in columns B. The estimates are based on data obtained from farmers, from workers at the Kansas State

TABLE 3.—*Estimated average acre yields of seeded wheat and grain sorghum grown on the arable soils under two levels of dryland management*

Soil	Wheat [1]		Sorghum	
	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*
Bayard fine sandy loam	8. 5	12. 0	14. 0	17. 5
Bowdoin clay loam	8. 0	12. 0	9. 0	11. 5
Bridgeport clay loam	12. 5	15. 5	12. 0	14. 5
Colby silt loam, 1 to 3 percent slopes	10. 0	14. 0	10. 0	12. 0
Dalhart-Vona loamy fine sands, 0 to 1 percent slopes [2]	------	------	------	------
Goshen silt loam	16. 0	20. 0	22. 0	27. 0
Las clay loam, deep	11. 0	14. 5	12. 0	14. 5
Las clay loam, moderately deep	10. 0	13. 0	11. 0	13. 5
Las-Las Animas complex	8. 0	10. 5	9. 5	11. 5
Las Animas clay loam	8. 0	10. 0	9. 0	11. 0
Las Animas sandy loam	8. 0	11. 0	10. 0	12. 5
Lofton silty clay loam	9. 0	13. 0	13. 0	15. 0
Mansic clay loam, 0 to 1 percent slopes	12. 0	16. 0	14. 0	17. 0
Mansker loam, 0 to 3 percent slopes	8. 0	10. 0	8. 0	9. 5
Manter fine sandy loam, 0 to 1 percent slopes	12. 0	16. 0	16. 0	20. 0
Manter fine sandy loam, 1 to 3 percent slopes	10. 0	14. 0	15. 0	19. 0
Manter fine sandy loam, 3 to 5 percent slopes	8. 0	11. 0	14. 0	17. 5
Richfield silt loam, 0 to 1 percent slopes	14. 5	18. 0	15. 0	18. 0
Richfield-Mansic complex, 1 to 3 percent slopes	11. 5	16. 0	12. 0	14. 5
Ulysses silt loam, 0 to 1 percent slopes	14. 0	18. 0	15. 0	18. 0
Ulysses silt loam, 1 to 3 percent slopes	11. 5	16. 0	12. 0	14. 5
Ulysses silt loam, 3 to 5 percent slopes	10. 0	14. 0	10. 0	12. 0
Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded	10. 5	15. 0	11. 0	13. 0
Ulysses and Richfield soils, silted, 0 to 1 percent slopes	13. 5	16. 5	13. 5	16. 5
Vona loamy fine sand [3]	------	------	13. 0	16. 5

[1] Wheat yields reflect the general use of summer fallow.
[2] All of this soil is under native vegetation. If it were cultivated the yields would be comparable to those on Vona loamy fine sand
[3] Not suitable for wheat.

Agricultural Experiment Station, and from soil surveyors who made observations during the course of the survey. The estimates are not precise because the longtime records of yields needed to make close estimates are limited in Kearny County. Yields in this county fluctuate so much according to dry and wet seasons that longtime records of yields are essential if close estimates are to be made.

Prevailing management.—The following is the prevailing, or most common, system of management used in the production of wheat:

1. Tillage is performed in straight lines, generally parallel to field boundaries and not on the contour.
2. Tillage is done with such equipment, in such a manner, and so frequently that protective crop residues are soon destroyed.
3. Commonly, the cropping system consists of alternate wheat and fallow. Winter wheat is seeded early in fall on fields that have been left idle and kept free of weeds during the growing season. If a satisfactory stand of wheat is obtained, or if the wheat blows out during winter or spring, the fields are planted to sorghum. Since a program to control the acreage in wheat was begun, however, a cropping system has been used that consists of 1 year each of wheat, sorghum, and fallow and then wheat again.
4. Crop residues are grazed wherever available. Growing wheat, both seeded and volunteer, is generally grazed during fall and winter.

Improved management.—The improved system of management used to obtain the yields in columns B consists of applying practices to conserve moisture and to protect the soil from erosion. A flexible cropping system that is based on the depth of moist soil is also used. The practices used include proper management of the crop residues, minimum use of tillage, stripcropping, contour tillage, and cover crops. The practices needed for each soil used to grow dryland crops are described in the section "Management by Capability Units (Dryland)."

No estimates are given for yields of irrigated crops in Kearny County. The practices needed to grow crops on each of the irrigated soils are described in the section "Management by Capability Units (Irrigated)."

Management of Irrigated Soils

Irrigation in Kearny County started before the turn of the century. It is reported that the second irrigation project in western Kansas was begun near Lakin in 1878. At first, only a tract consisting of a few acres in the Arkansas River Valley was irrigated. In 1900, a large irrigation system was developed north of Deerfield and about 10,000 acres of nearly level soils of the uplands was brought under irrigation. By 1940, about 20,000 acres of soils in the valleys and on uplands was irrigated with water from the river and from shallow wells. At the present time, deep wells are being drilled in the uplands in the west-central part of the county.

On many large farms part of the acreage is irrigated and the rest is dry-farmed. The semiarid climate affects irrigation practices in this county, and, during periods of below-average rainfall, irrigation is often used to supplement the moisture received from rainfall.

It is important to irrigate at a time and with the amount of water that allow the best yields and the most efficient use of the irrigation water, but that do not damage the soils. This section discusses factors that need to be considered when planning an irrigation system and describes management practices to use in areas that are irrigated.

Characteristics of the soils that affect irrigation.—The suitability of the soil for irrigation depends on such characteristics as the permeability of the subsoil and substratum, the texture of the surface layer and subsoil, the tilth of the soil, and the available water-holding capacity of the root zone. It also depends on the depth of the soil over coarse sand and gravel, wetness, susceptibility of the soil to erosion, and the amount of salts in the profile. Some of these characteristics affect others.

Permeability is that quality of a porous substance relating to the readiness with which it conducts or transmits water and air. The texture of a soil affects its permeability. Most of the soils in this county have moderate permeability. A soil that has slow permeability either contains a layer that is high in clay or is clayey throughout. The amount of clay also affects the available water-holding capacity and the tilth of the soil. A clayey soil takes up water slowly; it stays wet and sticky for a long time after it is irrigated and has high water-holding capacity once it is saturated. A clayey soil is hard to work and crusts over easily. A loamy soil is generally high in water-holding capacity and has moderate to moderately rapid permeability. It is easily worked but has other limitations.

Available water-holding capacity is the capacity of the soil to retain water within its root zone that plants can use. Sandy soils have low water-holding capacity, but they release water to plants fairly readily. Loamy and clayey soils have a higher capacity to hold water than do sandy soils, but they do not release all of it to plants readily. Soils that are limited in water-holding capacity are likely to be droughty and to need irrigation frequently. The following are average values that have been determined to be the available water-holding capacity of a given foot of soil as influenced by texture:

Texture	*Inches of water per foot of soil*
Sand	0.25 to 0.75
Loamy sand	0.75 to 1.25
Sandy loam	1.00 to 2.00
Loam, sandy clay loam, silt loam, clay loam, silty clay loam, clay	2.00 to 3.00

Depth of the soil is an important factor in establishing an irrigation system. Soils that are shallow over coarse sand and gravel are limited in water-holding capacity and need lighter and more frequent irrigation than deeper soils. If shallow soils are leveled, it is important to leave enough soil material to hold water and to allow room for roots to make adequate growth. The shallow soils that are irrigated are in the Arkansas River Valley. Most of them have a high, fluctuating water table.

Wetness of the soil, whether from a high water table or from standing water, limits the yields and the kinds of crops that can be grown. Some soils in the Arkansas River Valley are not suited to alfalfa and other deep-rooted crops, because they have a high water table. Shallow-rooted crops may also be affected by a high water table. Flooding is hazardous to crops and to the soils because it increases the danger of erosion. Moreover, fresh material is deposited each time the soils are flooded.

The amount of salts in the soil is influenced by the texture of the subsoil and substratum and by the fluctuating water table. Soluble salts are carried up into the soil profile when the water table rises and are deposited in the soil when the water table falls. When the soil dries out, the salts tend to move upward. Because water from the river and water pumped from the alluvium in the valley contain soluble salts, irrigation increases the hazard of salts accumulating in the soils, especially in the more clayey soils. These soils need to be irrigated heavily during off seasons to leach out the salts that have accumulated in the root zone.

Irrigation management practices.—The productivity of some irrigated soils is short lived, but many irrigated soils continue to be highly productive for a long time. Successful irrigation farming depends on the development of a planned irrigation system and sound management practices. The practices needed for the soils of Kearny County consist of choosing a proper cropping sequence, leaving crop residues on the surface, adding fertilizer, using sound engineering practices, and using irrigation water properly.

A cropping sequence effective in increasing yields consists of a deep-rooted legume grown in rotation with wheat or some other small grain. Alfalfa is one of the best legumes for increasing the amount of available nitrogen and active organic matter in many of the soils. On shallow soils a shallow-rooted legume can be used. A cropping system that includes a legume also helps to control many plant diseases and insect pests. Growing a cover crop helps to minimize leaching and losses from erosion; the cover crop also adds organic matter to the soil when it is turned under for green manure. Alternating deep-rooted and shallow-rooted plants also improves the structure of the subsoil when the roots of the plants decay.

To rebuild and stabilize the soil aggregates, the cropping system should include a sod or legume crop every few years. A good cropping sequence, proper use of crop residues, proper tillage, and use of fertilizer help to maintain fertility and to improve the tilth and increase the productivity of the soils.

Crop residues ought to be left on the surface to provide a protective cover for the soils until it is time to plant a new crop, and they should then be plowed under. They should not be grazed or burned. Plowing under crop residues improves the structure of the soils and increases the supply of organic matter. This, in turn, makes the soils easier to work and increases yields. Plowing under crop residues improves the tilth of the clayey soils under irrigation and increases the capacity of the sandy soils to absorb and hold sufficient moisture and plant nutrients.

The use of commercial fertilizer, particularly nitrogen, is increasingly important when the soils are irrigated. On some soils, phosphate is needed for high yields. The Kansas Agricultural Experiment Station at Manhattan and the branch station at Garden City maintain laboratories for testing the soils to determine their need for fertilizer. A small charge is made for each sample tested.

Capability Groups of Soils for Irrigation

The soils of the county have been grouped in capability units to show their suitability for irrigation farming. The capability classes, subclasses, and units for irrigation farming are described in the list that follows.

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

Unit I–1.—Deep, nearly level, well-drained soils.

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

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

Unit IIe–2.—Gently sloping, moderately sandy soil of the uplands.

Unit IIe–4.—Gently sloping, silty soils of the uplands.

Subclass IIw.—Soils that have moderate limitations because of excess water.

Unit IIw–1.—Deep clay loam on bottom lands.

Subclass IIs.—Soils that have moderate limitations of moisture capacity or tilth.
Unit IIs-1.—Nearly level, moderately sandy soils.
Unit IIs-2.—Nearly level, silted soils on the uplands.
Class III.—Soils that have severe limitations that reduce the choice of plants, or that require special conservation practices, or both.
Subclass IIIw.—Soils that have severe limitations because of excess water.
Unit IIIw-1.—Poorly drained, moderately deep clay loam on bottom lands.
Unit IIIw-2.—Somewhat poorly drained, moderately deep sandy loam on bottom lands.
Class IV.—Soils that have very severe limiations that restrict the choice of plants, that require very careful management, or both.
Subclass IVe.—Soils subject to very severe erosion if they are cultivated and not protected.
Unit IVe-7.—Sandy soils of the uplands.
Subclass IVw.—Soils that have very severe limitations for cultivation because of excess water.
Unit IVw-3.—Poorly drained, clayey soil on bottom lands.
Unit IVw-4.—Loamy to clayey soils of bottom lands.
Unit IVw-5.—Calcareous, clayey soil of bottom lands.

Management by capability units (irrigated)

In this section the irrigated soils of Kearny County have been placed in capability units. Each capability unit is described, and suggestions for the use and management of the soils are given. For further information about irrigation and about engineering problems related to irrigation, consult a local technician of the Soil Conservation Service.

CAPABILITY UNIT I-1 (IRRIGATED)

This unit consists of nearly level soils that are deep and well drained. The soils are dark colored and fertile. Their surface layer is silt loam or clay loam, and their subsoil is silt loam or silty clay loam. Roots, air, and water can penetrate easily, and the soils are high in water-holding capacity. The following soils are in this unit:

Bridgeport clay loam (Bp).
Goshen silt loam (Go).
Mansic clay loam, 0 to 1 percent slopes (Ma).
Richfield silt loam, 0 to 1 percent slopes (Rm).
Ulysses silt loam, 0 to 1 percent slopes (Ua).

When irrigated, these soils are suited to wheat, sorghum, alfalfa, sugar beets, corn, tame grasses, vegetables, and other crops commonly grown in the area. Fertility and tilth can be maintained or improved by including a deep-rooted legume in the cropping sequence, managing crop residues properly, applying fertilizer as needed, and using irrigation water efficiently.

Engineering practices to help conserve irrigation water and to use it efficiently are necessary in managing these soils. Land leveling is a practice that is commonly needed, and, in some places, it is necessary to provide surface drainage and to control runoff water from adjacent areas.

CAPABILITY UNIT IIe-2 (IRRIGATED)

Only one soil—Manter fine sandy loam, 1 to 3 percent slopes (Mh)—is in this capability unit. This moderately sandy, gently sloping soil of the uplands is deep, moderately dark colored, and fertile. Its surface layer is fine sandy loam, and its subsoil is sandy loam to fine sandy clay loam. The soil is easily penetrated by roots, air, and water and has moderate water-holding capacity. It is susceptible to erosion.

This soil is suited to sorghum, wheat, alfalfa, sweetclover, and grasses. It needs fertilizer, a cropping sequence that consists of close-growing crops and deep-rooted legumes, and proper management of the crop residues to help maintain or improve fertility and tilth. If it is irrigated, the soil also needs practices that help to control erosion and to make the use of irrigation water more efficient. Leveling the areas to be irrigated, laying underground pipelines, irrigating on the contour, and using sprinkler irrigation on close-growing crops are practices that generally help to control erosion and to make the use of irrigation water most efficient.

CAPABILITY UNIT IIe-4 (IRRIGATED)

In this unit are gently sloping, silty soils of the uplands. The soils are deep, fertile, and well drained. They have a surface layer of silt loam or clay loam and a subsoil of silt loam to silty clay loam. Permeability is moderate, and the water-holding capacity is high. The soils are susceptible to erosion by water. The following soils are in this unit:

Colby silt loam, 1 to 3 percent slopes (Cb).
Richfield-Mansic complex, 1 to 3 percent slopes (Rx).
Ulysses silt loam, 1 to 3 percent slopes (Ub).
Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded (Ue).

When irrigated, these soils are suited to wheat, sorghum, alfalfa, sweetclover, and tame grasses. Using a cropping sequence that consists of close-growing crops and deep-rooted legumes, managing crop residues properly, and applying fertilizer help to maintain or improve the fertility and tilth of the soils. Good management is also needed to help control erosion and to make the use of water more efficient. Leveling the areas to be irrigated, irrigating on the contour, and using sprinkler irrigation for close-growing crops minimize the risk of erosion. In some places, however, drop structures and underground pipelines are needed to help control erosion in the irrigation ditches.

CAPABILITY UNIT IIw-1 (IRRIGATED)

Only one soil—Las clay loam, deep (Lb)—is in this capability unit. This deep soil is on bottom lands of the Arkansas River. It has moderately slow permeability, is somewhat poorly drained, and is somewhat restricted in water-holding capacity. The water table fluctuates and is 3 to 10 feet below the surface. The slight to moderate salinity of this soil is a hazard unless proper irrigation practices are used.

Wheat, sorghum, and alfalfa are the main crops. If this soil is used for irrigated crops, fertility and tilth can be maintained or improved by choosing a cropping sequence that includes a deep-rooted legume, managing crop residues well, irrigating heavily at least once each year to leach out the accumulated salts, and using fertilizer as needed.

Leveling the land, floating it, and providing adequate surface drainage are engineering practices that conserve irrigation water.

CAPABILITY UNIT IIs-1 (IRRIGATED)

This unit consists of deep, nearly level, well-drained soils that are moderately sandy. The surface layer of these soils is fine sandy loam, and their subsoil is sandy loam to fine sandy clay loam. The soils are moderately permeable and are moderate in water-holding capacity. The following soils are in this unit:

Bayard fine sandy loam (Ba).
Manter fine sandy loam, 0 to 1 percent slopes (Mf).

When irrigated, these soils are suited to wheat, sorghum, alfalfa, tame and native grasses, and other crops commonly grown in the area. Good management is needed to maintain and to improve fertility and tilth and to make the use of irrigation water more efficient. It is important to avoid excessive irrigation because the excess water leaches out plant nutrients.

Fertility can be maintained by using a cropping sequence that includes a deep-rooted legume, by managing crop residues properly so that a supply of organic matter will be maintained, by using irrigation water efficiently, and by applying manure and commercial fertilizer as needed.

Leveling the land and installing underground pipelines are practices that result in more efficient use of the irrigation water. In many places, however, sand pockets occur in Bayard fine sandy loam; therefore, it is important to avoid removing soil material from these areas when leveling.

CAPABILITY UNIT IIs-2 (IRRIGATED)

This capability unit consists of only Ulysses and Richfield soils, silted, 0 to 1 percent slopes (Ux). These nearly level soils are on the uplands and are deep, fertile, and well drained. Their surface layer is silty clay loam to silty clay, and their subsoil is silty clay loam.

Permeability is slow in these soils, and careful management is needed to maintain favorable soil structure and good tilth. The soils crust readily and are difficult to work. They take up water slowly, stay wet for a long time after they are irrigated, and are likely to become compacted.

These soils are suited to wheat, sorghum, alfalfa, sugar beets, vegetables, and other crops grown in the area. Including a deep-rooted legume in the cropping sequence and plowing under crop residues are practices that improve the tilth of these soils. The soils need to be plowed and cultivated at different depths to keep a tillage pan from forming. In some places it will be necessary to level the areas so that irrigation water can be used efficiently.

CAPABILITY UNIT IIIw-1 (IRRIGATED)

Only one soil—Las clay loam, moderately deep (Lo)—is in this capability unit. This poorly drained soil is on the bottom lands of the Arkansas River. It has a surface layer and subsoil of clay loam and a substratum of coarse sand.

This soil has moderately slow permeability. The root zone is fairly shallow, and the soil is somewhat restricted in its use for crops by its moderately low water-holding capacity. The water table fluctuates and is 3 to 8 feet below the surface. It is not practical to drain this soil. Slight to moderate salinity is a hazard unless proper irrigation practices are used.

Wheat and sorghum are the main crops grown on this soil. Alfalfa can be grown, but a good stand is hard to maintain in the shallower areas, and the stand may be damaged when the water table is high. Plowing under crop residues and applying fertilizer will help to maintain the fertility and to improve the tilth of the soil. At times, a heavy irrigation is necessary to leach salts out of the root zone.

Practices to conserve water and to use it most efficiently are necessary in managing this soil. Leveling the land may be necessary in some places, and providing adequate surface drainage is necessary in other areas.

CAPABILITY UNIT IIIw-2 (IRRIGATED)

Only one soil—Las Animas sandy loam (Lk)—is in this capability unit. This soil is on bottom lands along the Arkansas River. It is moderately deep and is somewhat poorly drained. The water table fluctuates and is 3 to 8 feet below the surface. The surface layer and subsoil are sandy loam, and the substratum is coarse sand. The sandy texture and the moderate depth of the soil cause the soil to be low in water-holding capacity. Salinity is only a slight hazard if proper irrigation practices are used.

Wheat and sorghum are the main crops grown. The soil is not suited to alfalfa, but alfalfa can be grown where the soil is fairly deep over sand and the water table is fairly low. Much of this soil is no longer used for field crops because a large part of the acreage is almost covered by johnsongrass. Good management, including a cropping sequence that allows summer fallowing, is needed to control the johnsongrass.

If the soil is irrigated, it needs water frequently because its water-holding capacity is low. It is important to avoid excessive irrigation, however, because too much water leaches out the plant nutrients. Crop residues and manure should be plowed under to build up the supply of organic matter.

Land leveling and practices to help control erosion are necessary in managing this soil if water is to be used efficiently. Because of the sandy substratum, the soil needs to be leveled carefully to avoid mixing sand in the surface layer.

CAPABILITY UNIT IVe-7 (IRRIGATED)

This unit consists of deep, sandy, nearly level to undulating soils of the uplands. The soils are moderately dark colored and moderately fertile. They have a surface layer of deep loamy fine sand and a subsoil of sandy loam to sandy clay loam. Their substratum is sandy loam or loamy fine sand. The soils are low in water-holding capacity and have moderately rapid permeability. There is a serious hazard of wind erosion. The following soils are in this unit:

Dalhart-Vona loamy fine sands, 0 to 1 percent slopes (Dx).
Vona loamy fine sand (Vo).

These soils are well suited to native grasses. They are not well suited to field crops because of their susceptibility to wind erosion, but they can be used for cultivated crops. Using minimum tillage, employing a cropping system that consists of tame grasses or sorghum grown year after year, and managing crop residues properly are all practices that help to control wind erosion. If the soils are used for irrigated crops, it is important to use irrigation water efficiently and to protect them from wind erosion. Because of the low water-holding capacity and moderately rapid permeability of the soils, sprinkler irrigation is best.

CAPABILITY UNIT IVw-3 (IRRIGATED)

Only one soil—Bowdoin clay loam (Bd)—is in this capability unit. This soil is moderately deep and poorly drained, and it has a clayey surface layer and subsoil. The soil is on bottom lands of the Arkansas River. Very slow permeability, a high water table, restricted internal drainage, and slight to moderate salinity limit its use for crops.

Wheat and sorghum are the main crops. Some alfalfa is grown, but a good stand is hard to maintain because of the high water table. Plowing under crop residues and using a commercial fertilizer will help to maintain fertility and to improve the tilth of the soil. At least one heavy irrigation is needed each year to leach out salts that have accumulated in the root zone. Leveling the land and using other engineering practices to conserve water are necessary.

CAPABILITY UNIT IVw-4 (IRRIGATED)

In this unit are moderately permeable, loamy to clayey, alluvial soils of bottom lands. The soils are along old stream channels and in the lower part of the Arkansas River Valley. They are shallow over coarse sand. A high water table, low water-holding capacity, a shallow root zone, and salinity are limitations to the use of these soils for field crops. The following soils are in this unit:

Las Animas clay loam (Lg).
Las-Las Animas complex (Ld).

Wheat and sorghum are the main crops grown. If the soils are irrigated, fertility and tilth can be maintained or improved by managing crop residues properly, applying commercial fertilizer as needed, and using irrigation water efficiently. Because these soils are shallow over coarse sand and are low in water-holding capacity, they need to be irrigated frequently with small amounts of water. Also, it is important to avoid mixing sand in the surface layer when the soils are leveled.

CAPABILITY UNIT IVw-5 (IRRIGATED)

Only one soil—Church clay, dark variant (Ca)—is in this capability unit. This soil is nearly level, deep, moderately dark colored, and calcareous. It is in the lower part of the Bear Creek depression.

There are many limitations to the use of this soil for crops. Very slow permeability restricts the movement of water and air. The soil is difficult to work, and it crusts readily. It takes up water slowly, stays wet for long periods after it is irrigated or flooded, and is readily compacted. An adequate seedbed is difficult to prepare in the clayey surface layer. In addition, floodwaters of streams that flow from the uplands sometimes damage crops and irrigation systems.

This soil is suited to wheat, sorghum, and alfalfa. Some melons are grown, but they are difficult to harvest because huge cracks that form in the dry soil destroy the vines and interfere with the harvesting equipment.

Favorable structure and tilth can be maintained by using a cropping sequence that includes a deep-rooted legume and managing the crop residues properly. Using a commercial fertilizer, as needed, helps to maintain fertility. Plowing and cultivating at different depths help to keep a tillage pan from forming. In some places it is necessary to level the areas to be irrigated if water is to be used efficiently.

Range Management [1]

In Kearny County rangeland occupies about 39 percent of the total acreage. The rangeland is scattered throughout the county, but a large acreage is in the sandhills south of the Arkansas River. Generally, the rangeland is not suited to cultivation.

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

Principles and practices of range management

Maintaining and improving the native vegetation will assure high yields of forage and the conservation of soil, water, and plants. To improve the vegetation, it is necessary to manage grazing so that the best native range plants will be encouraged.

The development of leaves, growth of the roots, formation of flower stalks, production of seed, regrowth of forage, and the storage of food in the roots are all essential stages in the development and growth of grass. To maintain maximum yields of forage and peak production of animals, grazing should be regulated to permit these natural processes of growth.

Livestock graze selectively; they seek out the more palatable plants. If grazing is not regulated carefully, the better plants are eventually eliminated. If heavy grazing is continued, even the second-choice plants are thinned out or eliminated and undesirable weeds or invaders take their place.

Research by agricultural workers and the experience of ranchers have shown that if only about half of the yearly volume of grass produced is grazed, damage to the more desirable plants is minimized and the range will improve. The forage left on the ground has the following effects on the range:

1. It serves as a mulch that allows the rapid intake of water; the more water stored in the soils, the better the growth of grass for grazing.
2. Roots grow so they can reach additional moisture and plant nutrients; overgrazed grass cannot reach deep moisture because too few green shoots are left to provide the food needed for roots to grow properly.
3. A good growth of grass protects the soils from erosion by wind and water; grass is one of the best kinds of cover for preventing erosion.
4. If grasses are vigorous, the better grasses can crowd out the weeds.
5. Plants can store food for quick and vigorous growth after droughts and in spring.

[1] PETER N. JENSEN, range conservationist, Soil Conservation Service, Dodge City, Kans., prepared this section.

6. Snow melts where it falls and soaks into the soils.
7. Plenty of grass also provides a reserve of feed for the dry years that otherwise might force the rancher to sell his livestock.

To manage the range properly, the operator needs to adjust the number of cattle he has on hand from season to season according to the supply of forage. Reserve pastures or supplies of other feed are needed during droughts or other periods when yields of forage are low in order that the range can be moderately grazed at all times. It is often a good plan to keep part of the livestock, such as stocker steers, readily salable. If this is done, the rancher can balance his herd to the amount of forage produced without selling breeding animals.

Management practices that improve the range and that cost little are defined as follows:

1. *Proper range use.*—This refers to the rate of grazing that maintains the vigor of the plants, reserves of forage, and enough residues to protect the soils and to conserve water. Grazing at this rate also helps to improve the quality of vegetation that has deteriorated.
2. *Deferred grazing.*—This practice consists of resting a pasture or range for a definite period during the growing season. It increases the vigor of the plants, permits the desirable plants to reproduce naturally by seed, and builds up a reserve of forage.
3. *Rotation-deferred grazing.*—This is a practice in which one or more pastures are rested at planned intervals throughout the growing season. Each pasture is given a different rest period each successive year to permit the desirable forage plants to develop and to produce seed.

The following are practices that also improve the range and help to control the movement of livestock.

1. *Range seeding.*—This practice is used to establish native or improved dominant grasses by seeding or reseeding land that is suitable for range. The land to be seeded should have a climate suited to range plants and soils that will naturally support the plants. A mixture of native grasses that consists primarily of species dominant in the climax vegetation should be seeded. Strains of each species that are known to be suited to the area can be used. Only grass seed that has been harvested within 250 to 400 miles south and 100 to 150 miles north of the site should be planted. The grasses should be seeded in the stubble of forage or grain. This type of cover protects the soils from erosion, provides a firm seedbed, and helps control weeds; the mulch helps to retain moisture in the upper layer of the soil. Newly seeded areas should not be grazed for at least 2 years. This gives the plants time to become firmly established.
2. *Water developments.*—Watering places should be located over the entire range, if feasible, so that livestock do not have to go far for water. Good distribution of water helps to achieve uniform use of the range. Generally, wells, ponds, and dugouts supply water for livestock, but in some areas water must be hauled. The makeup of each range determines which type of water development is the most practical.
3. *Fencing.*—Fences should be constructed to separate the ranges that are used for different purposes and during different seasons. In some places range sites that are large enough to be used alone need to be fenced if they differ greatly from an adjoining range site.
4. *Salting.*—This practice is necessary to supplement the native forage on the range. Moving the salt to a different area periodically will help distribute grazing.
5. *Weed and brush control.*—Chemical or mechanical means may be needed to control undesirable plants on some sites. This improves the quality of the forage on the range and also makes livestock easier to handle.

Management practices that encourage high production of forage and conserve the range are the following:

1. Furnish enough feed and forage to keep livestock in good condition throughout the year. At appropriate times and in suitable combinations, allow the animals to graze on the range, feed them concentrates and hay or harvested roughage, and allow them to graze on improved pasture. To guard against emergencies, grow surplus feed in good years and store it in stacks, pits, or silos.
2. Practice deferred grazing to allow the grass to make enough growth to protect the soils, to conserve water, and to provide reserve grazing.
3. Provide a breeding program that will keep the type of livestock best suited to the range, and plan so that calves will arrive in seasons when forage is most nutritious. Cull out nonproductive animals, and continually improve the herd by selective breeding.

Range sites

Different kinds of range produce different kinds and amounts of grass. If the operator is to manage his rangeland properly, he should know the different kinds of land, or range sites, in his holdings and the plants each site is capable of growing. He will then be able to use the management needed to produce the best forage plants on each site.

Range sites are areas of range that produce significantly different kinds or amounts of climax, or original, vegetation. A significant difference is one great enough to require different grazing or other management practices to maintain or improve the present vegetation.

Climax vegetation, or the climax plant cover, is the combination of plants that originally grew on a given site. The most productive combination of forage plants on rangeland is generally the climax type of vegetation.

Range condition is a term used to relate the current condition of the range to the potential of which the site is capable. It is expressed as the percentage of the climax, or natural, vegetation that is present on the site. Changes in range condition are caused primarily by the intensity of the grazing and by drought. Following are the different classes of range condition and the percentage of the climax vegetation present in each:

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Condition class:	*Percentage of climax vegetation on the site*
Excellent	76 to 100
Good	51 to 75
Fair	26 to 50
Poor	0 to 25

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

The soils of Kearny County have been grouped into the range sites described in this section. The description of each range site gives the important characteristics of the soils, the principal grasses, and information about how to use and manage the vegetation.

SALINE SUBIRRIGATED SITE

This site is made up of nearly level, somewhat poorly drained, saline and saline-alkali soils on the bottom lands of the Arkansas River. The texture of the surface layer ranges from clay loam to loamy sand. The soils receive extra moisture from flooding and from the high water table. The following soils are in this site:

Bowdoin clay loam (Bd).
Las clay loam, deep (Lb).
Las clay loam, moderately deep (La).
Las Animas clay loam (Lg).
Las Animas loamy sand (Lh).
Las Animas sandy loam (Lk).
Las-Las Animas complex (Ld).
Sweetwater clay loam (Sw).

The climax plant cover on this site is a mixture of alkali sacaton, switchgrass, Indiangrass, western wheatgrass, and other decreasers; saltgrass and other increasers; and alkali muhly, western ragweed, foxtail barley, tamarisk, and other common invaders. Decreasers, mainly alkali sacaton and switchgrass, make up at least 80 percent of the total cover on the site. Increasers, dominantly saltgrass, make up as much as 20 percent of the climax plant cover.

LOAMY LOWLAND SITE

This site consists of nearly level, deep soils that have a texture of sandy loam to clay loam. The soils are moderately permeable and are high in water-holding capacity. They receive extra moisture from occasional flooding or from runoff from higher areas. The following soils are in this site:

Alluvial land (An).
Goshen silt loam (Go).

The climax plant cover on this site is a mixture of switchgrass, big bluestem, Indiangrass, Canada wildrye, little bluestem, and other decreaser grasses and of western wheatgrass, blue grama, buffalograss, and other increasers. Increasers make up as much as 45 percent of the climax plant cover. The decreaser grasses make up at least 55 percent of the total plant cover on the site, and other perennial forbs and grasses make up the rest.

CLAY LOWLAND SITE

Only one soil—Church clay, dark variant (Ca)—is in this range site. This soil is nearly level and deep. It is slowly permeable and gives up water slowly to plants. This soil is high in water-holding capacity and is flooded occasionally or receives runoff from higher areas.

The climax plant cover consists mainly of decreaser grasses, such as western wheatgrass, switchgrass, big bluestem, and side-oats grama. The increaser grasses are blue grama and buffalograss. Annuals are the principal invaders.

LOAMY UPLAND SITE

This site is made up of nearly level to sloping soils of the uplands. The texture of the surface layer and subsoil of these soils is loam to clay loam. The soils are moderately permeable, well drained, and high in water-holding capacity. The following soils are in this site:

Bridgeport clay loam (Bp).
Colby silt loam, 1 to 3 percent slopes (Cb).
Colby silt loam, 3 to 5 percent slopes (Cc).
Mansic clay loam, 0 to 1 percent slopes (Ma).
Richfield silt loam, 0 to 1 percent slopes (Rm).
Richfield-Mansic complex, 1 to 3 percent slopes (Rx).
Ulysses silt loam, 0 to 1 percent slopes (Ua).
Ulysses silt loam, 1 to 3 percent slopes (Ub).
Ulysses silt loam, 3 to 5 percent slopes (Uc).

On this site the climax plant cover consists mainly of blue grama, buffalograss, western wheatgrass, side-oats grama, and little bluestem. If the site has been overgrazed, buffalograss is the main increaser. In most years annuals are the principal invaders, but prickly-pear is the common invader in droughty years.

LIMY UPLAND SITE

This site consists of nearly level to steeply sloping soils of the uplands. The soils have a surface layer and subsoil of loam to clay loam. They are moderately to strongly calcareous and are moderately permeable, well drained, and high in water-holding capacity. The following soils are in this site:

Colby silt loam, 5 to 15 percent slopes (Cd).
Mansker loam, 0 to 3 percent slopes (Mb).
Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded (Ue).
Ulysses-Colby silt loams, 3 to 5 percent slopes, eroded (Um).

The climax plant cover consists of a mixture of little bluestem, side-oats grama, blue grama, hairy grama, and buffalograss. The dominant decreasers are little bluestem and side-oats grama. The dominant increasers include buffalograss and broom snakeweed.

CLAY UPLAND SITE

In this site are nearly level to gently sloping soils of the uplands. The soils have a surface layer and subsoil of silty clay loam to silty clay. They are droughty and slowly permeable. The following soils are in this site:

Lofton silty clay loam (Lo).
Ulysses and Richfield soils, silted, 0 to 1 percent slopes (Ux).

The climax plant cover consists of a mixture of decreaser grasses, such as western wheatgrass, side-oats grama, big bluestem, and switchgrass. Buffalograss and blue grama are the main increaser grasses. The principal invaders are annuals.

SANDY SITE

The soils in this site are deep and nearly level to gently sloping. They are on uplands. Their surface layer is fine sandy loam, and their subsoil is sandy loam to clay loam. These soils are moderately permeable and are moderate to high in water-holding capacity. The following soils are in this site:

Bayard fine sandy loam (Ba).
Manter fine sandy loam, 0 to 1 percent slopes (Mf).
Manter fine sandy loam, 1 to 3 percent slopes (Mh).
Manter fine sandy loam, 3 to 5 percent slopes (Mk).

About 55 percent of the climax plant cover on this site is a mixture of decreaser grasses, such as sand bluestem, little bluestem, switchgrass, and side-oats grama. Other perennial grasses and forbs make up the rest. The principal increaser grasses are blue grama, buffalograss, sand dropseed, and sand paspalum. Sand sagebrush and small soapweed are the principal woody increasers. Common invaders are perennial three-awn and windmillgrass.

SANDS SITE

In this site are deep, nearly level to undulating soils that in some places resemble dunes. Their surface layer is loamy fine sand, and their subsoil ranges from loamy fine sand to clay loam. These soils are rapidly permeable and have low to high water-holding capacity, depending upon the texture of the subsoil. The following soils are in this site:

Dalhart-Vona loamy fine sands, 0 to 1 percent slopes (Dx).
Tivoli-Vona loamy fine sands (Tv).
Vona loamy fine sand (Vo).

About 65 percent of the climax plant cover is a mixture of decreaser grasses, such as sand bluestem, little bluestem, switchgrass, side-oats grama, and big sandreed. Other perennial grasses and forbs make up the rest. The dominant increaser grasses are blue grama, sand dropseed, and sand paspalum, and the principal woody increaser is sand sagebrush. Common invaders are false buffalograss, purple sandgrass, and red lovegrass.

CHOPPY SANDS SITE

This site is made up of deep soils that consist of fine sand. These soils are in the sandhills in hummocky to choppy areas that resemble dunes. Blowouts are numerous throughout the areas. The soils are rapidly permeable, somewhat excessively drained, and low in water-holding capacity. The following soils are in this site:

Active dunes (Ad).
Tivoli fine sand (Tf).
Tivoli-Dune land complex (Tx).

About 60 percent of the climax plant cover on this site is a mixture of decreaser grasses, such as sand bluestem, switchgrass, little bluestem, and big sandreed. Other perennial grasses and forbs make up the rest. The increaser grasses are mainly sand dropseed and sand paspalum. Sand sagebrush is the principal woody increaser. Blowoutgrass and big sandreed are the first perennial grasses to stabilize blowouts or dunes. Common invaders are false buffalograss and purple sandgrass.

GRAVELLY HILLS SITE

The soils in this site are gravelly, calcareous sandy loams and loams that are moderately deep over a variable substratum of coarse sand, gravel, and caliche. These soils are rapidly permeable and are low in water-holding capacity. The following soils are in this site:

Gravelly broken land (Gr).
Otero gravelly complex (Ox).

The climax plant cover consists of a mixture of decreaser grasses, such as little bluestem, side-oats grama, and sand bluestem. The increaser grasses are mainly blue grama, hairy grama, and sand dropseed. Sand sagebrush and small soapweed are the dominant woody increasers. Tumblegrass and other grasses that form a sod or mat are common invaders.

ROUGH BREAKS SITE

This range site is made up of Potter soils (Po). The soils have steep, somewhat broken slopes. Their surface layer ranges from loam to sandy loam, and caliche and limestone are near the surface. These soils are well drained and permeable. They are low in water-holding capacity.

About 60 percent of the climax plant cover is a mixture of such decreaser grasses as little bluestem and side-oats grama. Other perennial grasses and forbs make up the rest. The dominant increasers are blue grama, hairy grama, and sand dropseed. Broom snakeweed is a common invader.

UNSTABLE SITES

Because of the instability of the soils and the vegetation, the following soils are not true range sites, although they have been given the name Unstable sites:

Broken land (Bx).
Lincoln sand (Ln).

Broken land consists of alluvial sandy loam or clay loam along intermittent streams in the uplands. Lincoln sand is a nearly level to slightly hummocky, very sandy and gravelly soil along the Arkansas River.

The plant cover on both of these soils is unstable and sparse because winding channels of streams cut into the areas. The areas are subject to flooding and receive fresh deposits of material each time they are flooded. On Broken land the vegetation is mainly annual grasses and forbs, and on Lincoln sand it consists mostly of cottonwood, tamarisk, sand willow, and annual grasses.

Estimated yields of forage

The characteristics of the soils, the amount of rainfall, relief, the management practices used, and the amount of grazing all affect yields on the different range sites. In addition, rodents, insects, and trampling affect the annual yield of forage. The following gives the estimated average yield of forage for range sites that are in excellent condition and that have had the average amount of rainfall. The total yield of forage is given in pounds per acre and is based on air-dry weight.

Range site	*Pounds per acre*
Saline Subirrigated	3,000 to 4,000
Loamy Lowland	2,000 to 3,000
Clay Lowland	1,000 to 1,500
Loamy Upland	1,250 to 2,000
Limy Upland	1,500 to 2,250
Clay Upland	750 to 1,500
Sandy	1,500 to 2,000
Sands	2,000 to 2,500
Choppy Sands	1,250 to 1,750
Gravelly Hills	1,500 to 2,000
Rough Breaks	1,250 to 1,750

Wildlife Management

Managing the land to produce useful wildlife can be a part of the operation of the farm or ranch. Areas that are otherwise unproductive can be improved to provide food, cover, and water for wildlife. Ditches, streams, fence rows, old roads, odd areas, ponds, windbreaks, old gravel pits, irrigation ditches, and reservoirs are ideal habitats for wildlife. To improve these areas, it is necessary to control grazing and burning, to construct ponds, and to fence off ponds, streams, and ditches. Planting conifers and food-bearing shrubs will provide the food and winter cover wildlife need. Pheasant, quail, and doves need protected, grassy areas for nesting and trees and shrubs for cover.

Most birds need year-round woody and grassy cover in or along the borders of fields. The cover and food need to be close together. During severe winters, many birds find shelter in windbreaks. Fence rows provide food, cover, travel lanes, nesting sites, and protection from enemies. A few rows of uncut grain near the habitat will provide food in winter. Stripcropping, stubble mulching, and allowing crop residues to remain on the surface are all good practices to provide food and cover for wildlife. The seeds and waste grain that remains in the strips or in the crop residues are choice food for birds.

By developing and maintaining ponds, lakes, irrigation reservoirs, and other areas of open water, migrating ducks and geese can be attracted. Better fishing will result if more attention is given to constructing ponds that are the proper size and depth, to stocking with the right kinds and numbers of fish, to fertilizing the pond, and to controlling the weeds in the pond. The area around the pond ought to be protected from erosion.

In long-range planning, the farmer or rancher needs to adjust his operations according to the capabilities of the land so that he will protect cultivated crops, livestock, woodland, and wildlife. Providing habitats by protecting the soils and conserving water increases the number of birds and animals that live in an area. Planning so that the use of the soils for wildlife will fit into other uses yields not only the basic requirements of living, but also recreational and esthetic values.

Fish and wildlife provide food and recreation to farmers and ranchers and some income to business people in towns where sportsmen purchase supplies. Each fall many nonresident hunters come into the county to hunt pheasants. They hunt ducks along the Arkansas River, on Lake McKinney, and on the ponds and intermittent lakes. More information about managing areas for wildlife can be obtained from a local representative of the Soil Conservation Service or from the Kansas Forestry, Fish, and Game Commission.

Woodland Management

Kearny County has practically no native forests or woodland of any consequence. Small areas on flood plains along the Arkansas River, however, support scattered, mixed stands of cottonwood, tamarisk, willow, and Russian-olive. Because trees and shrubs have little chance of survival unless they receive extra moisture, plantings in this county have been limited to windbreaks for farmsteads and to trees for shade and ornament. The rather severe climate in this area limits the kinds of trees that can be grown. The small amount of precipitation, the wide range of temperature and the sudden changes in temperature, the severity and frequency of hailstorms and sleetstorms, the prevailing dry winds, and the alkalinity or salinity of some of the soils all affect the growth of trees and shrubs.

Windbreak plantings are desirable for protecting farmsteads. They can be maintained successfully if they are watered and cared for properly. Competition is great among the plants in the windbreak; therefore, frequent watering is important during periods of drought. Trees that have a bushy, compact root system need to be watered often. Aggressive trees whose roots reach out over a large area need to be watered thoroughly, but less frequently. Commercial or barnyard fertilizer may be added after the seedlings are planted. It is important to protect the plantings from fire, livestock, insects, and rabbits and to cultivate them to keep them free from weeds and grass. Rabbits are especially fond of young trees, so it is advisable to protect the trees until the plantings are at least 5 years old.

The uplands are not favorable sites for trees, because, in most years, there is too little rainfall to provide the necessary moisture. Extra moisture can be provided by irrigation, by diverting runoff from other areas, or by clean cultivation between the rows of trees and shrubs. The rows should be run on the contour if feasible. The trees most tolerant of drought and suitable for planting are eastern redcedar, Siberian (Chinese) elm, and Osage-orange.

In table 4 the soils suitable for growing trees and shrubs have been grouped in planting sites. The table shows the kind of trees that are suitable for windbreaks, the species best suited to each site, and the approximate average height that can be attained by the trees or shrubs in 10 years. Additional information about planting trees and developing windbreaks for farmsteads can be obtained from a local technician of the Soil Conservation Service.

Engineering Properties of the Soils [2]

Some properties of the soils affect design, construction, and maintenance of engineering structures. The most important of these properties are permeability, shear strength, consolidation characteristics, texture, plasticity, and reaction. Depth of consolidated material and topography are also important and need to be considered in locating sites for construction.

This section describes the outstanding engineering properties of the soils in the county and indicates the suitability of the soils for highway construction and for conservation engineering. It also gives brief descriptions of the classification systems used by engineers.

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[2] By CARL L. ANDERSON, civil engineer, and KENNETH H. SALLEE, soil scientist, Soil Conservation Service.

TABLE 4.—*Soils grouped into tree (windbreak) planting sites, suitable trees and shrubs on the soils of each site, and the average height attained by the trees after 10 years of growth on dryland and irrigated soils*

Tree planting site and soils	Suitable trees and shrubs	Approximate average height	
		Dryland	Irrigated land
		Feet	*Feet*
Silty upland: Bridgeport clay loam (Bp). Colby silt loam (Cb, Cc, Cd). Mansic clay loam (Ma). Mansker loam (Mb). Richfield silt loam (Rm). Richfield-Mansic complex (Rx). Ulysses silt loam (Ua, Ub, Uc). Ulysses-Colby silt loams (Ue, Um). Ulysses and Richfield soils, silted (Ux).	Tamarisk	10	15 to 18
	Russian-olive	12	22
	Osage-orange	15	22
	Mulberry	15	20 to 22
	Siberian elm	22	32 to 35
	Honeylocust	12	22 to 25
	Eastern redcedar	5 to 8	10 to 15
	Rocky Mountain juniper	5 to 7	9 to 12
	Ponderosa pine	5 to 8	8 to 12
	Skunkbush sumac	5 to 7	7 to 10
Sandy upland: Bayard fine sandy loam (Ba). Dalhart-Vona loamy fine sands (Dx). Manter fine sandy loam (Mf, Mh, Mk). Tivoli-Vona loamy fine sands (Tv). Vona loamy fine sand (Vo).	Tamarisk	10	15 to 16
	Russian-olive	10 to 14	20 to 25
	Osage-orange	12 to 14	20 to 22
	Mulberry	15 to 17	21 to 24
	Siberian elm	25	35
	Honeylocust	13 to 15	22 to 25
	Eastern redcedar	8 to 9	11 to 15
	Rocky Mountain juniper	8	11
	Ponderosa pine	6 to 9	10 to 15
	Skunkbush sumac	6 to 8	9 to 10
Well-drained lowland: Alluvial land (An). Goshen silt loam (Go).	Tamarisk	10	16 to 18
	Russian-olive	15	22 to 25
	Osage-orange	18	24
	Mulberry	18	24
	Siberian elm	25	32 to 36
	Honeylocust	15	22 to 25
	Eastern redcedar	8 to 10	12 to 15
	Rocky Mountain juniper	8 to 9	9 to 12
	Ponderosa pine	8 to 10	9 to 12
	Skunkbush sumac	7 to 9	10 to 12
Saline lowland: Bowdoin clay loam (Bd). Las clay loam, deep (Lb). Las clay loam, moderately deep (La). Las Animas clay loam (Lg). Las Animas loamy sand (Lh). Las Animas sandy loam (Lk). Las-Las Animas complex (Ld). Sweetwater clay loam (Sw).	Tamarisk	10	15 to 16
	Russian-olive	12 to 16	18 to 20
	Cottonwood	30	35
	Willow	12 to 15	20 to 25

The information in this report can be used to—

1. Make soil and land use studies that will aid in selecting and developing industrial, business, residential, and recreational sites.
2. Make preliminary estimates of the engineering properties of soils that will help in planning agricultural drainage systems, farm ponds, terraces, waterways, dikes, diversions, irrigation canals, and irrigation systems.
3. Make preliminary evaluations of soil and ground conditions that will aid in selecting locations for highways and airports and in planning detailed investigations of the selected locations.
4. Locate probable sources of gravel, sand, and other materials needed in construction.
5. Correlate performance of engineering structures with soil mapping units, and thus develop information that will be useful in designing and 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 the information obtained from other published maps and reports and aerial photographs for the purpose of making maps and reports that can be used readily by engineers.
8. Develop other preliminary estimates for construction purposes pertinent to the particular area.

The mapping and descriptions of the soils are somewhat generalized. The report, therefore, should be used only in planning more detailed field surveys to determine the in-place condition of the soil at the site proposed for engineering construction.

Some terms used by soil scientists have special meanings in soil science and may not be familiar to engineers. Most of these terms are defined in the Glossary.

Engineering classification systems

The United States Department of Agriculture system of classifying soil texture is used by soil scientists. In some ways this system is comparable to the two systems used by engineers for classifying soils. All three of these systems are described in the PCA Soil Primer (*5*).[3] The systems used by engineers are explained briefly as follows:

The American Association of State Highway Officials (AASHO) has developed a classification based on the field performance of soils (*1*). In this system soil materials are classified in seven principal groups. The groups range from A–1 (gravelly soils having high bearing capacity) to A–7 (clayey soils having low strength when wet). Within each group, the relative engineering value of the material is indicated by a group index number. Group indexes range from 0 for the best material to 20 for the poorest. The group index number is shown in parentheses, following the soil group symbol, if the classification is made from test data. Because test data are not available for the soils in Kearny County, the group classification is estimated and the group index is not indicated.

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

The soils are divided into (1) *granular materials* containing 35 percent or less material passing a No. 200 mesh sieve, and (2) *silt-clay materials* containing more than 35 percent passing a No. 200 mesh sieve. Whether a soil is silty or clayey depends on its plasticity index, or the numerical difference between the liquid limit and plastic limit. Fine material having a plasticity index of 10 or less is silty, and that having a plasticity index of more than 10 is clayey. The liquid limit is the moisture content at which the soil material passes from a plastic to a liquid state. The plastic limit is the moisture content at which the material passes from a solid to a plastic state.

Following are the general characteristics of the materials in each textural group:

1. *Granular materials:*
   - A–1 soils consist of well-graded mixtures that range from coarse to fine in texture and are nonplastic or weakly plastic. This group also includes coarse-textured material without silt or clay.
     - A–1–a soils consist predominantly of gravel or fragments of stone.
     - A–1–b soils consist predominantly of coarse sand.
   - A–2 soils are composed of many different granular materials that cannot be classified A–1 or A–3, because of their content of fines, plasticity, or both.
     - A–2–4 and A–2–5 soils include those granular materials that have plasticity characteristics of the A–4 and A–5 soil group.
     - A–2–6 and A–2–7 soils include those granular materials that have plasticity characteristics of the A–6 and A–7 soil groups.
   - A–3 soils consist primarily of fine sands and are deficient in material passing the No. 200 sieve, coarse sand, and gravel.
2. *Silt-clay materials:*
   - A–4 soils are composed predominantly of silt. They contain only a moderate to small amount of coarse material and only a small amount of sticky, colloidal clay.
   - A–5 soils are similar to A–4 soils except that they include very poorly graded soils containing such materials as mica and diatoms.
   - A–6 soils are composed predominantly of clay, but they contain moderate to negligible amounts of coarse material.
   - A–7 soils are composed predominantly of clay, as are the A–6 soils. Because of the presence of one-size particles of silt, organic matter, mica flakes, or lime carbonate, however, they are elastic.
     - A–7–5 soils represent those A–7 soils that have a moderate plasticity index in relation to liquid limit.
     - A–7–6 soils represent those A–7 soils that have a high plasticity index in relation to liquid limit.

Some engineers prefer to use the Unified Soil Classification system (*9*). In this system the soils are identified according to their texture and plasticity and are grouped according to their performance as engineering construction materials. The system established 15 soil groups, which are divided as (1) coarse-grained soils (eight classes), (2) fine-grained soils (six classes), and (3) highly organic soils.

The following shows the major divisions of soils that are recognized in this survey and brief definitions of the group symbols that are used in the Unified Classification system.

Coarse-grained soils (More than half of the material is too large to pass through a No. 200 sieve).
- Sands (More than half of coarse fraction will pass through a No. 4 sieve).
  - *Clean sands* (Little or no fines).
    - SW Well-graded sands and gravelly sands.
    - SP Poorly graded sands and gravelly sands.
  - *Sands with fines* (Appreciable amount of fines).
    - SM Silty sands and sand-silt mixtures.
    - SC Clayey sands and sand-clay mixtures.

Fine-grained soils (More than half of material is small enough to pass through a No. 200 sieve).
- *Silts and clays* (Liquid limit less than 50).
  - ML Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts of slight plasticity.
  - CL Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, and lean clays.
- *Silts and clays* (Liquid limit greater than 50).
  - MH Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, and elastic silts.
  - CH Inorganic clays of high plasticity, and fat clays.

Brief descriptions of the soils

This section is intended as a reference guide and not as a manual for using soil materials in engineering. A brief description of the soils of the county is given in table 5, and estimated physical properties of the soils are described that are significant to engineering. Test data were not available for the soils in Kearny County. The data in table 5, therefore, are based on results of laboratory tests of similar soils in Ford, Logan, and Morton Counties; on soil tests made by engineers of the State Highway Commission of Kansas at the site of construction; on experiences with the same kinds of soils in other counties; and on information in other sections of this report.

Generally, properties are given for the typical profile in each soil series. The soil profile is made up of layers, or horizons, and the depth of each layer is given in inches. More complete profile descriptions are given in the section "Formation, Classification, and Morphology of Soils."

Depth to bedrock and to consolidated, calcareous deposits, or caliche, are not given for all the soils. The depth varies according to the physiographic position of the soil and the topography. Where the calcareous deposits are less than 10 feet below the surface, the approximate depth is given in the description of the soil and the site. The layers of caliche or of mixed gravel, sand, silt, and clay commonly occur in deposits of Pliocene and Pleistocene age. In some areas these materials have been used for surfacing roads. The Potter soils are a good source of such materials, and pockets of these materials also occur within areas of Otero and Colby soils along the side slopes that border streams in the uplands.

Greenhorn limestone and Graneros shale outcrop between Hartland and the Hamilton County line along the bluffs adjacent to the Arkansas River Valley. Sandstone of the Dakota formation also outcrops at the base of the sandhills and in the Arkansas River Valley across the river from Hartland. A more detailed discussion of the geology of Kearny County is given in the section "Formation, Classification, and Morphology of Soils."

In table 5, depth to a seasonally high water table is mentioned only for those soils that may be affected by it if they are used for engineering. In most of the soils, the water table is not high enough to affect engineering. Depth to the water table varies, however, as the result of variations in elevation and in the kind of geologic material that underlies the soils. Depth to the water table in the nearly level soils of the uplands ranges from about 240 feet northwest of Lakin to about 25 feet north of Deerfield. The water table underlies most of the areas of sandhills and is at a depth between 25 and 120 feet.

In table 5 the soils are classified according to the textural classes of the U.S. Department of Agriculture. Each important layer is also classified according to the Unified and AASHO systems.

The columns that show the percentage passing through sieves of various sizes indicate the relative amounts of coarse-grained and fine-grained material. The percentage passing the No. 200 sieve is the fine-grained fraction of the material. The grain-size analyses in this table were based on tests made by combined sieve and hydrometer methods.

Permeability is the ability of the soil to transmit water or air. It is measured by determining the rate at which water percolates through the soil. In table 5 the column that shows permeability gives the estimated rate in inches per hour.

The column that shows available water capacity gives the amount of moisture that the soil can hold in a form available to plants. It is the amount of moisture held between field capacity and the permanent wilting point.

The salinity of the soils is estimated according to the electrical conductivity of the soil saturation extract, expressed in millimhos per centimeter. Only a limited number of analyses for salinity were available for the soils in this county. The relative terms used in table 5 to indicate salinity, and their equivalent in millimhos per centimeter, are as follows:

	Millimhos per centimeter
None	0 to 2
Slight	2 to 4
Moderate	4 to 8
Severe	8 to 16
Very severe	More than 16

The analyses show an increase in the amount of salts that have accumulated in the subsoil in some areas of Las soils under irrigation. They also show that some areas of the Las soils have an accumulation of both salts and alkali. Alkali soils contain more than 15 percent exchangeable sodium or have a pH of 8.5 or higher, and some have both. In the Ulysses and Richfield undifferentiated soil group, salinity has increased slightly in the subsoil and to a great degree in the substratum.

Salinity is more of a problem in the Bowdoin and Sweetwater soils than in the other soils of the county, and dispersion may be a problem in some areas of these soils. The slowly permeable clay subsoil of the Bowdoin soils restricts the movement of water through the profile, thus allowing salts to accumulate. The Sweetwater soils range from moderately saline to saline-alkali.

The ratings in the column that shows shrink-swell potential indicate the volume change, that is, how much the soil shrinks when it dries and how much it swells as it takes up moisture. Typical examples of soils that have a high shrink-swell potential are the Bowdoin, Church, and Lofton soils. These soils shrink greatly when they dry and swell when they are wet. The Tivoli soils are examples of soils that have a low to very low shrink-swell potential. Knowledge of the shrink-swell potential is important in planning the use of a soil for roads or for other engineering structures.

Reaction is not shown in table 5, but most of the soils are neutral to moderately alkaline. The pH of the surface layer and subsoil ranges from 7.0 to 8.5, and that of the substratum, from 7.9 to 8.5.

Interpretations of engineering properties of soils

In table 6 the suitability of the soils for various engineering uses is indicated. In this table are also indicated the characteristics of the soils that affect the use of the soils for highways and for conservation engineering practices.

The suitability of the soils as a source of topsoil is indicated because topsoil is important for establishing vegetation on embankments, on the shoulders of roads, in ditches, and on cut slopes. Each layer of the soil profile was considered as a possible source of topsoil. Consequently, in some soils the surface layer may have a different rating than the subsoil as a source of topsoil because the subsoil contains clayey or sandy material or caliche. In many places, as on embankments and on cut slopes, some part of the soil material can be used as topsoil whether it is still in place or has been moved. Generally, slopes cut through silty soils can be seeded without adding a layer of topsoil. On the more sandy Tivoli and Vona soils, however, a layer of suitable topsoil will be needed before the slopes can be seeded.

Sand and gravel in quantities of commercial value are in pockets along gravelly terraces, and they are at the surface in areas between the sandhills and the Arkansas River Valley. Deposits of sand and gravel are also in the Lincoln, Otero, and Potter soils. Mixed and stratified layers of sand and gravel underlie the Las, Las Animas, Lincoln, Bowdoin, and Sweetwater soils at a depth of 20 to 50 inches. Also, many pockets of sand and gravel are on or near the surface along old, winding channels of streams in the Arkansas River Valley and along intermittent streams in the uplands. The Tivoli soils are a dependable source of large quantities of fine quartz sand.

The suitability of the soil material for road fill depends largely on the texture of the soil material and on its natural water content. Highly plastic soil material with high natural water content is rated "Poor." Highly erodible soils (silts and fine sands) are difficult to compact and require moderately gentle slopes and fast vegetative coverage; therefore, they are rated "Poor to fair."

TABLE 5.—*Brief description of the soils*

Map symbol	Soil	Soil description	Depth of horizon	USDA textural class
			Inches	
Ad	Active dunes.	Actively shifting fine sand in hilly ridges and cone-shaped dunes; lacks a definite soil profile.	0 to 60	Fine sand
An	Alluvial land.	Stratified loamy and sandy soil material on valley floors along streams in the uplands; subject to occasional flooding and deposition.	(1)	(1)
Ba	Bayard fine sandy loam.	48 inches of fine sandy loam stratified with loam and loamy sand; on slightly undulating alluvial fans; well drained; water table is at a depth of more than 10 feet.	0 to 48	Fine sandy loam
Bd	Bowdoin clay loam.	From 0 to 20 inches of clay loam over stratified, clayey alluvium that is underlain by sandy and gravelly material; occurs in nearly level areas or in slight depressions in alluvial terraces along the Arkansas River; slow internal drainage; fluctuating water table is within 10 feet of the surface.	0 to 5 5 to 42 42 to 51 51 to 64	Clay loam Clay to clay loam Sandy loam Sand and gravel
Bp	Bridgeport clay loam.	About 6 to 10 feet of calcareous clay loam on nearly level alluvial fans and aprons.	0 to 48	Clay loam
Bx	Broken land.	Steep, alluvial sandy loams to clay loams along intermittent streams in the uplands; subject to scouring and deposition.	(1)	(1)
Ca	Church clay, dark variant.	Deep, calcareous clay in the lower part of the Bear Creek depression; nearly level; very slowly permeable.	0 to 64	Clay
Cb Cc Cd	Colby silt loam, 1 to 3 percent slopes. Colby silt loam, 3 to 5 percent slopes. Colby silt loam, 5 to 15 percent slopes.	From 3 to 12 feet of calcareous silt loam formed in loess over deposits of mixed outwash material of the Pleistocene age; sloping soils of uplands.	0 to 52	Silt loam
Dx	Dalhart-Vona loamy fine sands, 0 to 1 percent slopes. (Data for Dalhart loamy fine sand.)	The Dalhart soils consist of 5 to 18 inches of loamy fine sand over 15 to 26 inches of sandy clay loam that is underlain by sandy loam. The Vona soils consist of 6 to 20 inches of loamy fine sand over 19 to 40 inches of fine sandy loam that is underlain by loamy fine sand. The Dalhart and Vona soils overlie partly reworked, sandy deposits of Pleistocene age and are on nearly level flats in the sandhills; deep; well drained.	0 to 12 12 to 30 30 to 64	Loamy fine sand Sandy clay loam Fine sandy loam
Go	Goshen silt loam.	From 8 to 20 inches of silt loam over 8 to 14 inches of silty clay loam that is underlain by calcareous silt loam; soils formed in colluvial and alluvial sediments washed from higher areas in the uplands; nearly level; deep; well drained; subject to occasional flooding and deposition.	0 to 18 18 to 24 24 to 48	Silt loam Silty clay loam Silt loam
Gr	Gravelly broken land.	Steep, rough, and broken, gravelly and sandy areas and small areas of loamy soils; outcrops of gravel and caliche of the Pliocene and Pleistocene ages; slopes range from 15 to 40 percent.	(1)	(1)
La Lb	Las clay loam, moderately deep. Las clay loam, deep.	From 30 to 60 inches of clay loam over 3 to 8 inches of sandy loam or loamy sand that is underlain by sand and gravel; on nearly level alluvial terraces in the Arkansas River Valley; somewhat poorly drained; fluctuating water table is seasonally within 10 feet of the surface.	0 to 33 33 to 40 40+	Clay loam Loamy sand Sand and gravel
Ld	Las-Las Animas complex.	See descriptions of Las and Las Animas soils.		

See footnotes at end of table.

and their estimated physical properties

Engineering classification		Percentage passing—			Permeability	Available water capacity	Salinity	Shrink-swell potential
Unified	AASHO	No. 4 sieve	No. 10 sieve	No. 200 sieve				
		Percent	*Percent*	*Percent*	*Inches per hour*	*Inches per inch*		
SP–SM or SM.	A–2–4 or A–3.	100	100	5 to 20	2. 0 to 5. 0	0. 04	None	Low.
(1)	(1)	(1)	(1)	(1)	(1)	(1)	None	(1).
SM	A–2–4	95 to 100	95 to 100	20 to 30	0. 5 to 1. 0	. 13	None	Low.
CL	A–7	95 to 100	95 to 100	85 to 95	0. 2 to 0. 5	. 18	None to moderate	Moderate.
CH	A–7–6	95 to 100	95 to 100	90 to 100	0. 05 to 0. 2	. 17	Slight to severe	High.
SM	A–2–4	95 to 100	95 to 100	20 to 30	0. 5 to 1. 0	. 12	Slight to moderate	Low.
SP	A–1–b	95 to 100	80 to 95	0 to 10	5. 0 +	. 03	None to moderate	Very low.
CL	A–6	95 to 100	95 to 100	85 to 95	0. 2 to 0. 5	. 18	None	Moderate.
(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1).
CH	A–7–6	100	100	90 to 100	(2)	. 17	None	High.
ML–CL	A–6	100	100	85 to 95	0. 2 to 0. 5	. 19	None	Moderate.
SM	A–2–4	100	100	10 to 20	2. 0 to 5. 0	. 08	None	Low.
SC	A–2 or A–4	100	100	30 to 40	0. 5 to 1. 0	. 18	None	Low.
SM	A–2–4	100	100	20 to 30	1. 0 to 2. 0	. 13	None	Low.
ML–CL	A–4	100	95 to 100	85 to 95	0. 2 to 0. 5	. 19	None	Moderate.
CL	A–6	100	95 to 100	85 to 95	0. 2 to 0. 5	. 18	None	Moderate.
ML–CL	A–4 or A–6	100	95 to 100	85 to 100	0. 2 to 0. 5	. 19	None	Moderate.
(1)	(1)	(1)	(1)	(1)	(1)	(1)	None	(1).
CL	A–7	95 to 100	95 to 100	85 to 95	0. 2 to 0. 5	. 18	None to moderate	Moderate to high.
SM	A–2–4	95 to 100	85 to 100	10 to 20	2. 0 to 5. 0	. 06	None to slight	Low.
SP	A–1–b	95 to 100	80 to 95	0 to 10	5. 0+	. 03	None to slight	Very low.

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TABLE 5. *Brief description of the soils and*

Map symbol	Soil	Soil description	Depth of horizon	USDA textural class
			Inches	
Lg	Las Animas clay loam.	From 8 to 20 inches of clay loam over 5 to 18 inches of sandy loam that is underlain by deposits of stratified sand and gravel; on nearly level alluvial terraces in the Arkansas River Valley; somewhat poorly drained; fluctuating water table is seasonally within 10 feet of the surface.	0 to 15 15 to 20 20 to 40+	Clay loam Sandy loam Loamy sand, sand, and gravel.
Lh	Las Animas loamy sand.	Stratified, sandy alluvial soil; somewhat more sandy than Las Animas clay loam and Las Animas sandy loam, but similar to these soils in other characteristics.	0 to 20 20 to 40	Loamy sand Sand and gravel
Lk	Las Animas sandy loam.	Sandy alluvial soil; similar to Las Animas loamy sand, except that it has less sand in the upper 30 inches; thin, clayey layers at a depth of more than 20 inches.	0 to 31 31 to 50+	Sandy loam Sand and gravel
Ln	Lincoln sand.	From 4 to 10 inches of loamy sand and fine sand over 10 feet of stratified fine, medium, and coarse sand and thin layers of loam and clay; on the slightly undulating lower flood plains of the Arkansas River; subject to occasional flooding, scouring, and deposition.	0 to 4 4 to 18 18 to 40+	Loamy sand Fine sand Coarse sand and gravel.
Lo	Lofton silty clay loam.	From 4 to 8 inches of silty clay loam over 12 to 20 inches of heavy silty clay loam or light clay that is underlain by more than 48 inches of silt loam or light silty clay loam; in enclosed depressions in the uplands where water is ponded after rainstorms.	0 to 8 8 to 24 24 to 63	Silty clay loam Clay Silt loam
Ma	Mansic clay loam, 0 to 1 percent slopes.	Deep, calcareous clay loam formed in loamy outwash of Pleistocene age; occupies nearly level to slightly concave areas.	0 to 44+	Clay loam
Mb	Mansker loam, 0 to 3 percent slopes.	From 10 to 20 inches of calcareous loam over clay loam that is from 30 to 60 percent lime; slightly indurated and partly weathered, hard caliche in some areas; formed in outwash material of the Pleistocene age.	0 to 14 14 to 40+	Loam Clay loam
Mf Mh Mk	Manter fine sandy loam, 0 to 1 percent slopes. Manter fine sandy loam, 1 to 3 percent slopes. Manter fine sandy loam, 3 to 5 percent slopes.	From 17 to 30 inches of fine sandy loam over sandy loam or loam; formed in reworked, sandy outwash material of the Pleistocene age.	0 to 17 17 to 50+	Fine sandy loam Loam to fine sandy loam.
Ox	Otero gravelly complex.	Sandy loam over partly cemented sand and gravel; outcrops of gravel and caliche of Pleistocene age; mixed with gravelly soils that are too variable for characteristics to be estimated; 5 to 15 percent slopes.	0 to 19 19 to 36 36 to 40+	Sandy loam Loam Sand and gravel
Po	Potter soils.	From 2 to 12 inches of loam and sandy loam over hard caliche; outcrops of caliche, limestone, and shale; on rough and broken slopes in the uplands; slopes range from 5 to 25 percent.	0 to 5 5 to 11	Loam Clay loam (caliche)
Rm	Richfield silt loam, 0 to 1 percent slopes.	From 4 to 10 inches of silt loam over 8 to 16 inches of silty clay loam that is underlain by 5 to 12 feet of silt loam or loam formed in loess; on long, smooth slopes in the uplands; deep; well drained.	0 to 4 4 to 28 28 to 40	Silt loam Silty clay loam Silt loam
Rx	Richfield-Mansic complex, 1 to 3 percent slopes.	See descriptions of Richfield and Mansic soils.		

See footnotes at end of table.

their estimated physical properties—Continued

Engineering classification		Percentage passing—			Permeability	Available water capacity	Salinity	Shrink-swell potential
Unified	AASHO	No. 4 sieve	No. 10 sieve	No. 200 sieve				
		Percent	*Percent*	*Percent*	*Inches per hour*	*Inches per inch*		
CL	A-7	95 to 100	95 to 100	85 to 95	0. 2 to 0. 5	0. 18	None to moderate	Moderate.
SM	A-2-4	95 to 100	95 to 100	20 to 30	0. 5 to 1. 0	. 12	None to slight	Low.
SP	A-1-b	95 to 100	80 to 95	0 to 10	5. 0+	. 03	None to slight	Very low.
SM	A-2	95 to 100	85 to 100	10 to 20	2. 0 to 5. 0	. 06	None to slight	Low.
SP	A-1-b	95 to 100	80 to 95	0 to 10	5. 0+	. 03	None to slight	Very low.
SM	A-2-4	95 to 100	95 to 100	20 to 30	0. 5 to 1. 0	. 12	None to slight	Low.
SP	A-1-b	95 to 100	80 to 95	0 to 10	5. 0+	. 03	None to slight	Very low.
SM	A-2	100	90 to 100	10 to 20	2. 0 to 5. 0	. 06	None to slight	Low.
SP	A-1-b	100	90 to 95	0 to 10	5. 0+	. 04	None to slight	Very low.
SP	A-1-b	90 to 95	80 to 95	0 to 10	5. 0+	. 03	None to slight	Very low.
CL	A-7-6	100	100	90 to 100	0. 05 to 0. 2	. 18	None	Moderate to high.
CH	A-7-6	100	100	95 to 100	(2)	. 17	None	High.
ML-CL	A-7-6	100	100	95 to 100	0. 2 to 0. 5	. 19	None	Moderate.
CL	A-6	100	100	85 to 95	0. 2 to 0. 5	. 18	None	Moderate.
CL	A-6	95 to 100	85 to 95	50 to 70	0. 5 to 1. 0	. 19	None	Moderate.
CL	A-6	95 to 100	80 to 95	50 to 70	0. 2 to 0. 5	. 18	None	Moderate.
SM	A-2-4	100	95 to 100	25 to 35	0. 5 to 1. 0	. 13	None	Low.
CL or SM	A-6	100	95 to 100	45 to 55	0. 5 to 1. 0	. 16	None	Moderate to low.
SM	A-2-4	90 to 100	85 to 95	20 to 30	0. 5 to 1. 0	. 13	None	Low.
CL	A-6	90 to 100	85 to 95	45 to 60	0. 5 to 1. 0	. 18	None	Moderate.
SP	A-1-b	80 to 95	60 to 80	0 to 10	5. 0+	. 03	None	Low.
CL	A-6	90 to 100	85 to 95	45 to 60	0. 5 to 1. 0	. 18	None	Moderate.
SC	A-6	95 to 100	90 to 100	40 to 50	(1)	(1)	None	Moderate.
CL	A-4 or A-6	100	100	85 to 95	0. 2 to 0. 5	. 19	None	Moderate.
CL	A-7-6	100	100	90 to 100	0. 2 to 0. 5	. 18	None	Moderate to high.
ML-CL	A-7-6	100	100	90 to 100	0. 2 to 0. 5	. 19	None	Moderate.

TABLE 5.—*Brief description of the soils and*

Map symbol	Soil	Soil description	Depth of horizon	USDA textural class
			Inches	
Sw	Sweetwater clay loam.	Calcareous clay loam stratified with sandy loam and sand to a depth of 20 to 36 inches and underlain by sandy and gravelly material; nearly level, alluvial soil in the lower part of the Arkansas River Valley; saline to alkali; poorly drained; fluctuating water table between 2 and 8 feet from the surface.	0 to 23 23 to 28 28 to 30+	Clay loam Loamy sand Sand and gravel
Tf	Tivoli fine sand.	From 5 to 30 feet of loose, noncalcareous fine sand; undulating to choppy dune topography of sandhills.	0 to 40+	Fine sand
Tx	Tivoli-Dune land complex.	Same as Tivoli[1] fine sand, but contains numerous blowouts.		
Tv	Tivoli-Vona loamy fine sands.	See descriptions of Tivoli and Vona soils.		
Ua Ub Uc	Ulysses silt loam, 0 to 1 percent slopes. Ulysses silt loam, 1 to 3 percent slopes. Ulysses silt loam, 3 to 5 percent slopes.	About 3 to 8 inches of silt loam over 10 to 25 inches of light silty clay loam that is underlain by silt loam formed in loess; deep, well-drained, nearly level to sloping soils of uplands.	0 to 5 5 to 27 27 to 48	Silt loam Light silty clay loam Silt loam
Ue Um	Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded. Ulysses-Colby silt loams, 3 to 5 percent slopes, eroded.	See descriptions of Ulysses and Colby soils.		
Ux	Ulysses and Richfield soils, silted, 0 to 1 percent slopes.	See descriptions of Ulysses and Richfield soils; water used for irrigation has deposited from 5 to 15 inches of silty clay loam on the surface of these soils.	0 to 40 40 to 60	Silty clay loam Silt loam
Vo	Vona loamy fine sand.	From 6 to 20 inches of loamy fine sand over 19 to 40 inches of fine sandy loam that is underlain by loamy fine sand; formed in partly reworked sandy material of the Pleistocene age; undulating; deep, well-drained soils of the uplands.	0 to 8 8 to 40 40 to 52	Loamy fine sand Fine sandy loam Loamy fine sand

[1] Variable.

During wet seasons, some soils are ponded or have a high water table. Roads across these soils should be constructed on embankment sections, or a good system of surface drains or underdrains needs to be provided. The Church and Lofton soils, for example, are in depressions; they have slow to very slow permeability and poor surface drainage, and they are occasionally flooded by the accumulation of runoff from higher areas. The Bowdoin, Las, Las Animas, and Sweetwater soils are in the Arkansas River Valley. They have a seasonally high water table that may affect the foundations of roads.

The layers of clay in the Bowdoin, Church, and Lofton soils shrink greatly when they dry and swell when they are wet. If these soils are used in a subgrade and are too wet when the pavement is constructed above them, they shrink and dry out under the edges of the pavement. Then the pavement is likely to crack. If these soils are used as a subgrade when they are too dry, they will swell as they absorb moisture. As a result, the pavement warps. Pavements laid over plastic soils will crack and warp less if a granular base course is used beneath the pavement. Extending this foundation base course through the shoulders of the road will also provide adequate drainage. Therefore, in table 6, these soils are rated "Poor" as to their stability for subgrade. The Tivoli and Vona soils are subject to serious wind erosion when they are not protected by a cover of plants. Therefore, the hazard of erosion is severe on the shoulders of roads, in ditches, and in cut slopes if roads are constructed through these sandy soils.

In table 6, the Bowdoin, Church, Las, Las Animas, Lofton, and Sweetwater soils are rated as not suitable as sites *their estimated physical properties*—Continued

Engineering classification		Percentage passing—			Permea-bility	Available water capacity	Salinity	Shrink-swell potential
Unified	AASHO	No. 4 sieve	No. 10 sieve	No. 200 sieve				
		Percent	*Percent*	*Percent*	*Inches per hour*	*Inches per inch*		
CL	A-7	95 to 100	95 to 100	80 to 95	0.2 to 0.5	0.18	Slight to very severe	Moderate.
SM	A-2-4	95 to 100	85 to 100	10 to 20	2.0 to 5.0	.06	Slight to moderate	Low.
SP	A-1-b	95 to 100	80 to 95	0 to 10	5.0+	.03	None to moderate	Very low.
SP-SM	A-2-4	100	100	5 to 20	3.0 to 5.0	.04	None	Low.
ML-CL	A-6	100	100	80 to 95	0.2 to 0.5	.19	None	Moderate.
ML-CL	A-6	100	100	85 to 100	0.2 to 0.5	.19	None	Moderate.
ML-CL	A-6	100	100	80 to 95	0.2 to 0.5	.19	None	Moderate.
CL	A-7-6	100	100	90 to 100	0.1 to 0.3	.18	None to moderate	Moderate to high.
ML-CL	A-6	100	100	90 to 100	0.2 to 0.5	.19	None to moderate	Moderate.
SM	A-2-4	100	100	10 to 20	1.0 to 2.0	.08	None	Low.
SM	A-2-4	100	100	20 to 35	0.5 to 1.0	.13	None	Low.
SM	A-2-4	100	100	10 to 20	1.0 to 2.0	.08	None	Low.

[2] Less than 0.05.

for reservoirs or for pond embankments. These soils are nearly level. They are in valleys or in depressions in the uplands that lack natural drainage. The topography in those areas is such that sites for farm ponds generally do not exist. Dugouts could be constructed, however, in the depressions where the Church and Lofton soils occur. The Otero, Potter, and Bayard soils are not suitable as sites for ponds, because they contain stratified layers of sand and gravel in some places. Sand pockets commonly occur in the bottom of drainage channels at any of the pond sites in the county. Reservoirs and embankments in areas of Lincoln sand would be subject to large losses from seepage. The Lincoln and Manter soils are subject to piping. There are no suitable sites for ponds in the Dalhart, Tivoli, and Vona soils.

It is not practical to construct drains in the Bowdoin, Las, Las Animas, Lincoln, and Sweetwater soils, because of athe seasonally high water table. Drains are difficult to construct in the Lofton and Church soils because possible outlets are remote; the Lofton soil occurs in depressions in the uplands where good natural drainage has not developed. The Church soil is in the lower part of the Bear Creek depression.

The soil properties and limitations that affect irrigation are discussed in the section "Management of Irrigated Soils." Terraces and diversions are not needed on the level or nearly level soils in the county. Terraces are not suitable for use on the Tivoli and Vona soils, because these soils are in undulating to hummocky areas and are subject to wind erosion.

Waterways are not needed on some of the soils. Wind erosion is a hazard to the waterways. Windblown materials accumulate in the waterways, smother the vegetation, and hinder the flow of water.

TABLE 6.—*Interpretation of*

Soil series and map symbol	Suitability as source of—					Highway location
	Topsoil	Sand	Gravel	Fill [1]	Subgrade [1]	
Bayard (Ba)	Fair	Poor	Unsuitable; localized pockets.	Good	Fair	Moderate erodibility.
Bowdoin (Bd)	Good in surface layer; poor in subsoil.	Unsuitable in upper part of profile; fair in substratum; poorly graded.	Unsuitable in upper part of profile; fair in substratum; poorly graded.	Fair	Poor; fair below a depth of 3 to 4 feet.	High water table; subsoil highly plastic.
Bridgeport (Bp)	Good	Unsuitable	Unsuitable	Good	Fair	(3)
Church (Ca)	Poor	Unsuitable	Unsuitable	Fair	Poor	Highly plastic; slow permeability.
Colby (Cb, Cc, Cd)	Good	Unsuitable	Unsuitable	Fair; erodible	Good	(3)
Dalhart (Dx)	Poor in surface layer, good in subsoil.	Fair	Unsuitable	Good	Good	Moderate permeability and erodibility.
Goshen (Go)	Good	Unsuitable	Unsuitable	Good	Fair	Occasional flooding and resulting deposition.
Las (La, Lb, Ld)	Good	Unsuitable in upper part of profile; fair in substratum; poorly graded; high water table.	Poor in upper part of profile; fair in substratum; poorly graded; high water table.	Good	Poor to fair	High water table

See footnotes at end of table.

engineering properties of soils

Soil features affecting engineering practices						
Dikes and canals	Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways
	Reservoir area	Embankment				
Well graded; moderate stability and permeability.	Occasional strata of sand; moderate to rapid permeability.	Well-graded material; moderate shear strength and stability; moderate erodibility.	Well drained; moderate permeability; low plasticity.	Limited water-holding capacity; sand pockets; well drained; moderate permeability.	(2)	Moderate stability and erodibility; friable.
Very slow permeability; low shear strength; poor stability and compaction; high shrink-swell potential.	(2)	(2)	Very slow permeability; drainage difficult because of fluctuating water table.	Very slow permeability; poorly drained; high, fluctuating water table; saline to alkali.	(2)	Moderate stability and erodibility; saline alkali.
Deep; moderate stability and permeability.	Moderately slow permeability.	Moderate shear strength and stability; compaction fair to good; high compressibility.	Well drained; moderately slow permeability; plasticity moderate.	Deep; well drained; moderately slow permeability; high water-holding capacity.	Deep; friable; moderate stability and plasticity; permeability moderately slow.	Deep; friable and fertile; moderate stability; low erodibility.
High plasticity and shrink-swell potential; poor stability and compaction.	(2)	(2)	Deep; very slow permeability; highly plastic; outlets remote.	Deep; high water-holding capacity; very slow permeability; high shrink-swell potential; occasionally flooded.	(2)	(2).
Moderately erodible; low to moderate shear strength and plasticity.	Deep; moderate permeability; stream channels may contain rapidly permeable sand.	Moderate to low stability, shear strength, and plasticity; moderate to high compaction and compressibility.	Deep; well-drained sloping soils over permeable deposits of outwash material.	Sloping; high water-holding capacity; moderate permeability; deep; friable.	Deep; friable; sloping; moderate to high erodibility.	Deep; friable; sloping; moderate to high erodibility; moderate to low stability.
Moderate stability, erodibility, and plasticity; good compaction.	(2)	(2)	Well drained; deep; moderate permeability, medium plasticity; good structure.	Moderately rapid permeability; moderately low water-holding capacity; moderate erodibility.	Nearly level; moderately rapid permeability.	Deep; moderately stable and erodible; well drained; good structure.
Moderate permeability; fair compaction; moderately erodible.	Deep; moderate permeability; moderate shrink-swell.	Moderate shear strength, permeability, and plasticity; moderate to high compressibility.	Deep; well drained; moderate permeability; good structure; moderate to high erodibility.	Moderate to rapid permeability; high water-holding capacity; fertile; nearly level.	Deep; friable; nearly level; moderate to high erodibility.	Good structure; friable; moderate to high erodibility; moderately stable.
Good compaction; moderate to low shrink-swell potential and erodibility	(2)	(2)	Seasonally high water table.	Poorly drained; high fluctuating water table; slight to moderate salinity.	(2)	Moderate stability and erodibility; outlets remotely situated.

TABLE 6.—*Interpretation of engineering*

Soil series and map symbol	Suitability as source of—					
	Topsoil	Sand	Gravel	Fill [1]	Subgrade [1]	Highway location
Las Animas (Lg, Lh, Lk).	Clay loam, good; sandy loam, fair; loamy sand, poor.	Poor to good; high water table.	Poor in upper part of profile; fair in substratum; poorly graded; high water table.	Good	Poor to good	High water table
Lincoln (Ln)	Poor	Good; poorly graded; high water table.	Good to poor; localized pockets; high water table.	Fair to good	Poor to good	High water table; hazard of flooding.
Lofton (Lo)	Poor	Unsuitable	Unsuitable	Poor	Poor	Depressed areas fill with runoff water during storms.
Mansic (Ma)	Good	Unsuitable	Unsuitable	Fair	Fair	High compressibility.
Mansker (Mb)	Surface layer, fair; substratum, poor.	Unsuitable	Unsuitable	Fair	Poor	High compressibility; moderately plastic.
Manter (Mf, Mh, Mk)	Fair	Poor	Unsuitable	Good	Good	[3]
Otero (Ox)	Poor	Fair; local deposits.	Fair; local deposits.	Good	Good	[3]
Potter (Po)	Surface layer fair; substratum, poor.	Poor	Unsuitable; local deposits.	Good	Poor	Steep; layer of hard caliche and bedrock.
Richfield (Rm)	Good	Unsuitable	Unsuitable	Fair to good	Fair to poor	[3]

See footnotes at end of table.

properties of soils—Continued

Soil features affecting engineering practices						
Dikes and canals	Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways
	Reservoir area	Embankment				
Deep; moderate permeability and shear strength.	(2)	(2)	Seasonally high water table.	Somewhat poorly drained; moderate permeability; local deposits of sand.	(2)	Moderate stability and erodibility.
(2)	Rapid permeability.	Rapid seepage; low stability; piping.	Seasonally high water table.	Rapid permeability; very low water-holding capacity; subject to flooding with scouring and deposition.	Rapid permeability; unstable; subject to wind accumulation.	High erodibility; unstable banks; low fertility.
Deep; slow permeability.	(2)	(2)	Ponding in depressions; outlets remote.	(2)	(2)	(2).
Moderately slow permeability; moderate shrink-swell potential.	Moderately slow permeability.	Highly compressible; moderate stability, shrink-swell potential shear strength, and permeability.	Well-drained uplands.	Moderate permeability; high water-holding capacity; well drained; friable; deep.	Deep; friable; low erodibility.	Good structure, stability, and fertility.
Moderately slow permeability; moderate shrink-swell potential and plasticity.	Moderately slow permeability.	Moderate shear strength, stability, shrink-swell potential, and permeability; high compressibility.	Well drained	Moderately shallow over caliche; sloping.	Moderately shallow over caliche at a depth between 12 to 36 inches.	Moderately shallow; moderate stability; low erodibility.
Deep; moderate permeability; medium erodibility.	Moderate permeability.	Well graded; slight compressibility; good compaction; slight piping potential.	Well drained	Limited water-holding capacity; moderate permeability.	Deep; friable	Moderate erodibility; deep; friable; moderate stability.
(2)	Occasional strata of sand; moderate permeability.	Well-graded material.	Well drained	(2)	Steep	Limited water-holding capacity; medium erodibility.
(2)	Moderate to rapid permeability; occasional strata of sand.	Moderate permeability; shallow; outcrops of caliche.	Well drained	(2)	Shallow; steep	Shallow; steep.
Deep; moderate shear strength and stability; moderately slow permeability.	Moderately slow permeability.	Moderate shear strength and stability; low to moderate shrink-swell potential and erodibility; fair to good compaction.	Well drained	Deep; moderately slow permeability; high water-holding capacity; nearly level.	Deep; moderately slow permeability; moderate stability; low to moderate erodibility.	Deep; friable; moderate stability; low to moderate erodibility.

TABLE 6.—*Interpretation of engineering*

Soil series and map symbol	Suitability as source of—					
	Topsoil	Sand	Gravel	Fill [1]	Subgrade [1]	Highway location
Sweetwater (Sw)	Poor	Unsuitable in upper part.	Unsuitable in upper part of profile; fair in substratum; poorly graded; high water table.	Poor to a depth of 2 feet, good below.	Poor to fair	High water table
Tivoli (Tf, Tx)	Poor	Good	Unsuitable	Poor to fair; erodible; good if confined.	Good if confined.	Unstable slopes because of high erodibility.
Ulysses (Ua, Ub, Uc)	Good	Unsuitable	Unsuitable	Good	Fair to good	([3])
Vona (Vo)	Poor	Fair	Unsuitable	Good	Good	Unstable slopes because of high erodibility.

[1] C. W. Heckathorn, field soils engineer, and Herbert E. Worley, soils research engineer, Kansas State Highway Commission, helped prepare these columns. This assistance was performed under a coöperative agreement with the U.S. Department of Commerce, Bureau of Public Roads.

Formation, Classification, and Morphology of Soils

This section discusses the factors that affect the formation of soils and classifies the soils of Kearny County into higher categories. It also describes each soil series in the county and gives a soil profile that is typical of that series.

Factors of Soil Formation

Soil is the product of the forces of weathering and soil formation acting on the parent material deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by the interaction of the following factors: (1) The kind of parent material; (2) the climate under which the soil material has accumulated and has 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 development have acted on the material. A discussion of each of these factors of soil formation follows.

Parent material

Parent material is the unconsolidated material from which the soils have developed. It is formed as the result of the weathering of rocks through the processes of freezing and thawing, wind erosion, and the grinding away by rivers and glaciers. It is also formed as the result of chemical processes. Because much of the parent material is derived from the weathering of the underlying rocks, the type of bedrock affects the characteristics of the soils. To give some idea of the kinds of rocks that underlie Kearny County, the geological history of the county is discussed in the following paragraphs.

Geological history.—Between 180 and 200 million years ago, the area that is now western Kansas was covered by a *properties of soils*—Continued

Soil features affecting engineering practices						
Dikes and canals	Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways
	Reservoir area	Embankment				
Moderately slow permeability; moderate shrink-swell potential, stability, and plasticity.	(2)	(2)	Seasonally high water table.	Seasonally high water table; moderately saline to alkali.	(2)	Sandy substratum allows seepage; saline.
Moderate to high permeability and erodibility; poor to moderate stability.	(2)	Moderate to high permeability and erodibility; poor to moderate stability; fair to good compaction.	Well drained	(2)	(2)	(2).
Deep; moderate permeability; low to moderate stability, erodibility, plasticity, and shrink-swell potential.	Moderate permeability; low to moderate shrink-swell potential.	Moderate permeability; low to moderate shear strength, stability, plasticity, and erodibility; fair to good compaction.	Well drained	Deep; moderate permeability; high water-holding capacity; nearly level to gently sloping.	Deep; friable; low to moderate stability and erodibility.	Deep; friable; low to moderate stability and erodibility.
Moderately rapid permeability; moderate stability and erodibility.	(2)	Moderately rapid permeability; moderate shear strength and erodibility; good compaction; low plasticity.	Well drained	Low water-holding capacity; moderately rapid permeability.	(2)	(2).

[2] Practice considered not applicable because of location or physiographic position.
[3] No detrimental feature affecting highway location.

shallow sea. During this period, marine sediments were deposited, and these sediments formed the lower part of what is known as the Permian rocks. Later in the Permian period, other marine and nonmarine sediments were deposited, probably in shallow water. These sediments have a reddish color, and the deposits are known as red beds. An arid climate prevailed during this period. As the shallow water evaporated, vast deposits of salt, anhydrite, and gypsum were left in the shallow basins. Gas is obtained in this area from the limestone of the Wolfcampian formation of Permian age (*4*).

At about the end of the Permian period, the High Plains rose above the level of the sea. Streams flowing over the exposed Permian rocks eroded the rocks, carried away the fine-textured materials, and redeposited them on the flood plains. These materials formed the Triassic (?) red beds and the rocks of Jurassic age that underlie the Cretaceous rocks. At least part of Kearny County is underlain by rocks of the Jurassic age, but rocks of the Triassic (?) red beds are not known to occur in the county.

The Cretaceous period began about 100 million years ago when the sediments that formed the sandstone of the Cheyenne formation were deposited. The Cheyenne sandstone originated from stream deposits and from marine sediments deposited in shallow water. It may have originated partly from deposits carried by wind and deposited on the beaches.

After the material was deposited that formed the Cheyenne sandstone, the land was again covered by the sea, and the clay that formed the Kiowa shale was deposited in this sea. Later, conditions similar to those during the formation of the Cheyenne sandstone recurred. The sediments that formed the sandstones, shales, and clays of the Dakota formation were laid down on beaches and near the shore during a period in which the sea receded far to the south. The uppermost division of the

Dakota formation is exposed in the vicinity of Hartland. Sandstones of the Dakota formation are important water-bearing beds in Kearny County.

After the sediments in the Dakota formation were laid down, there was a rapid change in the way sediments were deposited. From time to time, the land emerged above the level of the sea, or rose to near sea level, and sediments that formed shale, limestone, and chalk were deposited. The first sediments to be deposited were those that formed Graneros shale. Later, sediments that formed Greenhorn limestone were deposited, then Carlile shale, and, finally, those that formed the Niobrara formation. In the southern part of Kearny County, however, part of the deposits were removed by erosion.

A great uplift near the close of the Cretaceous period caused the Rocky Mountains to form, and this uplift affected part of the High Plains. At this time, it is thought that the area was tilted to produce the present regional dip toward the north. The present shape and relationship of the geologic formations underlying Kearny County are shown in figure 14.

Probably near the beginning of the Tertiary period, sediments laid down during the Late Cretaceous period were truncated during a long period of erosion. Also near the beginning of the Tertiary period, there was a moderate folding that produced the Scott-Finney Basin and the Syracuse anticline.

Near the close of the Tertiary period, when the Rocky Mountains reached their maximum height and began to erode, sand, silt, clay, and gravel were carried great distances by the swift streams and were deposited over the area that is now Kearny County. The Ogallala formation developed from the Pliocene deposits of calcareous outwash material. These deposits gradually built up to about the present level of the High Plains. Later, however, erosion removed much of this material in the southern part of the county. The Ogallala formation is among the principal water-bearing formations in the county.

Near the close of the Tertiary period or early in the Pleistocene epoch, there was a renewed downwarping of the Scott-Finney Basin, as well as a renewed folding of the Syracuse anticline accompanied by faulting (*4*). After this folding and faulting had taken place, there was a long period of aggrading when many of the streams shifted laterally. During that period, thick deposits of silt, sand, and gravel were laid down. These deposits resemble the material in the Ogallala formation. There were continued movements and further displacement in the fault after these sediments were deposited. Much of the present topography of the area originated during this period of movement and deposition. It is believed that the high, gravelly terraces along the Arkansas River and under the sandhills were formed during this time, and that during this time the Arkansas River swung in a northeasterly direction at a point near Hartland.

During the latter part of the Pleistocene epoch, great duststorms deposited a mantle of loess over much of the area. The storms probably recurred many times and continued, at least intermittently, into the Recent epoch. Soon after the loess was deposited, the wind winnowed the sediments of the High Plains. This wind action produced the moderately sandy, partly reworked ridges and knobs that occur along the intermittent streams in the northern part of the county. During this time, sand dunes were forming south of the Arkansas River. As these dunes shifted, loose fine sand was deposited in the channel of Bear Creek and cut off the flow of water into the Arkansas River. The shifting of some of these dunes has continued to the present time.

Parent material of the principal soils.—The soils of Kearny County have developed mainly from deposits of loess and windblown sands. Some soils, however, formed in alluvial sediments deposited by water; others formed in partly reworked sediments of windblown sand from old, alluvial outwash; and a few soils formed in outwash sediments of the Plains.

The loess was deposited late in the Pleistocene epoch. 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. This loess is more than 50 percent silt and is pale brown, calcareous, friable, and porous. In Kearny County the Richfield, Ulysses, and Colby silt loams are the dominant soils formed in loess.

The windblown sands were probably deposited after the loess. They cover the area south of and adjacent to the Arkansas River Valley and are also along large, sandy drainageways in the sloping areas of the High Plains. Most of the area south of the Arkansas River Valley is strongly undulating, hummocky, and choppy. This area is occupied by the Tivoli soils.

The alluvial sediments consist of a mixture of sand, gravel, silt, and clay. They were deposited in the valleys of streams and along some drainageways in the uplands. The position of the soils formed in alluvial sediments has been important because different kinds of alluvial sediments were deposited in different areas and different kinds of soils formed in these different areas. Soils that formed in alluvium along drainageways and in swales in the uplands, for example, generally are loams. Deep soils formed in alluvium on fans, or aprons, are the clay loams. Those formed on the flood plains of the Arkansas River have various textures because their parent material was stratified sand, silt, and clay.

The partly reworked sediments of sandy outwash were deposited by streams during the Pliocene and Pleistocene epochs. These sediments are the parent material of the Manter and Vona soils. A few of the minor soils in the county formed in other outwash material of the Plains that has not been reworked.

During the Recent epoch, this area has undergone erosion that has formed much of its present topography. Many intermittent streams have cut into the Pleistocene deposits and into the rocks of the Ogallala formation. West of Hartland, the Arkansas River has cut through the Greenhorn limestone and Graneros shale. These formations outcrop along the bluffs between Hartland and the county line.

Climate

The climate of Kearny County is temperate and semiarid. The average annual temperature is about 55° F., and the average annual precipitation is about 16.07 inches. Precipitation, temperature, humidity, and wind are all important in the formation of soils.

The downward movement of water is one of the main factors in transforming the parent material into a soil

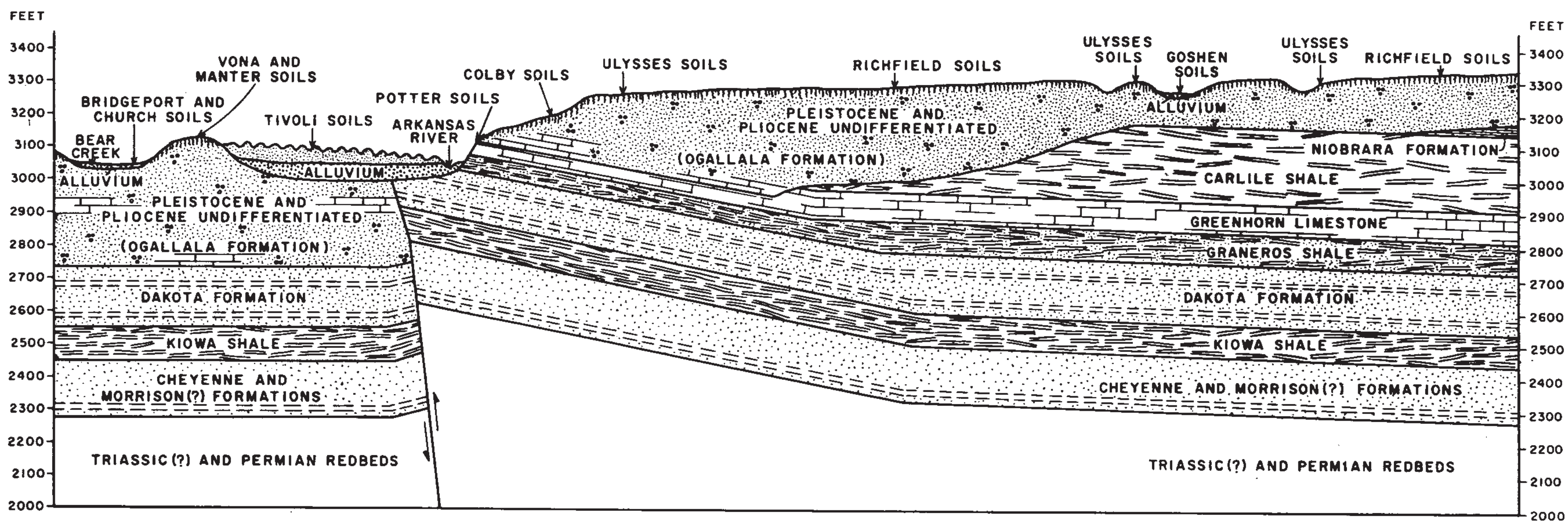

Figure 14.—An approximate geologic profile of Kearny County, extending in a north-south direction across the county near Hartland.

that has distinct horizons. The amount of water that actually percolates through the soil depends upon the amount of rainfall, humidity, relief, and temperature and on the kind of soil material. Temperature has a great effect on the growth of plants, on the rate of decomposition of organic matter, on the activity of organisms in the soils, and on the speed of chemical reaction. Differences in climate in various regions cause differences in the soils. In general, fewer differences are caused by climate in a smaller area, such as Kearny County.

Plant and animal life

Plants and animals are indispensable in the formation of soils. The kind of plant cover affects the development of the soils, and, as characteristics of the soils change, the plant cover adjusts itself accordingly. The growth of plants depends on the parent material of the soils and on the climate. Plants produce organic matter. The kind of plants and the amount of the plant cover determine the amount of organic matter that is added to the soils. This, in turn, affects the color and structure of the soils and other physical and chemical properties. In this county the soils have formed mainly under grass.

Bacteria, fungi, and other tiny organisms help to weather rocks and to decompose organic matter. They influence the chemical, physical, and biological processes that affect the formation of soils. The many worm casts in the friable, calcareous, silty soils in Kearny County are evidence that very small organisms live or have lived in the soils.

Relief

Relief, or lay of the land, affects the formation of soils. It determines the amount of water that is retained in the soils, the amount of soil material lost through erosion, the direction in which materials in suspension or in solution are moved, and the kind and amount of plant cover. On steep slopes, runoff results in the loss of water and in the continual loss of soil material through erosion. In this way, the processes of soil formation are slowed down. On nearly level areas and in depressions, the soils not only receive the same amount of precipitation as is received on the steeper areas, but they also receive the runoff from the sloping areas. Consequently, the soils in nearly level areas have a more strongly developed profile than the sloping soils, and they have a darker colored surface layer.

Time

The length of time needed for the formation of soils depends largely on the other factors of soil formation. In a dry climate under sparse vegetation, soils form slowly. They form much more rapidly in a moist climate under dense vegetation. The kind of parent material influences the length of time that is required for a soil to reach equilibrium with its environment. Time is also a factor in the different degrees of development in soils. For example, soils formed in loess in sloping areas are younger than those formed in the same kind of loess in nearly level areas because erosion removes the surface soil, or the developed material, and exposes material that has been relatively little altered by soil-forming processes.

Classification and Morphology of Soils

Soils are placed in narrow classes for the organization and application of knowledge about their behavior within farms, ranches, or counties. They are placed in broad classes for study and comparison of large areas, such as continents. In the comprehensive system of soil classification followed in the United States (*2*), the soils are placed in six categories, one above the other. Beginning at the top, the six categories are the order, suborder, great soil group, family, series, and type.

In the highest category, the soils of the whole country are grouped into three orders, namely, the zonal, intrazonal, and azonal orders (*7*), whereas thousands of soil types are recognized in the lowest category. The suborder and family categories have never been fully developed and thus have been little used. Attention has largely been given to the classification of soils into soil types and series within counties or comparable areas and to the subsequent grouping of series into great soil groups and orders. The soil series and soil type were discussed in an earlier section "How This Soil Survey Was Made." Subdivisions of soil types into phases so as to provide finer distinctions significant to soil use and management are also discussed in that section. Table 7 shows the order and great soil group to which each series in the county belongs and gives the important characteristics of the soils in each series. Following the table is a discussion of the soil series in each great soil group. A description of a typical soil profile is given for each series.

Zonal soils

Soils of the zonal order have evident, genetically related horizons that reflect the dominant influence of climate and plant and animal life in their formation. The zonal soils in Kearny County are in the Brown and Chestnut great soil groups.

BROWN SOILS

The Brown soils have a brown surface layer that grades to the lighter colored soil material below. They have an accumulation of calcium carbonate at a depth of 1 to 3 feet. These soils developed under short grasses, bunch grasses, and shrubs in a temperate to cool, semiarid climate. The soils of the Vona series are in the Brown great soil group.

Vona series.—The Vona soils typically have a surface layer of loamy fine sand that overlies a weakly developed, noncalcareous B horizon of fine sandy loam. Their C horizon is calcareous and is somewhat variable. The soils formed in strongly calcareous sediments of the High Plains. Most of these sediments are moderately sandy and form a mantle that consists mainly of partly reworked, windblown material deposited during the latter part of the Pleistocene age.

The Vona soils are gently sloping to gently undulating, but generally have slopes of less than 5 percent. They occur in the sandhills and along the outer edges of the sandhills. The following describes a profile of Vona loamy fine sand that has slopes of about 3 percent and is in a native range 700 feet east and 50 feet south of the northwestern corner of section 32, T. 25 S., R. 38 W.:

A_1—0 to 8 inches, grayish-brown (10YR 5/2, dry) or dark grayish-brown (10YR 4/2, moist) loamy fine sand; structureless and only slightly coherent; very soft

TABLE 7.—*Soil series classified by soil orders and great soil groups and factors that have contributed to differences in soil morphology*

ZONAL ORDER

Great soil group and series	Physiographic position	Relief	Parent material	Native vegetation
Brown soils:				
Vona	Uplands of the High Plains.	Gently undulating to gently sloping.	Partly reworked, moderately sandy sediments of the High Plains.	Mid and tall grasses, sagebrush, and yucca.
Chestnut soils:				
Dalhart	Uplands of the High Plains.	Nearly level	Partly reworked, moderately sandy sediments of the High Plains.	Mid and tall grasses, sagebrush, and yucca.
Goshen	Swales and broad intermittent drainageways.	Nearly level	Colluvial-alluvial sediments.	Short and mid grasses.
Lofton	Depressions in the High Plains.	Nearly level to concave	Fine-textured loess and alluvial sediments.	Short and mid grasses.
Mansic	Uplands of the High Plains.	Nearly level to gently sloping.	Silty sediments of the High Plains.	Short grasses.
Manter	Uplands of the High Plains.	Nearly level to gently undulating.	Partly reworked, moderately sandy sediments of the High Plains.	Short and mid grasses.
Richfield	Uplands of the High Plains.	Nearly level to gently sloping.	Loess	Short grasses.
Ulysses	Uplands of the High Plains.	Nearly level to sloping	Loess	Short grasses.

INTRAZONAL ORDER

Great soil group and series	Physiographic position	Relief	Parent material	Native vegetation
Calcisols:				
Mansker	Sloping uplands	Gently sloping	Calcareous sediments of the High Plains.	Short and mid grasses.
Grumusols:				
Church	Bear Creek depression	Nearly level but has gilgai microrelief.	Fine-textured sediments deposited by water.	Short and mid grasses.
Humic Gley soils:				
Sweetwater	Flood plains of the Arkansas River.	Nearly level	Stratified alluvium	Mid and tall grasses.

AZONAL ORDER

Great soil group and series	Physiographic position	Relief	Parent material	Native vegetation
Lithosols:				
Potter	Upland breaks	Steep and broken	Plain sediments (caliche)	Short and mid grasses.
Regosols:				
Colby	Sloping soils of the High Plains.	Gently sloping to steep	Loess	Short grasses.
Otero	Sloping uplands	Moderately steep	Partly reworked, moderately sandy sediments of the High Plains.	Mid and short grasses and sagebrush.
Tivoli	Sandhills	Hummocky to choppy dunes.	Stabilized, windblown sands.	Mid and tall grasses, sagebrush, and yucca.
Alluvial soils:				
Bayard	Alluvial fans, or aprons	Nearly level to gently undulating.	Moderately sandy alluvium.	Mid and tall grasses.
Bowdoin	Flood plains of the Arkansas River.	Nearly level	Stratified clayey alluvium	Mid and tall grasses.
Bridgeport	Alluvial fans, or aprons	Nearly level	Loamy alluvium	Short grasses.
Las	Flood plains of the Arkansas River.	Nearly level	Stratified loamy alluvium	Mid and tall grasses.
Las Animas	Flood plains of the Arkansas River.	Nearly level	Stratified sandy and loamy alluvium.	Mid and tall grasses.
Lincoln	Flood plains of the Arkansas River.	Nearly level to slightly undulating.	Recent alluvial sands	Sparse grasses, weeds, and trees.

when dry and very friable when moist; noncalcareous; gradual boundary.

B_2—8 to 16 inches, brown (10YR 5/3, dry) or dark-brown (10YR 3.5/3, moist) fine sandy loam; weak, coarse, prismatic and weak, granular structure; slightly hard when dry and friable when moist; noncalcareous; gradual boundary.

B_{22}—16 to 40 inches, brown (10YR 5/3, dry or 10YR 4/3, moist) light fine sandy loam; weak, granular structure; porous; soft when dry and very friable when moist; noncalcareous; gradual boundary.

C—40 to 52 inches, pale-brown (10YR 6/3, dry) or brown (10YR 5/3, moist) loamy fine sand; structureless and only slightly coherent; soft when dry and very friable when moist; calcareous, but no segregated lime.

Range in characteristics: The A_1 horizon ranges from 5 to 20 inches in thickness. Depth to the calcareous material ranges from 16 to 46 inches.

Topography: Nearly level to gently undulating uplands of the High Plains.

Drainage: Well drained. Surface runoff, slow. Permeability, moderately rapid.

CHESTNUT SOILS

The Chestnut soils have a dark grayish-brown surface layer that grades to lighter colored soil material below. They have a layer of accumulated calcium carbonate at a depth of 1 to 4 feet, but their surface layer is noncalcareous. These soils formed under mixed tall, mid, and short grasses where the climate is cool and subhumid to semiarid. Their parent material was loess, sandy and silty sediments of the Plains, and colluvial and alluvial sediments. In Kearny County the soils of the Dalhart, Goshen, Lofton, Mansic, Manter, and Richfield series are in the Chestnut great soil group. The Ulysses soils are also in that great soil group, although they have some characteristics of Regosols.

Dalhart series.—The Dalhart soils typically have a surface layer of dark grayish-brown to brown loamy fine sand that is noncalcareous. Their B horizon is heavy sandy loam to sandy clay loam and overlies somewhat variable soil material. These soils formed mainly in strongly calcareous material that is generally at a depth of more than 24 inches. The calcareous material consists of moderately sandy sediments of the High Plains. It forms a mantle that consists chiefly of partly reworked, windblown material deposited late in the Pleistocene age.

The only soil of this series in the county is a Dalhart loamy fine sand that is mapped in a complex with a Vona loamy fine sand. The soils of the complex are on isolated flats in the sandhills or on old, high stream terraces or benches that underlie part of the sandhills. The following describes a profile of a Dalhart soil, under native grass, 1,600 feet east and 1,050 feet south of the northwestern corner of section 34, T. 25 S., R. 35 W.:

A_1—0 to 12 inches, intermediate between dark grayish-brown and brown (10YR 4.5/2.5, dry) or dark-brown (10YR 3/3, moist) loamy fine sand; structureless and only slightly coherent; very soft to loose when dry and very friable when moist; noncalcareous; clear boundary.

B_2—12 to 23 inches, brown (10YR 5/3, dry) or dark-brown (10YR 3/3, moist) heavy fine sandy loam; weak, coarse, prismatic structure breaking to weak, fine, granular; slightly hard when dry and friable when moist; noncalcareous; very few scattered worm casts; very faint clay films; gradual boundary.

B_3—23 to 30 inches, brown (10YR 5/3, dry) or dark-brown (10YR 3.5/3, moist) heavy sandy loam to light sandy clay loam; weak, coarse, prismatic structure breaking to weak, fine and medium, granular; slightly hard when dry and friable when moist; noncalcareous; very few scattered worm casts; gradual boundary.

C_1—30 to 59 inches, brown (10YR 5.5/3, dry) or dark-brown (10YR 4/3, moist) loamy fine sand; structureless and only slightly coherent; soft to loose when dry and very friable when moist; noncalcareous; abrupt boundary.

C_b—59 to 64 inches, gray (10YR 6/1.5, dry) or dark-gray (10YR 4/1.5, moist) sandy loam; massive; slightly hard when dry and very friable when moist; strongly calcareous and contains a few streaks and films of lime.

Range in characteristics: The A horizon ranges from very dark grayish brown to brown in color and from 5 to 18 inches in thickness. In places the uppermost 2 inches is loam. The B horizon ranges from heavy sandy loam to sandy clay loam in texture and from 15 to 30 inches in thickness. In places the surface layer of a buried soil is below a depth of 24 inches.

Topography: Nearly level uplands of the High Plains.

Drainage: Well drained. Surface runoff, slow. Permeability, moderately rapid.

Goshen series.—The Goshen soils typically are nearly level and have a surface layer of dark-colored, friable, noncalcareous silt loam. They are in broad, intermittent drainageways and in swales in the uplands. The profile of these soils is moderately well developed. The soils formed in local colluvium and alluvium washed from higher lying Richfield, Ulysses, and Colby soils, and they receive runoff from those soils. The following describes a profile of Goshen silt loam, in a cultivated field, 250 feet south and 250 feet west of the northeastern corner of section 9, T. 23 S., R. 36 W.:

A_1—0 to 18 inches, dark grayish-brown (10YR 4/2, dry) or very dark brown (10YR 2/2, moist) silt loam; moderate, medium, granular structure; slightly hard when dry and friable when moist; noncalcareous; porous and permeable; gradual boundary.

B_2—18 to 28 inches, grayish-brown (10YR 5/2, dry) or dark grayish-brown (10YR 4/2, moist) light silty clay loam; moderate, fine, subangular blocky structure; hard when dry and friable when moist; calcareous; gradual boundary.

C_{ca}—28 to 44 inches, pale-brown (10YR 6/3, dry) or brown (10YR 5/3, moist) heavy silt loam; massive; soft when dry and friable when moist; strongly calcareous with a few, soft lime concretions; porous and permeable; diffuse boundary.

C—44 to 48 inches, very pale brown (10YR 7/3, dry) or brown (10YR 5/3, moist) silt loam; massive; soft when dry and friable when moist; strongly calcareous; porous and permeable.

Range in characteristics: The A_1 horizon ranges from loam to silt loam in texture and from 8 to 20 inches in thickness. Depth to calcareous material ranges from 15 to 36 inches.

Topography: Nearly level planes or concave slopes in swales and broad, intermittent drainageways of the High Plains.

Drainage: Well drained. Surface runoff, medium. Permeability, moderate.

Lofton series.—The Lofton soils formed in fine-textured material that was blown or washed from the adjacent higher lying areas of silty soils. The soils are deep and dark colored, and they are noncalcareous. They are in shallow basins in the uplands, locally called potholes. Runoff from higher lying areas collects in these basins. Consequently, the soils have formed where there is more moisture than normal for the area, and the soil materials are highly weathered. The following describes a typical profile of Lofton silty clay loam, under native vegetation, 2,040 feet east and 120 feet south of the northwestern corner of section 2, T. 22 S., R. 36 W.:

A_1—0 to 5 inches, grayish-brown (10YR 4.7/2, dry) or very dark grayish-brown (10YR 2.5/2, moist) light silty clay loam; massive; hard when dry and firm when moist; noncalcareous; abrupt boundary.

A_{12}—5 to 8 inches, gray (10YR 5.5/1, dry) or dark-gray (10YR 4/1, moist) silty clay loam; weak, medium, granular structure; very hard when dry and firm when moist; noncalcareous; gradual boundary.

B_{21}—8 to 21 inches, gray (10YR 5/1, dry) or dark-gray (10YR 3.7/1, moist) heavy silty clay loam; moderate, medium, prismatic structure breaking to moderate, medium, subangular blocky; very hard when dry and very firm when moist; noncalcareous; clay films distinct and continuous; diffuse boundary.

B_{22}—21 to 31 inches, gray (10YR 5/1, dry) or dark-gray (10YR 3.7/1, moist) silty clay loam; moderate, medium, prismatic structure breaking to weak, medium to fine, subangular blocky; very hard when dry and very firm when moist; noncalcareous; clay films distinct and continuous; many fine root holes and fine pores present; clear boundary.

B_3—31 to 52 inches, grayish-brown (10YR 5/2, dry) or very dark grayish-brown (10YR 3.5/2, moist) silty clay loam; massive; hard when dry and firm when moist; noncalcareous; few roots; clear boundary.

C—52 to 63 inches, grayish-brown (10YR 5.5/2, dry) or dark grayish-brown (10YR 4/2, moist) silty clay loam; massive; hard when dry and firm when moist; weakly calcareous.

Range in characteristics: Surface horizon ranges from gray to grayish brown in color and from heavy silt loam to heavy silty clay loam in texture. Depth to calcareous material ranges from 18 to 60 inches.

Topography: Depressions; soil occupies concave, undrained basins.

Drainage: Surface runoff, ponded. Permeability, slow to very slow.

Mansic series.—The Mansic soils are moderately dark colored and are weakly calcareous in the upper part of the profile. At a depth of about 20 inches, however, they have a distinct C_{ca} horizon that is strongly calcareous. A thin mantle of loess once covered the area where these soils occur, but it has been stripped away as the result of erosion. After the loess was removed, the soils formed in medium- to fine-textured, strongly calcareous outwash sediments of the High Plains. The following describes a profile of a Mansic clay loam that has slopes of less than 1 percent and is in a cultivated field in the central part of section 25, T. 23 S., R. 37 W.:

A_{1p}—0 to 5 inches, grayish-brown (10YR 5/2, dry) very dark grayish-brown (10YR 3/2, moist) light clay loam; massive; slightly hard when dry and firm when moist; weakly calcareous; clear boundary.

A_1—5 to 16 inches, dark grayish-brown (10YR 4/2, dry) or very dark grayish-brown (10YR 3/2, moist) clay loam; moderate, medium, granular structure; slightly hard when dry and firm when moist; weakly calcareous; few scattered worm casts; clear boundary.

AC—16 to 20 inches, grayish-brown (10YR 5.5/2, dry) or dark grayish-brown (10YR 4/2, moist) clay loam; weak, granular structure; slightly hard when dry and firm when moist; moderately calcareous; abrupt boundary.

C_{ca}—20 to 44 inches, white (10YR 8/2, dry) or very pale brown (10YR 7/3, moist) clay loam; massive; slightly hard when dry and firm when moist; strongly calcareous; contains about 35 percent calcium carbonate; small, hard concretions in places.

Range in characteristics: The A horizon ranges from grayish brown to dark grayish brown in color, from heavy loam to clay loam in texture, and from 8 to 24 inches in thickness. Below the A horizon is a transitional horizon that overlies the C_{ca} horizon. Depth to the C_{ca} horizon ranges from 12 to 26 inches. From 20 to 40 percent of the C_{ca} horizon by volume is calcium carbonate, which forms films on the peds or is in small, hard concretions of segregated lime.

Topography: Nearly level or concave areas on the tableland of the High Plains or gentle slopes in the uplands of the High Plains. Small, low dunes, where the texture of the soils is moderately sandy, occur within the areas.

Drainage: Well drained. Surface runoff, slow to medium. Permeability, moderate.

Erosion: Geologic erosion is evident on a large acreage of this soil. Erosion has caused the areas to be in slightly lower, concave positions than the rest of the tableland.

Manter series.—The Manter soils are moderately dark colored, noncalcareous, and moderately sandy. They are nearly level to rolling and are on uplands. The soils formed in strongly calcareous, moderately sandy sediments of the High Plains. Most of the sediments have been partly reworked and consist of windblown material deposited during the latter part of the Pleistocene age.

The Manter soils are slightly farther from the sandhills than the Vona soils with which they are associated, and they have formed in somewhat finer textured material. The following describes a profile of a Manter fine sandy loam that has slopes of about 2 percent, in a native pasture where the soil may have been cultivated at one time; the profile was observed 55 feet north and 300 feet east of the southwestern corner of section 7, T. 26 S., R. 37 W.:

A_p—0 to 6 inches, intermediate between dark grayish-brown to brown (10YR 4/2.5, dry) or very dark grayish-brown to dark-brown (10YR 3/2.5, moist) fine sandy loam; weak, granular structure to almost structureless; slightly hard when dry and friable when moist; noncalcareous; clear boundary.

AB—6 to 17 inches, intermediate colors, dark-brown (10YR 4/2.5, dry or 10YR 3/2.5, moist) fine sandy loam to loam; weak, coarse, prismatic structure breaking to weak, granular structure; slightly hard when dry and friable when moist; noncalcareous; numerous worm casts; fairly porous and permeable; clear boundary.

B_{ca}—17 to 36 inches, intermediate between grayish-brown and pale-brown (10YR 5.5/2.5, dry) or intermediate between dark grayish-brown and dark-brown (10YR 4/2.5, moist) loam; weak, granular structure; slightly hard when dry and friable when moist; moderately calcareous and contains a few films of lime and small, soft, white concretions of lime; numerous worm casts in upper part; gradual boundary.

C—36 to 50 inches, pale-brown (10YR 6/3, dry) or brown (10YR 5/3, moist) loam; massive, porous; soft when dry and friable when moist; calcareous.

Range in characteristics: The A horizon ranges from heavy loamy fine sand to heavy sandy loam in texture and from 5 to 10 inches in thickness. The subsoil ranges from sandy loam to light loam in texture. Depth to calcareous material ranges from 10 to 30 inches, but in most places it is about 18 inches. In places this soil is silty below a depth of 18 inches.

Topography: Nearly level to gently undulating; slopes of 0 to 6 percent.

Drainage: Well drained. Surface runoff, slow to medium. Permeability, moderate.

Richfield series.—The Richfield soils have a well-developed profile characterized by a textural B horizon of firm silty clay loam that has moderate to strong, subangular blocky structure. These soils formed in loess or in similar silty sediments and are on the tableland of the High Plains. The following describes a profile of a nearly level Richfield silt loam, in a cultivated field, 2,240 feet south of the center of section 36, T. 22 S., R. 36 W.:

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

B_2—4 to 13 inches, dark grayish-brown (10YR 4/2, dry) or very dark grayish-brown (10YR 3/2, moist) silty clay loam; weak to moderate, medium, prismatic structure breaking to moderate, medium, subangular blocky; hard when dry and firm when moist; continuous clay films; open pores and root channels; noncalcareous; gradual boundary.

B_{3ca}—13 to 28 inches, pale-brown (10YR 6/3, dry) or brown (10YR 5/3, moist) silty clay loam; weak to moderate, subangular blocky structure; hard when dry and firm when moist; thin, patchy clay films; strongly calcareous and has many, fine, soft concretions of lime; gradual boundary.

C—28 to 40 inches, very pale brown (10YR 7/3, dry) or brown (10YR 5/3, moist) silt loam; massive; porous; soft when dry and very friable when moist; strongly calcareous and contains a few, soft, fine concretions of lime in uppermost 6 inches.

Range in characteristics: Variations in the profile are few. Depth to calcareous material ranges from 10 to 22 inches, but in most places it is about 14 inches. In places a darkened layer that is the surface layer of an old, buried soil, is at a depth below 24 inches. This buried layer is not related to the present soil profile nor to any feature of the present landscape.

Topography: Most of the acreage is on the nearly level tableland of the High Plains where the slope is less than 1 percent. A few areas are gently sloping.

Drainage: Well drained. Surface runoff, slow to medium. Permeability, moderate.

Ulysses series.—The Ulysses soils are in the Chestnut great soil group but have some characteristics of Regosols. They have an A_p horizon of dark grayish-brown silt loam that is generally weakly calcareous. In some places these soils have a weak B horizon, but in other places they lack this horizon. These soils formed in loess.

In areas of these soils under native grass, calcareous material is at a depth of 6 to 15 inches in places, but in some areas that have been cultivated, these soils are calcareous throughout. The texture of the surface layer is predominantly silt loam. Where this soil is associated with the Manter fine sandy loams, however, the surface layer is more loamy than it is in other areas.

The Ulysses soils are similar to the Colby and Richfield soils. They have a deeper and slightly darker colored surface layer than the Colby soils and a less clayey and more friable subsoil than the Richfield soils.

The following describes a nearly level Ulysses silt loam, in a cultivated field, 1,000 feet west and 500 feet north of the southeastern corner of section 12, T. 24 S., R. 38 W.:

A_p—0 to 5 inches, dark grayish-brown (10YR 4/2, dry) or very dark grayish-brown (10YR 3/2, moist) silt loam; weak, granular structure; slightly hard when dry and friable when moist; weakly calcareous; clear boundary.

B_2—5 to 10 inches, dark grayish-brown (10YR 4.5/2, dry) or very dark grayish-brown (10YR 3/2, moist) light silty clay loam; weak, medium, prismatic structure breaking to moderate, medium, granular or, in places, to weak, fine, subangular blocky structure; hard when dry and friable when moist; calcareous; numerous clusters of granules that are worm casts; clear boundary.

B_{3ca}—10 to 19 inches, pale-brown (10YR 6/3, dry) or brown (10YR 4.5/3, moist) light silty clay loam; weak to moderate, medium, granular structure; slightly hard when dry and friable when moist; strongly calcareous; numerous clusters of granules that are worm casts; diffuse boundary.

C_{ca}—19 to 27 inches, pale-brown (10YR 6/3, dry) or brown (10YR 5/3, moist) light silty clay loam; moderate, medium, granular structure; slightly hard when dry and friable when moist; strongly calcareous and contains few, small, soft, white lime concretions; diffuse boundary.

C—27 to 47 inches, very pale brown (10YR 7/3, dry) or brown (10YR 5/3, moist) silt loam; massive and porous; soft when dry and friable when moist; calcareous.

Range in characteristics: In places there is a weak, textural B horizon, and 25 to 32 percent of this layer is clay. Remnants of a buried soil occur in places at various depths.

Topography: Nearly level to sloping planes and convex slopes of as much as 6 percent.

Drainage: Well drained. Surface runoff, medium. Permeability, moderate.

Erosion: Susceptible to erosion by both wind and water; erosion has been moderate on some of the sloping areas in most cultivated fields.

Intrazonal soils

Soils of the intrazonal order have evident, genetically related horizons that reflect the dominant influence of a local factor of topography or parent materials over the effects of climate and plant and animal life. In Kearny County the Calcisols, Grumusols, and Humic Gley soils are in the intrazonal order.

CALCISOLS

Calcisols lack a textural B horizon and have an accumulation of lime in the upper part of the C horizon. The Mansker soils are the only Calcisols in Kearny County.

Mansker series.—The Mansker series consists of grayish-brown, calcareous soils that are shallow to moderately deep over a prominent, slightly hard C_{ca} horizon. Their profile is only slightly developed and lacks a B horizon. Small fragments of hard caliche are scattered throughout the profile.

A thin mantle of loess once covered this area, but the loess did not affect the formation of the soils, because it was stripped away as the result of geologic erosion. The soils formed in medium-textured and fine-textured, strongly calcareous outwash sediments of the High Plains.

The Mansker soils have a much more strongly developed C_{ca} horizon than the Mansic soils, and the C_{ca} horizon is partly indurated. More than 10 percent of the horizon is made up of hard, white concretions. The Mansker soils are deeper and have a more strongly developed profile than the Potter soils. The following describes a profile of a Mansker loam that has slopes of about 2 percent, in a cultivated field, 2,340 feet east and 800 feet north of the southwestern corner of section 12, T. 23 S., R. 37 W.:

A_{1p}—0 to 3 inches, grayish-brown (10YR 5/2, dry) or dark grayish-brown (10YR 3.5/2, moist) loam; massive; soft when dry and friable when moist; strongly calcareous; many small rocks and fragments of hard caliche scattered on the surface; clear boundary.

A_1—3 to 9 inches, intermediate between dark grayish-brown and grayish-brown (10YR 4.5/2, dry) or dark grayish-brown (10YR 3.5/2, moist) loam; weak, granular structure; soft when dry and friable when moist; strongly calcareous and has small, hard fragments of caliche mixed throughout; clear boundary.

AC—9 to 14 inches, light brownish-gray (10YR 6/2, dry) or grayish-brown (10YR 5/2, moist) loam; weak, granular structure; soft when dry and friable when moist; strongly calcareous; clear boundary.

C_{ca}—14 to 28 inches, white (10YR 8/2, dry) or light-gray (10YR 7/2, moist) light clay loam; massive; hard when dry and friable when moist; strongly calcareous and contains soft and slightly hard concretions of calcium carbonate; about 30 to 40 percent of this layer is calcium carbonate; clear boundary.

C—28 to 40 inches, white (10YR 8/2, dry) or pale-brown (10YR 6.5/3, moist) light silty clay loam; massive; hard when dry and firm when moist; strongly calcareous.

Range in characteristics: The surface horizon ranges from grayish brown to pale brown in color and from loam to light clay loam in texture. Depth to the C_{ca} horizon ranges from 10 to 20 inches, and the content of calcium carbonate in the C_{ca} horizon ranges from 30 to 60 percent.

GRUMUSOLS

Grumusols are a group of soils having profiles rather high in content of clay and relatively uniform in texture. They are marked by signs of local soil movement resulting from shrinking and swelling as the soils wet and dry. Many of the soils have a thick, dark A horizon over a limy C horizon; others are uniform in general appearance except for the signs of churning. These soils formed in parent material having a high content of clay or of alkaline earth elements, or from rocks that provided abundant clay and alkaline earths upon weathering. In Kearny County only the Church soils are in this great soil group.

Church series.—The Church series consists of deep, grayish-brown to brown, calcareous soils that are very slowly permeable. The soils formed in fine-textured alluvial sediments. Their profile shows only slight development.

No typical Church soils are mapped in this county, but a dark variant, which has some characteristics like those of the Church soils, has been mapped. This dark variant is in the lower part of the Bear Creek depression. It is mainly in areas that are nearly level, but the areas under native vegetation have strong gilgai microrelief.

The characteristics of the profile are fairly uniform wherever this soil occurs in the county. Swelling and shrinking are distinct characteristics of the soil materials. The following describes a profile of this dark variant, in a cultivated field that has been irrigated, 2,125 feet east and 60 feet north of the southwestern corner of section 21, T. 26 S., R. 37 W.:

A_p—0 to 5 inches, grayish-brown (10YR 5/2.5, dry) or very dark grayish-brown to dark-brown (10YR 3.5/2.5, moist) light clay; weak, granular structure to massive; hard when dry and firm when moist; strongly calcareous; clear boundary.

AC—5 to 24 inches, dark grayish-brown (10YR 4/2.5, moist) or dark-brown (10YR 3/2.5, moist) clay; weak, prismatic structure breaking to weak, very fine, subangular blocky or irregular blocky; very hard when dry and very firm when moist; strongly calcareous; thin clay films are visible; diffuse boundary.

C_1—24 to 45 inches, brown (10YR 4.5/3 moist) or dark-brown (10YR 3.5/3, moist) light clay; massive; very hard when dry and very firm when moist; strongly calcareous; diffuse boundary.

C_2—45 to 64 inches, brown (10YR 5/3, dry) or dark-brown (10YR 4/3, moist) clay; massive; very hard when dry and very firm when moist; strongly calcareous and has a few very fine streaks of lime concentrations at a depth of less than 52 inches.

Range in characteristics: The profile characteristics are fairly uniform throughout the acreage.

Drainage: Moderately well drained. Surface runoff, very slow. Permeability, very slow.

HUMIC GLEY SOILS

Humic Gley soils, formed in depressions where natural drainage is poor to very poor, are in the intrazonal order. Their surface layer is dark colored and contains a large amount of organic matter. In most places it is more than 6 inches thick. The surface layer is underlain by strongly gleyed, mottled soil material. The Sweetwater soils are the only Humic Gley soils in the county.

Sweetwater series.—The Sweetwater soils have a dark-colored, friable layer that is high in organic-matter content and has strong, granular structure. These soils formed in stratified, calcareous alluvium on the lower flood plains of the Arkansas River. They are somewhat poorly drained because the water table fluctuates at a depth between 1 and 8 feet from the surface.

The following describes a profile of Sweetwater clay loam, in native vegetation, 1,600 feet south and 1,340 feet west of the northeastern corner of section 21, T. 24 S., R. 35 W.:

A_{11}—0 to 6 inches, grayish-brown (10YR 5/2, dry) or very dark grayish-brown (10YR 3.5/2, moist) clay loam; moderate, medium, granular structure; slightly hard when dry and firm when moist; calcareous; clear boundary.

A_{12}—6 to 15 inches, gray (10YR 5/1, dry) or very dark gray (10YR 2.5/1, moist) clay loam; strong, medium, granular structure; hard when dry and friable when moist; calcareous; numerous small nests and seams of white crystalline substance (gypsum) scattered throughout; very porous; many fine roots; few, fine, faint mottles of yellowish brown in lower part; abrupt boundary.

C_1—15 to 23 inches, grayish-brown (10YR 5.5/2, dry) or dark grayish-brown (10YR 4/2, moist) clay loam; moderate, medium, granular structure; hard when dry and friable when moist; strongly calcareous; many, fine and medium, faint mottles of yellowish brown and prominent mottles of reddish brown; clear boundary.

C_2—23 to 28 inches, pale-brown (10YR 6/3, dry) or brown (10YR 5/3, moist) loamy sand; structureless and loose; noncalcareous; prominent and coarse mottles of reddish brown; abrupt boundary.

C_3—28 inches +, pale-brown, stratified sand and gravel.

Range in characteristics: In places there is a surface accumulation of recently deposited sandy to clayey material. Below the surface layer, the soil material is stratified and the texture is extremely variable, ranging from sand to heavy clay. Depth to the fluctuating water table ranges from 16 to 36 inches. West of Hartland, this soil is generally wetter than it is in areas east of Hartland because the Dakota formation is nearer the surface and the water table is higher. Salinity ranges from slight to moderate; some areas are slightly affected by alkali.

Azonal soils

Soils of the azonal order lack distinct, genetically related horizons because of youth, resistant parent material, or steep topography. In this county the Lithosols, Regosols, and Alluvial soils are in the azonal order.

LITHOSOLS

Lithosols are soils that show little or no evidence of development in the profile. They consist mainly of a partly weathered mass of rock fragments or of nearly bare rock. In this county the Lithosols are very shallow over strongly calcareous, hard or slightly hard caliche of the Ogallala formation. They have strong slopes; much of the soil material that develops on the slope is removed as fast as it is forming. Thus, it is not possible for a well-developed profile to develop in the soils. The Potter soils are the only Lithosols mapped in Kearny County.

Potter series.—The Potter soils are young and have only weak development in the profile. They are very shallow over slightly hard, partly weathered caliche of the Ogallala formation. The caliche is less than 10 inches from the surface. The thin, slightly darkened surface layer is generally loam or sandy loam, and in places gravel and fragments of caliche are scattered over the surface. These soils have steep slopes and are in broken areas well below the level of the High Plains. They are somewhat less dark and are shallower over caliche than the Mansker soils.

The following describes a profile of a Potter loam, under native vegetation, 1,300 feet south and 1,050 feet west of the northeastern corner of section 32, T. 24 S., R. 38 W.:

A_1—0 to 5 inches, light brownish-gray (10YR 6/2, dry) or dark grayish-brown (10YR 4/2, moist) loam; weak, granular structure; slightly hard when dry and friable when moist; strongly calcareous; pebbles and fragments of caliche are scattered on the surface and in the soil profile; clear boundary.

C_1—5 to 11 inches, white, soft caliche mixed with soil material.

C_2—11 inches +, white, hard caliche.

Range in characteristics: The depth of the soil material over the caliche ranges from 2 to 12 inches, but in most places it is about 9 inches. In places geologic erosion has stripped away the silty and loamy sediments and has exposed the caliche, limestone, and shale. There are outcrops of caliche, limestone, and shale in many places on the steeper slopes.

REGOSOLS

Regosols consist of deep, unconsolidated material in which few or no clearly expressed soil characteristics have developed. Regosols are similar to the Lithosols; their youthfulness can be attributed to the recent accumulation of the parent material and to the steep slopes on which the soils occur. The forces of erosion remove the soil material as it forms so it is not possible for a deep, well-developed profile to form. The Regosols in this county are in the Colby, Otero, and Tivoli series.

Colby series.—The Colby series is made up of deep, grayish-brown soils that are friable and calcareous. The soils have a weakly developed, or AC-type, profile in which the A horizon consists of only slightly altered and somewhat darkened parent material. These soils are gently sloping to steep and have formed in loess under a cover of short grasses. In Kearny County they are generally in sloping areas between the High Plains and the Arkansas River Valley.

The Colby soils are closely associated with the Ulysses soils, but they have a thinner and lighter colored A horizon than the Ulysses soils. They also have a less developed profile and their surface layer is more calcareous.

The following describes a profile of a Colby silt loam that has slopes of about 2½ percent, in a cultivated field, 2,450 feet east of the center of section 9, T. 24 S., R. 36 W.:

A_p—0 to 4 inches, grayish-brown (10YR 5/2, dry) or dark grayish-brown (10YR 3.5/2, moist) silt loam; weak, granular structure; slightly hard when dry and friable when moist; calcareous; clear boundary.

AC—4 to 14 inches, brown (10YR 5.5/3, dry) or dark grayish-brown to brown (10YR 4.5/2.5, moist) silt loam; weak to moderate, fine and medium, granular structure; slightly hard when dry and friable when moist; strongly calcareous; numerous worm casts; clear boundary.

C_{ca}—14 to 32 inches, pale-brown (10YR 6/3, dry) or brown (10YR 5/3, moist) silt loam; massive but porous; soft when dry and very friable when moist; strongly calcareous and contains a few, fine, soft concretions of lime; few worm casts in upper 10 inches; clear boundary.

C—32 to 52 inches +, pale-brown (10YR 6.5/3, dry) or brown (10YR 5/3, moist) silt loam; massive; porous; soft when dry and very friable when moist; strongly calcareous.

Range in characteristics: The texture of the surface layer and of the underlying loess is essentially uniform within any one profile, but it ranges from silt loam to light silty clay loam. In some areas under grass, the A horizon is noncalcareous and is somewhat darker than the A horizon in areas not covered by grass; it is less than 6 inches thick in those areas.

Drainage: Well drained. Surface runoff, moderate to very rapid. Permeability, moderate.

Erosion: This soil is susceptible to serious erosion by both wind and water if it is not adequately protected by growing vegetation or by the residue of vegetation.

Otero series.—The Otero soils are deep, light-colored, friable, calcareous sandy loams that have a profile that shows only weak development. They formed in strongly calcareous, generally moderately sandy outwash sediments of the High Plains. These sediments form a mantle that consists mainly of partly reworked, windblown material deposited in the latter part of the Pleistocene age. In Kearny County the Otero soils are mapped as part of the Otero gravelly complex. Generally they occur on the crests of ridges and knolls and on side slopes along sandy and gravelly drainageways of intermittent streams. The Otero soils are more sandy and less silty throughout than the Colby and Ulysses soils. They are thinner, lighter colored, and more limy than the Manter and Vona soils.

The following describes a profile of an Otero sandy loam that has slopes of about 7 percent and is in native vegetation; this profile is 2,150 feet east and 400 feet south of the northwestern corner of section 34, T. 24 S., R. 38 W.:

A_1—0 to 9 inches, grayish-brown (10YR 5/2, dry) or intermediate between very dark grayish-brown and dark grayish-brown (10YR 3.5/2, moist) sandy loam; weak, granular structure; slightly hard when dry and very friable when moist; weakly calcareous; clear boundary.

AC—9 to 19 inches, grayish-brown (10YR 5/2, dry) or dark grayish-brown (10YR 4/2, moist) sandy loam; weak, granular structure; slightly hard when dry and very friable when moist; strongly calcareous and has many fine streaks and films of lime; few scattered worm casts; clear boundary.

C—19 to 36 inches, intermediate between pale brown and very pale brown (10YR 6.5/3, dry) or brown (10YR 5/3, moist) loam; massive; porous; slightly hard when dry and friable when moist; strongly calcareous and has a few faint films of lime in the upper part; few small pebbles that are coated with lime; abrupt boundary.

D—36 inches +, mixed sand and gravel partly cemented with lime.

Range in characteristics: The surface layer ranges from grayish brown to brown in color. Its texture is mainly sandy loam, but it ranges from loam to loamy sand. The depth to calcareous material ranges from 0 to 10 inches. The parent material and substratum, which are below a depth of 3 feet, generally consist of strongly calcareous, sandy and gravelly material, but part of this material has been reworked, and part has formed in place.

Drainage: Well drained. Surface runoff, slow to moderate. Permeability, moderate to moderately rapid.

Tivoli series.—The Tivoli soils are loose, noncalcareous, dry sands. They have an A horizon of grayish-brown fine sand or loamy sand. The A horizon is underlain by pale-brown fine sand that is windblown parent material of the Pleistocene age. These soils have practically no profile development. They formed in the fine sand of stabilized dunes in the sandhills south of the Arkansas River Valley. The areas are strongly undulating, hummocky, and choppy. On the steeper, more choppy areas of dunes, the sand is continually shifted by the wind. The Tivoli soils have a looser, more nearly noncoherent profile than the associated Vona soils, and they are more dunelike.

The following describes a profile of Tivoli loamy fine sand, in native vegetation, on the side of a dune 775 feet south and 525 feet west of the northeastern corner of section 21, T. 25 S., R. 36 W.:

A_1—0 to 3 inches, grayish-brown (10YR 5/2, dry) or intermediate color (10YR 3.5/2.5, moist) loamy fine sand; very weak, granular structure; soft when dry and loose when moist; noncalcareous; clear boundary.

AC—3 to 6 inches, pale-brown (10YR 6/3, dry) or brown (10YR 4/3, moist) fine sand; single grain; loose; noncalcareous; clear boundary.

C—6 to 40 inches +, light yellowish-brown (10YR 6/4, dry) or brown (10YR 5/3.5, moist) fine sand; single grain; loose; noncalcareous.

Range in characteristics: The color of the A horizon ranges from grayish brown to pale brown, and the texture, from loose, noncoherent, single grain fine sand to weak, granular loamy fine sand. The parent material is very pale brown to light yellowish-brown windblown sand.

Drainage: Excessively drained. These loose, open and porous sands absorb the limited precipitation as it falls. Internal drainage, very rapid.

Erosion: The soils are suceptible to severe wind erosion when the cover of plants is thin or absent. Active dunes, or fine sand in hills, ridges, and cone-shaped dunes that are continually shifted by the wind, are scattered throughout this area.

ALLUVIAL SOILS

The Alluvial great soil group consists of soils that formed in transported and fairly recently deposited alluvial material. The soils have little or no profile development. They vary from place to place in color, texture, and arrangement of layers because of variations in the sediments that make up the parent material. The Bayard, Bridgeport, Bowdoin, Las, Las Animas, and Lincoln soils are in the Alluvial great soil group in this county.

Bayard series.—The Bayard series consists of soils that are porous, calcareous, and well drained. They formed in alluvium and contain a moderate amount of sand. These soils have weak profile development. They are in narrow, undulating areas of uplands along streams that cross the alluvial fans, or aprons, bordering the Arkansas River Valley. The following describes a profile of a Bayard fine sandy loam, not used for agriculture, 1,700 feet east of the southwestern corner of section 10, T. 25 S., R. 37 W., and about 40 feet north of the road near Hartland:

A_1—0 to 8 inches, grayish-brown (10YR 5/2, dry) or dark grayish-brown (10YR 4/2, moist) fine sandy loam; massive to nearly structureless; soft when dry and friable when moist; calcareous; few small pebbles scattered throughout; gradual boundary.

AC—8 to 23 inches, sandy loam that has a color intermediate between that of the A_1 horizon and the C horizon; weak, granular structure; soft when dry and very friable when moist; calcareous; occasional clusters of worm casts; gradual boundary.

C—23 to 48 inches, pale-brown (10YR 6/3, dry) or brown (10YR 5/3, moist) sandy loam that is stratified with loam and loamy sand; massive to structureless; soft when dry and friable when moist; strongly calcareous and contains small, soft, lime concretions; many small pebbles scattered throughout.

Range in characteristics: In some places the surface layer is darker colored or lighter colored than the one in the profile described. The texture varies greatly throughout the profile. The soil material is stratified, and the texture in the layer ranges from clay loam to fine sand. Depth to coarse sand and gravel ranges from 30 to 60 inches.

Drainage: Well drained. Internal drainage, medium. Permeability, moderate to moderately rapid. The water table lies well below the root zone, generally below a depth of 10 feet.

Bowdoin series.—The Bowdoin soils are poorly drained, calcareous, and generally saline. Their subsoil consists of layers of gray clay that was derived from the fine sediments in which the soils formed. These soils are generally mottled at a depth of less than 40 inches. Depth to coarse sand is generally more than 40 inches. The following describes a profile of Bowdoin clay loam, in a cultivated field that has been irrigated, 1,600 feet east and 80 feet north of the southwestern corner of section 27, T. 24 S., R. 35 W.:

A_1—0 to 6 inches, dark grayish-brown (10YR 4/2, dry) or very dark grayish-brown (10YR 3/2, moist) heavy clay loam; moderate, medium, granular structure; hard when dry and slightly firm when moist; calcareous; abrupt boundary.

AC—6 to 14 inches, gray (10YR 4.7/1, dry) or very dark gray (10YR 3/1, moist) clay; massive structure to irregular blocky; very hard when dry and firm when moist; calcareous; numerous streaks and nests of a white crystalline substance (gypsum); very few, faint mottles of yellowish brown; clear boundary.

C_1—14 to 27 inches, brown (10YR 5/3, dry) or dark-brown (10YR 3.5/3, moist) clay loam; moderate, medium, granular structure; slightly hard when dry and slightly firm when moist; calcareous; numerous nests and films of white crystalline substance (gypsum); few, faint, prominent splotches and small mottles of brownish yellow and reddish brown; few fine pores; clear boundary.

C_2—27 to 42 inches, gray (10YR 5/1, dry) or very dark gray (10YR 3.5/1, moist) heavy clay loam and light clay; moderate, fine, subangular blocky structure; hard when dry and firm when moist; calcareous; numerous, small, prominent mottles of reddish brown; numerous nests and films of a white crystalline substance (gypsum); abrupt boundary.

C_3—42 to 51 inches, brown (10YR 5/3, dry) or dark yellowish-brown (10YR 4/4, moist) sandy loam; weak, granular structure; soft when dry and friable when moist; many, distinct, brownish-yellow splotches of mottles when moist; clear boundary.

C_4—51 to 64 inches, light yellowish-brown sand and gravel; prominently mottled in upper part with streaks and splotches of brownish yellow and reddish brown.

Range in characteristics: In places the profile contains thin strata of material ranging from sand to clay in texture. The surface layer ranges from gray to dark grayish brown in color, and from clay to light clay in texture.

Drainage: Somewhat poorly drained. Subsoil, slowly permeable. Fluctuating water table within 10 feet of the surface.

Bridgeport series.—The Bridgeport soils are nearly level and are moderately dark, deep, and calcareous. They are friable and are well drained. The soils are medium to moderately fine textured and have a weak, granular to moderate, medium, subangular blocky structure. They are on alluvial fans, or aprons, north of the Arkansas River Valley. The Bridgeport soils are lighter colored than the Goshen soils, and they are calcareous nearer the surface. They are deeper over sand and have better drainage than the associated Las soils.

A small area of Bridgeport soils occurs on an old, high, alluvial fan where Bear Creek enters the Arkansas River Valley. Below a depth of 30 inches in this area, these soils have faint, yellowish-brown mottles. This mottling has probably been caused either by a high water table in prehistoric times or from water seepage under the sandhills after Bear Creek was cut off from the Arkansas River by ridges of sand dunes.

The following describes a nearly level Bridgeport clay loam, in a cultivated field that has been irrigated, 1,840 feet south and 800 feet east of the northwestern corner of section 26, T. 24 S., R. 36 W.:

A_{1p}—0 to 6 inches, dark grayish-brown (10YR 4/2, dry) or very dark grayish-brown (10YR 3/2, moist) light clay loam; weak, medium, granular structure; slightly hard when dry and friable when moist; calcareous; gradual boundary.

A_1—6 to 13 inches, grayish-brown (10YR 5/2, dry) or very dark grayish-brown (10YR 3/2, moist) clay loam; moderate, fine, subangular blocky structure; hard when dry and friable when moist; weakly calcareous; few scattered granules of worm casts; gradual boundary.

AC—13 to 34 inches, grayish-brown (10YR 5.5/2, dry) or dark grayish-brown (10YR 4/2, moist) clay loam; weak, medium, prismatic structure breaking to moderate, medium, subangular blocky structure; hard when dry and friable when moist; strongly calcareous; few scattered granules of worm casts; porous; diffuse boundary.

C—34 to 48 inches, pale-brown (10YR 6/3, dry) or brown (10YR 4/3, moist) clay loam; massive but porous; slightly hard when dry and friable when moist; strongly calcareous and contains faint streaks and films of lime.

Range in characteristics: The color of the surface layer is lighter in places than is indicated in the profile described because light-colored material has accumulated on it. The texture of the surface layer ranges from loam to sand. Variations in the profile are few. Depth to sand and gravel is generally more than 5 feet.

Drainage: Well drained. Internal drainage, medium. Permeability, moderate. The water table lies well below the root zone.

Las series.—The Las soils are fairly light colored, calcareous loams to clay loams that are somewhat poorly drained. They are slightly to moderately saline. Their subsoil is mainly clay loam, but it contains layers of sandy alluvium. It is underlain by the substratum, which is generally very sandy and is at a depth of 2 to 5 feet. The soils are on nearly level, low terraces on the flood plains of the Arkansas River.

The Las soils are similar to the Bridgeport soils except that their subsoil is mottled. Their subsoil is less clayey than that of the Bowdoin soils and is more clayey than that of the Las Animas soils. The following describes a profile of Las clay loam, moderately deep, in an irrigated field, 2,500 feet west and 60 feet south of the northeastern corner of section 32, T. 24 S., R. 35 W.:

A_1—0 to 11 inches, grayish-brown (10YR 5/2, dry) or dark grayish-brown (10YR 3.7/2, moist) clay loam; moderate, medium, granular structure; hard when dry and firm when moist; calcareous; gradual boundary.

AC—11 to 17 inches, grayish-brown (10YR 5.5/2, dry) or dark grayish-brown (10YR 4/2, moist) clay loam; moderate, medium, granular to weak, medium, subangular blocky structure; hard when dry and firm when moist; calcareous; numerous root holes and pores; gradual boundary.

C_1—17 to 33 inches, pale-brown (10YR 6/3, dry) or brown (10YR 5/3, moist) clay loam; massive and compact; hard when dry and firm when moist; calcareous and contains a few, soft, lime concretions; numerous nests of a fine, white, crystalline substance; few to many, prominent, medium splotches and streaks of reddish brown; abrupt boundary.

C_2—33 to 40 inches +, very pale brown to brownish-yellow, stratified loamy sand and coarse sand distinctly mottled with yellowish brown and reddish brown.

Range in characteristics: The A_1 horizon ranges from loam to clay loam in texture and from 8 to 12 inches in thickness. In places the profile contains thin strata of sandy material.

Drainage: Somewhat poorly drained. Depth to the fluctuating water table ranges from 2 to 10 feet, but the water table is 3 to 7 feet below the surface most of the time. Runoff slow. Permeability of the subsoil, moderately slow. Subject to occasional flooding.

Las Animas series.—The Las Animas soils are fairly light colored and are somewhat poorly drained. They have a profile that shows only weak development, and they formed in calcareous, sandy and loamy alluvial sediments on the flood plains of the Arkansas River.

These soils have a surface layer of clay loam to loamy sand and a subsoil of sandy loam to loamy sand. Strata of sand, silt, or clayey material are common below a depth of 24 inches, but in places these strata are in other horizons. Depth to coarse sand and gravel is generally more than 20 inches, but sand is generally at a depth between 24 and 60 inches. The following describes a profile of Las Animas sandy loam in an area that has been plowed but is now in native vegetation; this area is on the flood plains of the Arkansas River, 1,800 feet east and 500 feet north of the southwestern corner of section 33, T. 24 S., R. 35 W.:

A_{1p}—0 to 4 inches, grayish-brown (10YR 5/2, dry) or dark grayish-brown (10YR 3.5/2, moist) sandy loam; structureless; soft when dry and very friable when moist; calcareous; clear boundary.

A_1—4 to 13 inches, sandy loam that is intermediate in color between brown and pale brown (10YR 5.5/3, dry) or brown (10YR 4/3, moist); weak, granular structure; soft when dry and very friable when moist; calcareous; few scattered worm casts; gradual boundary.

AC—13 to 25 inches, pale-brown (10YR 6/3, dry) or brown (10YR 5/3, moist) sandy loam; weak, granular structure; soft when dry and very friable when moist; calcareous; occasional small nests of a white, crystalline substance (gypsum) in lower part; few, faint mottles of brownish yellow and yellowish brown in lower part; abrupt boundary.

C_1—25 to 31 inches, pale-brown (10YR 6/3, dry) or brown (10YR 4.5/3, moist) clay loam; massive to compact; hard when dry and firm when moist; calcareous and contains a few, small, soft lime concretions and a few, hard lime concretions; few to many, fine and medium, faint mottles of brownish yellow and gray; clear boundary.

C_2—31 to 50 inches, mixed stratified, pale-brown (10YR 6/3, dry) sand and gravel; prominently mottled in upper part with medium to coarse streaks and splotches of yellowish brown and reddish brown.

Range in characteristics: The texture of the surface layer ranges from clay loam to loamy sand. Strata of sand, silt, or clay are common below a depth of 2 feet, but these strata may occur in any horizon.

Drainage: Somewhat poorly drained. A fluctuating water table is 2 to 10 feet below the surface. Surface runoff, slow. Permeability, moderate to rapid. Subject to occasional flooding.

Lincoln series.—The Lincoln soils are calcareous, noncoherent, and fairly light colored. These soils are on the flood plains of the Arkansas River, and they consist of only slightly altered, very sandy and gravelly alluvium. The soils are subject to recurrent flooding and receive fresh deposits of material each time they are flooded. They are generally lower and nearer the river than the associated Las Animas and Sweetwater soils. The following describes a profile of Lincoln sand, in native vegetation, 1,050 feet west and 260 feet south of the northeastern corner of section 35, T. 24 S., R. 36 W.:

A_1—0 to 4 inches, grayish-brown (10YR 5/2, dry) or dark grayish-brown (10YR 4/2, moist) sand; loose and structureless; calcareous; abrupt boundary.

C_1—4 to 18 inches, pale-brown (10YR 6/3, dry) or brown (10YR 5/3, moist) fine sand; loose and structureless; calcareous; abrupt boundary.

C_2—18 to 23 inches, grayish-brown (10YR 5/2, dry) or dark grayish-brown (10YR 4/2, moist) clay loam; massive to compact; hard when dry and firm when moist; calcareous; distinct to prominent mottles of yellowish brown and reddish brown; abrupt boundary.

C_3—23 to 40 inches +, stratified coarse sand and gravel.

Range in characteristics: The texture is extremely variable in these soils; it ranges from clayey material in the thin layers to fine or coarse sand in the thick layers. Depth to coarse sand ranges from 10 to 30 inches but is generally less than 24 inches. In places faint mottling is evident throughout the profile, but in some places distinct and prominent mottles may occur in the more clayey layers.

Drainage: Somewhat poorly drained. A fluctuating water table is 2 to 10 feet below the surface, generally at about the level of the flow in the river. Surface runoff, slow. Permeability, rapid to very rapid.

Additional Facts About the County

This section gives information about the early history and development of Kearny County and facts about the agriculture. It also describes the physiography, relief, drainage, and climate; discusses the water supplies, towns, markets, and transportation; and describes the industries, resources, and community facilities. Unless otherwise indicated, the figures used are from reports of the U.S. Bureau of the Census.

Early History

The area that is now Kearny County was opened for settlement when the Santa Fe Railroad reached Lakin in 1872. The following year, the county was organized, but it was abolished by legislative action in 1883. The county was reestablished in 1887; it had 2,891 inhabitants at that time. Lakin was the first county seat, but the county seat was moved to Hartland in 1890. It was returned to Lakin in 1894.

The early settlers grew most of their own food. Before World War I, agriculture consisted only of this subsistence type of farming and the raising of livestock.

Since the area was first settled, the population has fluctuated as the result of changes in the climate. The population decreases rapidly during prolonged periods of drought but increases during periods of above-average rainfall. In 1950, the population of Kearny County was 3,492. Lakin, the county seat and largest town, had a population of 1,618 in that year, and Deerfield had a population of 440.

Agriculture

Before World War I, most of the land in Kearny County was covered with native grasses. Only a small acreage was cultivated, mainly to grow feed grains and forage for livestock. Livestock was an important source of farm income.

Irrigation began in the late 1800's when water for irrigation was diverted from the Arkansas River and was used to irrigate soils in the valley and in the upland north of Deerfield. Increasingly large acreages of sod were plowed as wheat became more important as a cash crop and as tractor power became available. A large acreage that was formerly in grass was plowed in the late 1920's, and another large acreage, in the middle 1940's.

After the drought and duststorms of the 1930's, farmers and landowners became concerned about erosion and the deterioration of their land. In 1948, they organized the Kearny County Soil Conservation District to promote the proper use of land and the conservation of soil and water. Since the formation of the district, many acres of nonarable land have been reseeded to native grasses, terraces have been built in many places, and contour farming, stubble mulching, supplemental irrigation, and other practices to conserve soil and water have been applied on a large acreage used for cultivated crops.

Most of the arable land is used to grow cultivated crops, mainly wheat and sorghum, which are sold and shipped out of the county. Farming operations are on a large scale and are highly mechanized. The raising of livestock is confined mainly to ranches in the sandhills south of the Arkansas River and to the sloping areas in the uplands north of the river.

There were 318 farms in the county in 1954, according to records of the U.S. Bureau of the Census. In that year a total of 513,995 acres, or about 94 percent of the total acreage in the county, was in farms.

Crops

Wheat and sorghum are the only important crops suited to dryland farming in this part of the High Plains. High yields are obtained during years of average or of above-average rainfall, but crop failures or near failures are common in years when rainfall is below average. Sugar beets, corn, broomcorn, and barley were grown extensively in the early 1900's, but now they are only minor crops. Table 8 gives the acreage of the principal crops harvested in the county for stated years. The figures are based on reports of the Kansas State Board of Agriculture.

TABLE 8.—*Acreage of principal crops in stated years* [1]

Crops	1930	1940	1950	1959
	Acres	*Acres*	*Acres*	*Acres*
Wheat	56, 743	83, 560	134, 000	105, 000
Grain sorghum	13, 576	52, 140	40, 160	81, 000
Crops grown for silage or forage	3, 743	17, 250	10, 670	3, 000
Corn	16, 368	1, 300	90	1, 000
Barley	7, 979	10, 630	9, 000	5, 600
Alfalfa	8, 813	4, 480	2, 420	3, 700
Rye	(2)	140	100	1, 500
Prairie hay	694	1, 190	500	700
Broomcorn	10, 475	2, 900	600	210
Sugar beets	519	916	540	820

[1] Based on reports of the Kansas State Board of Agriculture.
[2] Figure not available.

On the silty soils, crops are usually grown in a system that leaves the land fallow every other year. During the fallow period, weeds are controlled so that moisture is conserved for the following crop. Sometimes, when little moisture has accumulated in the soils, fallowing is continued over a period of 2 years. Crops are usually grown continuously on the sandy soils. Sorghum is the crop generally grown to help control soil blowing, and it also provides forage for livestock. The acreage in sorghum has increased rapidly since World War II. Although wheat is the crop grown most extensively in the county, during periods of drought a large acreage of wheat is destroyed through erosion or by tillage used to help control soil blowing.

Irrigation has increased considerably in recent years. A large acreage is now under irrigation in the uplands north of the Arkansas River. The principal crops grown under irrigation are wheat, sorghum, alfalfa, sugar beets, corn, and vegetables, mainly beans and onions. When the soils lack an adequate cover of vegetation, wind erosion is a constant threat. Therefore, buffer strips of corn or sorghum are planted in the beanfields to help protect the soils.

Livestock

The number of livestock on farms and ranches in the county in stated years is shown in table 9. The figures are based on reports of the Kansas State Board of Agriculture. Cattle are raised more extensively than other kinds of livestock. Ranchers in the sandhills and valleys and in sloping areas of the uplands maintain herds of breeding cattle, mainly Herefords.

The number of cattle on the ranches is fairly stable, but the number decreases during periods of drought. Large numbers of cattle and sheep are brought into the county in fall when wheat pastures and sorghum stubble are available for grazing. Therefore, cattle and sheep are much more numerous in the county during the fall and winter months than in spring and summer.

There are only a few herds of dairy cattle in the county, and they are on irrigated farms. Dairy products are marketed at Lakin and in Garden City in Finney County. Hogs and poultry are of only minor importance commercially.

TABLE 9.—*Number of livestock on farms and ranches in stated years* [1]

Livestock	1930	1940	1950	1959
Horses and mules	3, 287	820	460	170
Milk cows	1, 275	1, 470	880	500
Other cattle	26, 776	5, 940	16, 320	17, 500
Sheep	241	6, 780	18, 720	10, 400
Hogs and pigs	2, 453	1, 980	2, 090	1, 400
Chickens	(2)	34, 080	28, 400	11, 000

[1] Based on reports of the Kansas State Board of Agriculture.
[2] Figure not available.

Pasture

About 39 percent of Kearny County is in native grasses and is used as range. Most of the rangeland is nonarable or lies adjacent to or within areas of nonarable soils, where the soils cannot be cultivated conveniently. The sandhills south of the Arkansas River consist of a large acreage of soils used exclusively for grazing. The soils in that area support a mixture of native tall and mid grasses and sand sagebrush. When these areas are overgrazed, the desirable grasses disappear and only the sagebrush and certain annual grasses and weeds are left. The tableland and sloping areas of uplands that are used for range support short and mid grasses. Native tall and mid grasses that tolerate salt grow abundantly in the valley of the Arkansas River, and scattered cottonwoods and tamarisk grow in some pastures on the bottom lands.

Land use and size and number of farms

Since 1940, there has been a marked change in the use of the land in Kearny County, as well as in the size of farms. Table 10 shows the acreage in different uses during the period 1940 to 1959. The figures given are based on reports of the U. S. Bureau of the Census.

TABLE 10.—*Land use and the average farm acreage in stated years*

Land use	1940	1949	1959
	Acres	*Acres*	*Acres*
Cropland harvested	51, 881	139, 677	170, 361
Cropland not harvested and not pastured	183, 603	111, 648	108, 079
Cropland left fallow	[1] 100, 885	91, 454	92, 074
Pasture not cropland and not woodland	(2)	185, 774	227, 363
Woodland	903	1, 915	984
All other land	(2)	5, 917	7, 502

[1] Includes idle cropland.
[2] Figures not available.

Farms were much larger in 1954 than in 1940, and there has been a decrease in the number of farms. In 1954, the average-sized farm contained 1,616 acres and there were 318 farms in the county. As the size of farms decreased and their number became smaller, the number of persons on farms decreased. The greatest decrease in population has been on farms in the uplands in the northern part of the county. Because of the improved roads and the improved means of transportation that have become available during recent years, many farm families have moved to nearby towns.

Types of farms

In Kearny County cash-grain farms were more numerous than other types of farms in 1954. In that year 275,963 acres of land was in crops. Most of the land used for crops was in crops grown under dryland farming, but a total of 22,895 acres was used to grow irrigated crops. In 1954, 37 farms had all the land irrigated, 7 farms had less than 100 acres irrigated, 13 farms had between 100 and 200 acres irrigated, and 17 had more than 200 acres irrigated. Most of the irrigated land is in the Arkansas River Valley and in the uplands north of Deerfield. The water for irrigation is taken mainly from the Arkansas River and from shallow wells. Since 1954, however, deep wells have been drilled in the uplands in the north-central part of the county.

Farm equipment and labor

All tillage and harvesting are done with mechanically powered equipment. Most tractors used on the dryland farms are large and are of the standard wheel type, but most of those used on irrigated farms are the general purpose type. The number of tractors increased from 419 in 1940 to 698 in 1954. Large, self-propelled combines are used to harvest wheat and grain sorghum.

Most farmers own enough equipment for tillage and planting, but many hire part or all of the equipment for harvesting. Custom operators from outside the area generally furnish much of the labor, as well as the equipment necessary for harvesting. The demand for farm labor is seasonal. The supply of local labor is about adequate for tilling and planting the crops, but transient labor is generally needed to supplement that provided by the custom operators who harvest the crop.

Farm tenure

Few dryland farmers own all the land they farm. It is not uncommon for one operator to rent land from four or five different landowners. The 1954 census shows 38 operators as full owners, 154 as part owners, 125 as tenants, and 1 operator as manager. The farms are generally leased on a share-crop basis; the landowner receives between one-fourth and one-third of the crop. Also, a large acreage is farmed by operators who live outside the county.

Physiography, Relief, and Drainage

Kearny County lies within the Central High Plains area of the Great Plains. Generally, its relief is typical of the High Plains (fig. 15). The Arkansas River crosses the county from west to east. The Arkansas River Valley is bordered by sandhills on the south and by bluffs and rough, broken areas on the north.

The uplands are nearly level, featureless plains that are covered with loess. They have an eastward slope of about 15 feet in 1 mile. North of the Arkansas River Valley, the uplands slope gradually eastward to the Scott-Finney Basin in Finney County. The uplands are drained by several long, narrow, intermittent streams. Many of these streams in the northern part of the county become smaller near the eastern boundary. The water from these streams empties onto the uplands and then spreads out and settles in depressions, or potholes.

Most of the sloping areas in this county border the Arkansas River Valley on the north. Except along the intermittent streams, the surface is gently sloping. Crests between the streams are rounded but nearly level. The strongest slopes are along the intermittent streams in the uplands and on breaks along the Arkansas River. The bluffs that border the valley are highest near the western boundary of the county; they are nearly 150 feet high at Hartland. The bluffs gradually diminish in height northeast of Lakin.

The Arkansas River enters this area at a point along the western boundary of the county. It flows southeast to Hartland and then swings abruptly toward the northeast and leaves the county near Deerfield. The valley is less than 1 mile wide at Hartland and is more than 4 miles wide at Lakin. The flood plain of the valley is only a few feet above the level of the riverbed, and the water table fluctuates from near the surface to a depth of 20 feet. In the valley north of the river are alluvial fans, or aprons, that have formed in sediments carried by intermittent streams of the uplands.

South of the Arkansas River Valley are sandhills that are only a few feet above the river terrace. The sandhills cover an area that is about 5 miles wide along the western side of the county and about 15 miles wide along the eastern side. In most places the areas are strongly undulating and hummocky. Within these areas are irregularly shaped basins. There are also nearly bare areas of actively blowing sand. In the eastern part of the county, some of the sandhills are nearly level or gently undulating. The area occupied by the sandhills is more than 150 feet lower than the area of uplands north of the valley.

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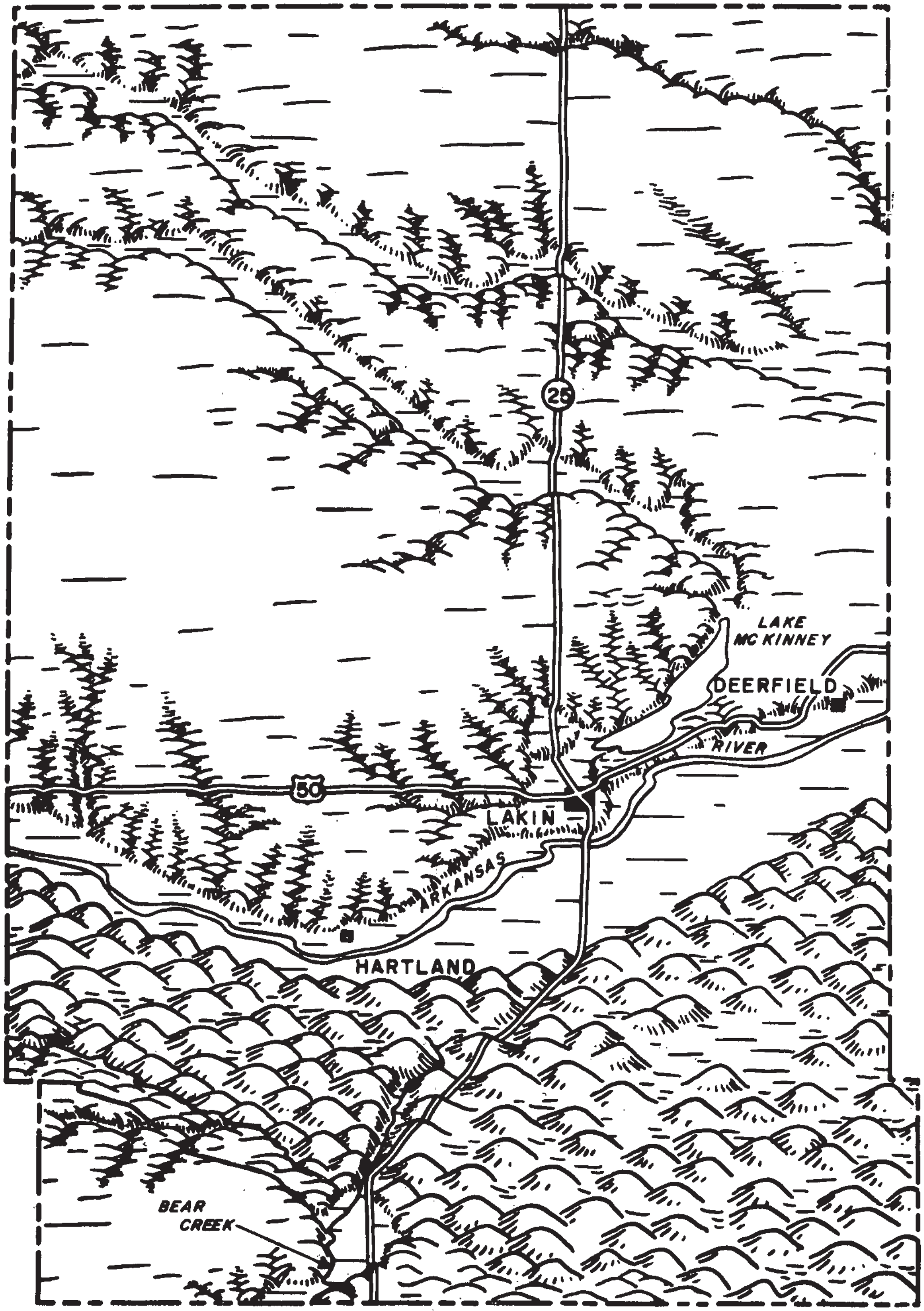

Figure 15.—**Physiographic map of Kearny County.**

A narrow, moderately sandy, transitional area separates the sandhills and the uplands south of the sandhills. In the southwestern part of the county, a small area of uplands is bordered by steep slopes, but in the central part the uplands are nearly level. The highest point on this nearly level tableland is more than 140 feet lower than the highest point on the tableland north of the river. Bear Creek, which was once a tributary of the Arkansas River, is a long, narrow depression that enters the county at the southern boundary and terminates in the sandhills southwest of Lakin.

Elevations in this county range from 2,925 feet above sea level, where the Arkansas River leaves the county near Deerfield, to 3,421 feet on the tableland in the northwestern part of the county.

Climate[4]

Kearny County has the dry air and the marked changes in temperature typical of a well-defined, continental climate. It is within the rain shadow of the Rocky Mountains and is at an elevation of about 3,000 feet.

Weather records, kept near Lakin since 1893, indicate that the climate is predominantly semiarid. The treeless plains and the vegetation of short grasses and desert-type weeds also show that a marginal climate, which affects the yields of crops, prevails in this area.

Extremes in temperature range from 112° F., recorded on July 13, 1913, to −23°, recorded on January 5, 1942 (fig. 16). The range in temperature is about 30° greater in winter than in summer. The range in average maximum temperatures from summer to winter is 34°, and the range in the average minimum temperature from winter to summer is 65°.

A temperature of 100° was recorded as early as April 18 in 1948 and as late as September 27 in 1947. Except for the summer of 1915, temperatures have reached 100° during the summer in every year since 1900. During 1934, a temperature of 100° was recorded for 45 days. In only 4 years, however, has the temperature reached 100° in as many as 5 months.

Freezing temperatures have occurred as early as September 16 in 1893 and 1903, and as late as May 27 in 1907. The earliest date of the last freezing temperature in spring was April 10, 1942, and the latest date of the first freezing temperature in fall was November 2, 1937. The average date of the last freezing temperature in spring is April 30, and the average date of the first freezing temperature in fall is October 15. The average date of the last temperature of 16° in spring is March 22, and the average date of the first temperature of 16° in fall is November 18 (*3*). The average growing season is about 165 days.

[4] By Andrew D. Robb, climatologist, U.S. Weather Bureau, Topeka, Kans.

Subzero temperatures are to be expected every winter. In only 5 of the last 60 winters has the temperature remained above zero throughout the winter. Temperatures of zero or below were recorded as early as November 13, 1940, and as late as March 26, 1955. Temperatures of zero or below have been recorded in two-thirds of the Januarys and in more than one-half of the Februarys.

The longest periods of sustained extreme temperatures at Lakin occurred in 1911 and in 1934. In 1911, the temperature dropped to zero or lower on 15 consecutive nights, and, in 1934, it rose to more than 100° on 15 consecutive days. In this area changes in temperature are sometimes abrupt, but a rapid drop in temperature is much more likely to occur in winter than a rapid rise in summer. During the year, there is a fairly wide daily range of temperature.

Insufficient and irregular rainfall is a distinctive feature of this climate. Precipitation is generally light in winter; the average amount is less than one-half inch per month. From May through August, however, the average amount of precipitation is between 2½ and 3½ inches per month.

Figures that show only the average amount of precipitation fail to show the extreme variation in the amount of rainfall, which is a significant characteristic in this area. In June, for example, the average amount of rainfall is 2.47 inches in this county, but the amount varies greatly from year to year. The greatest amount of rainfall received during the month of June is 9.88 inches, which was recorded in 1949. The least was recorded in 1952 when no rain fell. The records show that at two times more than 5 inches of rain fell in June during 2 successive years. During another 2-year period, however, less than 1 inch fell in June. During still another period of 3 successive years, less than 1 inch of rain fell in June. In only 2 successive years has less than a measurable amount of rain fallen in January, and in only 2 successive years has more than 1 inch of rain fallen in January.

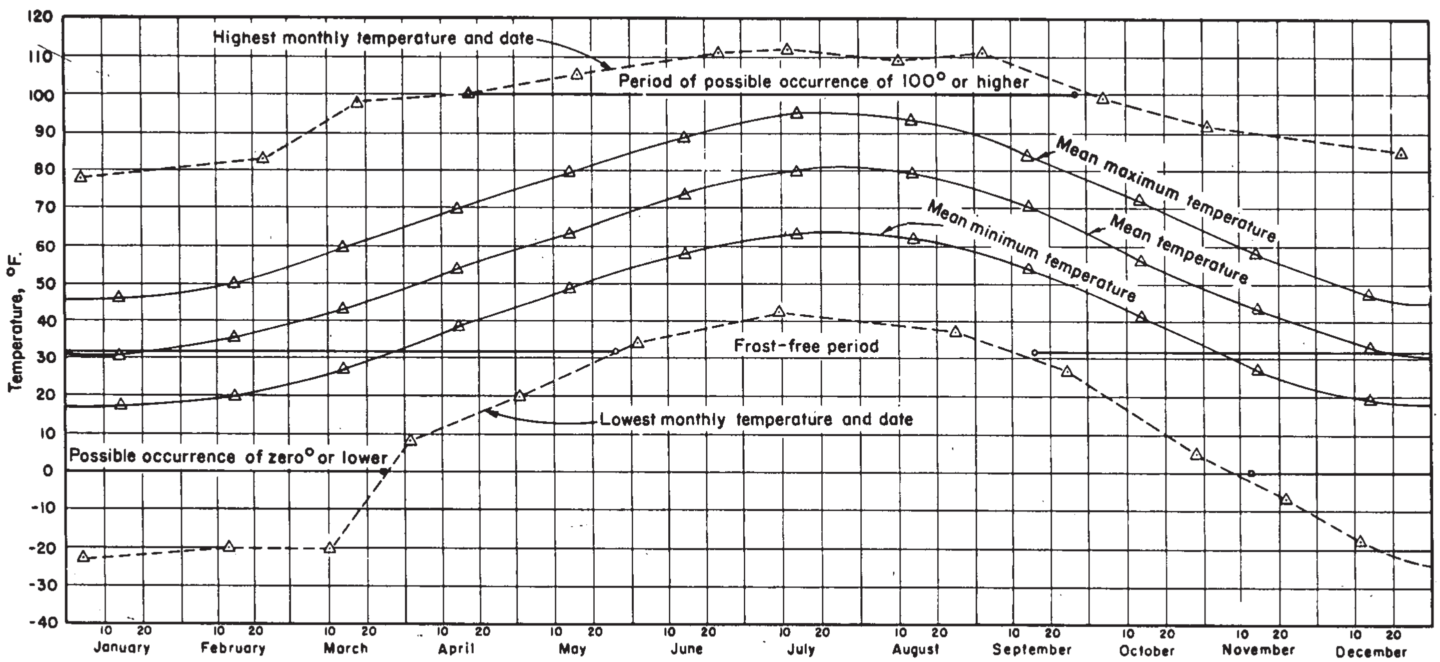

Figure 16.—**Averages (means) and extremes in temperature, as recorded at the Weather Bureau Station near Lakin, Kans.**

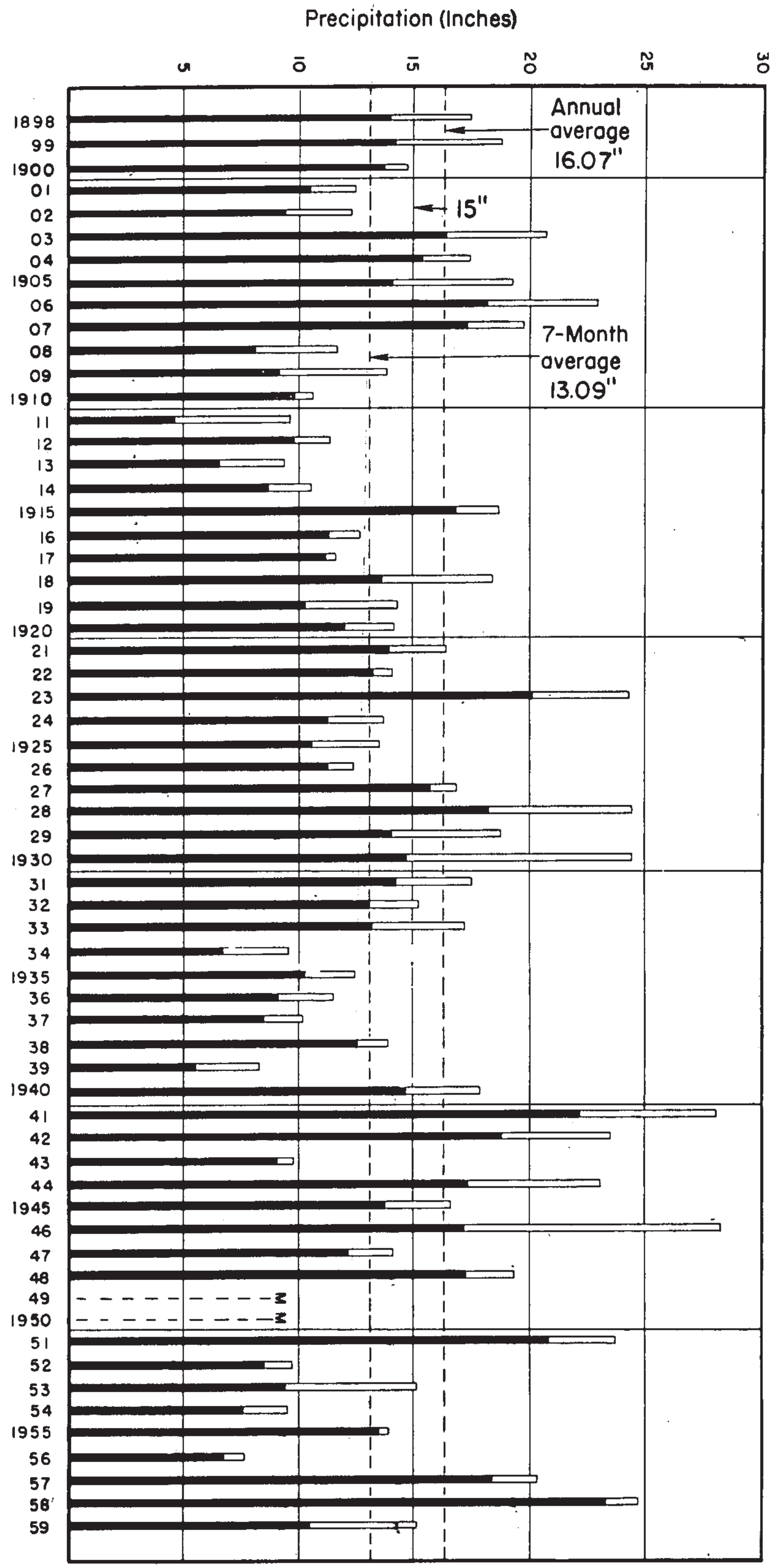

Figure 17.—Variations in annual and growing-season precipitation from 1898 through 1959, as recorded at the Weather Bureau Station near Lakin, Kans. The average annual amount of precipitation and the average precipitation for a period of 7 months are shown by vertical broken lines.

Figure 17 shows the variation in the annual precipitation at Lakin and variation in the precipitation during the growing season. From 1903 to 1907 and from 1927 to 1931, the annual precipitation was greater than average, but it was less than average from 1908 to 1914, from 1934 to 1939, and from 1952 to 1956. The average figures shown for annual precipitation coincide largely with those shown for precipitation during the growing season. Slightly more than 80 percent of the annual average precipitation falls during the 7-month growing season.

There is also a wide variation in the amount of rainfall received in individual years. In 1955, 98 percent of the total precipitation received fell during the 7-month growing season. In each of 9 years during the period from 1898 to 1959, however, 90 percent of the precipitation fell during the growing season. In 1911, which was very dry, 4.86 inches of precipitation fell during the winter and 4.76 inches fell during the summer; less than an inch fell during each of 5 months of the growing season. In 1920, 1923, and 1925, more than 1 inch of rain fell during each month of a 6-month period, and in 1926, more than 1 inch fell each month from March through September.

Figure 18 shows the probability of receiving at least the specified amount of precipitation during the warm season from March through September. There is a 50 percent probability that from 9 to 13½ inches of rain, or an average of 11 inches, will fall during that period; a 25 percent probability that less than 9 inches of rain will fall; and a 25 percent probability that from 14 to 23 inches will fall.

In this area there is a 30 percent probability that 1 inch or more of rain will fall during the period from May 31 to June 6, but there is less than a 5 percent probability that 1 inch or more will fall during the period from November 8 through March 28 (*6*).

A fall of 2 or more inches of precipitation during any 24-hour period is to be expected in only about half the years, but, once in 10 years, two such rains may occur during a single year. Over a period of 69 years, a fall of 4 inches or more in 24 hours has been recorded only 3 times—once in each of the months of April, June, and August. Such storms are generally in the form of hard, dashing rains accompanied by high winds, hail, and lightning. The heaviest fall during a 24-hour period was recorded on June 5, 1949, when 5.30 inches fell within a period of 15 to 20 minutes.

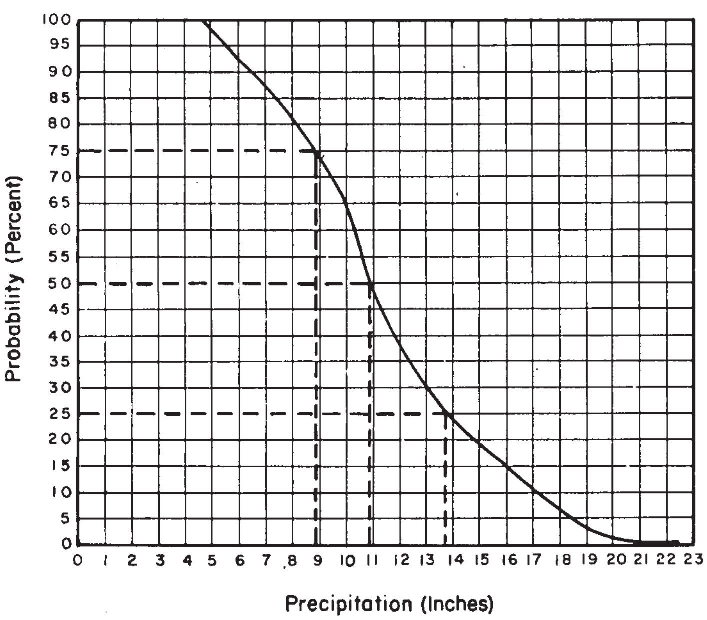

***Figure 18.*—Probability, in percent, of receiving at least a specified amount of warm-season precipitation at Lakin, Kans., from March through September.**

The amount of snowfall is extremely variable in Kearny County. Records kept from the winter of 1893 through the winter of 1958 show that only 1 inch of snow fell in the winter of 1949–50, and that 69.5 inches fell in the winter of 1923–24. Less than 5 inches of snow fell during 9 of the winters in that period, and less than 10 inches fell during 17 winters. A total of 45 inches of snow fell in 5 winters, and 30 inches in 2 winters. A fall of 2 inches of snow has been recorded as early as October, and 6 inches has been recorded as late as May. The greatest amount of snowfall was recorded in March 1924, when the amount of snowfall was 46 inches.

A newcomer to this area will notice the persistent, southerly winds. Records at the Weather Bureau station at Dodge City show that the average annual wind velocity is about 15 miles per hour. The average monthly wind velocity ranges from 17.1 miles per hour in March to 13.6 miles per hour in August. Winds of at least 56 miles per hour have been recorded for every month of the year, and, from March through August, winds of as high as 78 miles per hour have been recorded (*8*). In winter, high winds accompany the onrush of air as a cold wave advances, but in summer they accompany thunderstorms. A windspeed of at least 23 miles per hour for a period of about 3 days may be expected in April once every 2 years (*10*). Persistent high winds and scanty rainfall result in duststorms and increase the hazard of soil erosion.

Thunderstorms occur on an average of about 50 days a year, but they have occurred on as many as 66 days a year and on as few as 27 days. Hail strikes on about 4 days each year, but records show that hailstorms once occurred 12 times in a single year.[5]

An average of 142 days a year are clear, 109 are partly cloudy, and 114 days are cloudy. The sun shines 71 percent of the time (*8*).

In addition to the almost perennial hazard of drought, hot, burning winds affect this area. Precautions must be taken against blizzards, although blizzards do not occur frequently in the area. The most damage from storms is caused by high winds and hail. At times all of the ripe grain in large fields has been destroyed by hailstones the size of marbles. At other times, property has been damaged by hail of even larger size. Tornadoes occur occasionally in this county.

Water Supplies

In Kearny County, water for domestic use is obtained from drilled wells. Most of the water for livestock also comes from wells, but many small dams that impound water for livestock have been constructed across intermit-

[5] U.S. WEATHER BUREAU, THUNDERSTORM RAINFALL. Hydrometeorological Report No. 5, 331 pp. 1945. [Mimeographed.]

tent streams in the uplands. These small reservoirs furnish enough water for livestock during periods of average rainfall. During extended drought, however, there is too little rainfall to replenish the supply in the ponds, and water for livestock must then be supplied from some other source. Wells that will supply enough water for domestic use and for livestock can be drilled almost anywhere in the county.

The ground water is hard, but it is suitable for most uses. The main water-bearing formations are the alluvium, the rocks of the Dakota formation, and the undifferentiated Pliocene and Pleistocene deposits of the Ogallala formation. Water from the alluvium is generally very hard.

Enough water to irrigate field crops is pumped from shallow wells drilled in the alluvium of the Arkansas River Valley and from deep wells drilled in the Ogallala, Dakota, and Cheyenne formations north of the valley. Water from the Arkansas River is also used for irrigation. Cement dikes and headgates divert water from the river into irrigation ditches. The South Side Ditch carries water to irrigate many acres of land south of the river, and the Amazon Ditch supplies water to irrigate about 12,000 acres north of Deerfield.

Lake McKinney was constructed in 1905 to supply a reservoir for irrigation water. It covers about 2,300 acres.

Towns, Markets, and Transportation

Lakin and Deerfield are the principal towns in Kearny County. Lakin is near the center of the county at the point where State Highway No. 25 intersects U.S. Highway No. 50. Deerfield is near the eastern boundary of the county. Both towns are on the north side of the Arkansas River Valley, and both are along the Santa Fe Railroad.

Facilities to handle and store grain are located at Lakin and Deerfield. The Santa Fe Railroad provides a means of transporting farm products to terminal elevators and markets to the east. State Highway No. 25 crosses the county from north to south, and U.S. Highway No. 50 crosses it from east to west. Trucks carry produce to markets over these highways, and buses operate over both of them.

Industries and Resources

This county is basically agricultural. Production of natural gas, however, is the principal industry. This industry began in the early 1940's in the southeastern part of the sandhills. Most of the gas wells are in the southern part of the county, and they make up part of the Hugoton gasfield. Gas is obtained from rocks of the Permian series, which are at a depth of about 2,700 feet.

The first oil well was brought into production in 1941 in the northwestern part of the county. Since then, other wells have been brought into production in that area and also in the sandhills.

Sand and gravel, used locally in concrete mixtures and as material for road surfacing, are obtained from the channels of streams and from gravelly terraces along the Arkansas River. In some places hard, calcareous material, or caliche, is used for road surfacing. The sand, gravel, and caliche are taken from the Pleistocene and Pliocene deposits on the uplands north of Hartland.

Community Facilities

High schools are maintained at Lakin, Deerfield, and Kendall. North Kearny School, in the northern part of the county, is a consolidated rural grade school.

Churches of various denominations are located in Lakin and Deerfield. The county supports a hospital and a library in Lakin. The hospital is well equipped to handle the needs of the county. A county fair is held annually at the fairgrounds in Lakin. Exhibits consist of field crops, vegetables, flowers, livestock, and other items produced in the county.

Lake McKinney, northeast of Lakin, is leased by the State Forestry, Fish, and Game Commission. The lake and the surrounding park offer excellent opportunities for hunting, fishing, boating, waterskiing, and picnicking. The lake covers approximately 2,300 acres. The lake is also used as a reservoir to store water for irrigation. The supply of pheasants attracts many hunters into the county during the open season.

Public recreational facilities in Lakin are provided by a swimming pool, a park and picnic areas, and a ball diamond. A privately owned roller rink, golf course, and movie house are open to the public. In addition to the public facilities, the Lakin Sportsmen's Club owns a small, private lake. A cabin and a tract of land for hunting are also owned by a Dodge City Gun Club.

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Glossary

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

Alkali soil. Generally, a highly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is reduced.

Alluvial fan. A fan-shaped deposit of sand, gravel, and fine material, sometimes called an apron, dropped by a stream where its gradient lessens abruptly.

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

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

Caliche. A more or less cemented deposit of calcium carbonate in many soils of warm-temperate areas, as in the Southwestern States. The material may consist of soft, thin layers in the soil or of hard, thick beds just beneath the solum, or it may be exposed at the surface by erosion.

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

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

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Concretions. Hard grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds that cement the soil grains together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose. Noncoherent; will not hold together in a mass.

Friable. When moist, crushes easily under gentle 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 moisture.

Genesis, soil. The manner in which the soil originated, with special reference to the processes responsible for the development of the solum, or true soil, from the unconsolidated parent material.

Gilgai. The microrelief of those clays that have a high coefficient of expansion and contraction with changes in moisture; usually a succession of microbasins and microknolls in nearly level areas, or of microvalleys and microridges that run with the slope.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes.

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

Morphology, soil. The makeup of the soil, including the texture, structure, consistence, color, and other physical, chemical, mineralogical, and biological properties of the various horizons that make up the soil profile.

Mottled. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.*

Ogallala formation. Geologic formation of the Pliocene epoch consisting principally of silt, sand, gravel, and some clay deposits carried in from the Rocky Mountains by shifting streams. In places these poorly sorted materials are loosely consolidated or tightly cemented by calcium carbonate.

Outwash sediments. Thick deposits of old sediments carried by streams of melt water in glacial times and deposited beyond the glacial ice front. The sediments consist of sand, silt, or clay that has been sorted to some extent, and they are now generally in upland positions.

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

Poorly graded soil (engineering). A soil material consisting mainly of particles nearly the same size. Because there is little difference in size of the particles in poorly graded soil material, density can be increased only slightly by compaction.

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

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

Saline soil. A soil that contains soluble salts in amounts that impair growth of crop plants but that does not contain excess exchangeable sodium.

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. (See also Texture, soil.)

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. (See also Texture, soil.)

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

Substratum. Any layer lying beneath the solum, or true soil; the C or D horizon.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. 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 adding the words coarse, fine, or very fine to the name of the textural class. (See also Clay, Sand, and Silt.)

Topsoil. Presumably fertile soil or soil material, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Water table. The upper limit of the 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.

Well-graded soil (engineering). A soil or soil material consisting of particles that are well distributed over a wide range in size or diameter. Such a soil normally can be easily increased in density and bearing properties by compaction.

GUIDE TO MAPPING UNITS, CAPABILITY UNITS, AND RANGE SITES

[See table 1, p. 5, for the acreage and proportionate extent of the soils, and table 3, p. 26, for the estimated average yields per acre on arable soils under dryland farming. To find a discussion of range management, see the section beginning p. 30, and to find the engineering properties of the soils, see the section beginning p. 34].

			Capability unit				*Range site*	
Map symbol	*Mapping unit*	*Page*	*Dryland*	*Page*	*Irrigated*	*Page*	*Name*	*Page*
Ad	Active dunes	5	VIIe-1	25	[1]		Choppy Sands	33
An	Alluvial land	5	VIw-1	24	[1]		Loamy Lowland	32
Ba	Bayard fine sandy loam	6	IVe-4	23	IIs-1	29	Sandy	33
Bd	Bowdoin clay loam	6	IVw-2	24	IVw-3	30	Saline Subirrigated	32
Bp	Bridgeport clay loam	6	IIIc-1	22	I-1	28	Loamy Upland	32
Bx	Broken land	7	VIIw-1	25	[1]		Unstable	33
Ca	Church clay, dark variant	7	VIs-4	25	IVw-5	30	Clay Lowland	32
Cb	Colby silt loam, 1 to 3 percent slopes	7	IVe-2	23	IIe-4	28	Loamy Upland	32
Cc	Colby silt loam, 3 to 5 percent slopes	7	VIe-1	24	[1]		Loamy Upland	32
Cd	Colby silt loam, 5 to 15 percent slopes	7	VIe-1	24	[1]		Limy Upland	32
Dx	Dalhart-Vona loamy fine sands, 0 to 1 percent slopes.	8	IVe-1	23	IVe-7	29	Sands	33
Go	Goshen silt loam	8	IIIc-2	23	I-1	28	Loamy Lowland	32
Gr	Gravelly broken land	8	VIIs-4	25	[1]		Gravelly Hills	33
La	Las clay loam, moderately deep	9	IVw-2	24	IIIw-1	29	Saline Subirrigated	32
Lb	Las clay loam, deep	9	IVw-2	24	IIw-1	28	Saline Subirrigated	32
Ld	Las-Las Animas complex	9	IVw-2	24	IVw-4	30	Saline Subirrigated	32
Lg	Las Animas clay loam	9	IVw-2	24	IVw-4	30	Saline Subirrigated	32
Lh	Las Animas loamy sand	9	VIs-2	25	[1]		Saline Subirrigated	32
Lk	Las Animas sandy loam	10	IVw-2	24	IIIw-2	29	Saline Subirrigated	32
Ln	Lincoln sand	10	VIIw-1	25	[1]		Unstable	33
Lo	Lofton silty clay loam	10	IVw-1	23	[1]		Clay Upland	32
Ma	Mansic clay loam, 0 to 1 percent slopes	11	IIIc-1	22	I-1	28	Loamy Upland	32
Mb	Mansker loam, 0 to 3 percent slopes	11	IVe-2	23	[1]		Limy Upland	32
Mf	Manter fine sandy loam, 0 to 1 percent slopes	11	IIIe-3	22	IIs-1	29	Sandy	33
Mh	Manter fine sandy loam, 1 to 3 percent slopes	11	IIIe-2	22	IIe-2	28	Sandy	33
Mk	Manter fine sandy loam, 3 to 5 percent slopes	11	IVe-4	23	[1]		Sandy	33
Ox	Otero gravelly complex	12	VIe-6	24	[1]		Gravelly Hills	33
Po	Potter soils	12	VIIs-1	25	[1]		Rough Breaks	33
Rm	Richfield silt loam, 0 to 1 percent slopes	13	IIIc-1	22	I-1	28	Loamy Upland	32
Rx	Richfield-Mansic complex, 1 to 3 percent slopes	13	IIIe-1	22	IIe-4	28	Loamy Upland	32
Sw	Sweetwater clay loam	14	Vw-1	24	[1]		Saline Subirrigated	32
Tf	Tivoli fine sand	14	VIIe-1	25	[1]		Choppy Sands	33
Tv	Tivoli-Vona loamy fine sands	14	VIe-2	24	[1]		Sands	33
Tx	Tivoli-Dune land complex	14	VIIe-1	25	[1]		Choppy sands	33
Ua	Ulysses silt loam, 0 to 1 percent slopes	15	IIIc-1	22	I-1	28	Loamy Upland	32
Ub	Ulysses silt loam, 1 to 3 percent slopes	15	IIIe-1	22	IIe-4	28	Loamy Upland	32
Uc	Ulysses silt loam, 3 to 5 percent slopes	15	IVe-2	23	[1]		Loamy Upland	32
Ue	Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded.	15	IVe-2	23	IIe-4	28	Limy Upland	32
Um	Ulysses-Colby silt loams, 3 to 5 percent slopes, eroded.	15	VIe-1	24	[1]		Limy Upland	32
Ux	Ulysses and Richfield soils, silted, 0 to 1 percent slopes.	15	IIIc-1	22	IIs-2	29	Clay Upland	32
Vo	Vona loamy fine sand	16	IVe-1	23	IVe-7	29	Sands	33

[1] Considered unsuitable for irrigation.

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