SOIL SURVEY OF

Meade County, Kansas

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

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in the period 1962-72. Soil names and descriptions were approved in 1973. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1973. This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Meade County Conservation District.

HOW TO USE THIS SOIL SURVEY

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

Locating Soils

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

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

Finding and Using Information

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

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

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

Foresters and others can refer to the section "Windbreak Management," where the soils of the county are grouped according to their suitability for trees.

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

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

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

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

Newcomers in Meade County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county in the section "Environmental Factors Affecting Soil Use."

Cover: Irrigated corn and grain sorghum on Harney silt loam.

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SOIL SURVEY OF MEADE COUNTY, KANSAS

BY BOB I. TOMASU, SOIL CONSERVATION SERVICE

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

MEADE COUNTY, located in the southwestern part of Kansas (fig. 1), has an area of about 626,368 acres, or 979 square miles. Meade, the county seat, is in the central part of the county.

The farm income of Meade County is derived mainly from the sale of wheat, grain sorghum, corn, alfalfa, and cattle. Some milk cows are kept for dairy products. Irrigation is extensive. The natural gas and oil industries are the most extensive nonfarm enterprises in the county.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Meade County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes; the size and nature of streams; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* is the category of soil classification most used in a local survey.

Soils that have profiles alike or 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. Harney and Missler, for example, are the names of two soil series. All the soils in the United States that have the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

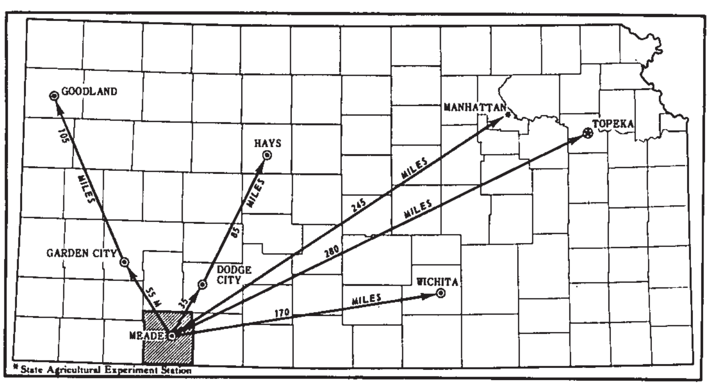

Figure 1.—Location of Meade County in Kansas.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Missler silty clay loam, 0 to 1 percent slopes, is one of two phases within the Missler series in Meade County.

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

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

Some mapping units are made up of soils of different series, or of different phases within one series. One such kind of mapping unit, the soil complex, is shown on the soil map of Meade County. A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Campus-Canlon complex, 5 to 15 percent slopes, is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Rough broken land is a land type in this survey.

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

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

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

General Soil Map

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

A map that shows soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field or for selecting the exact location of a road, building, or similar struc-

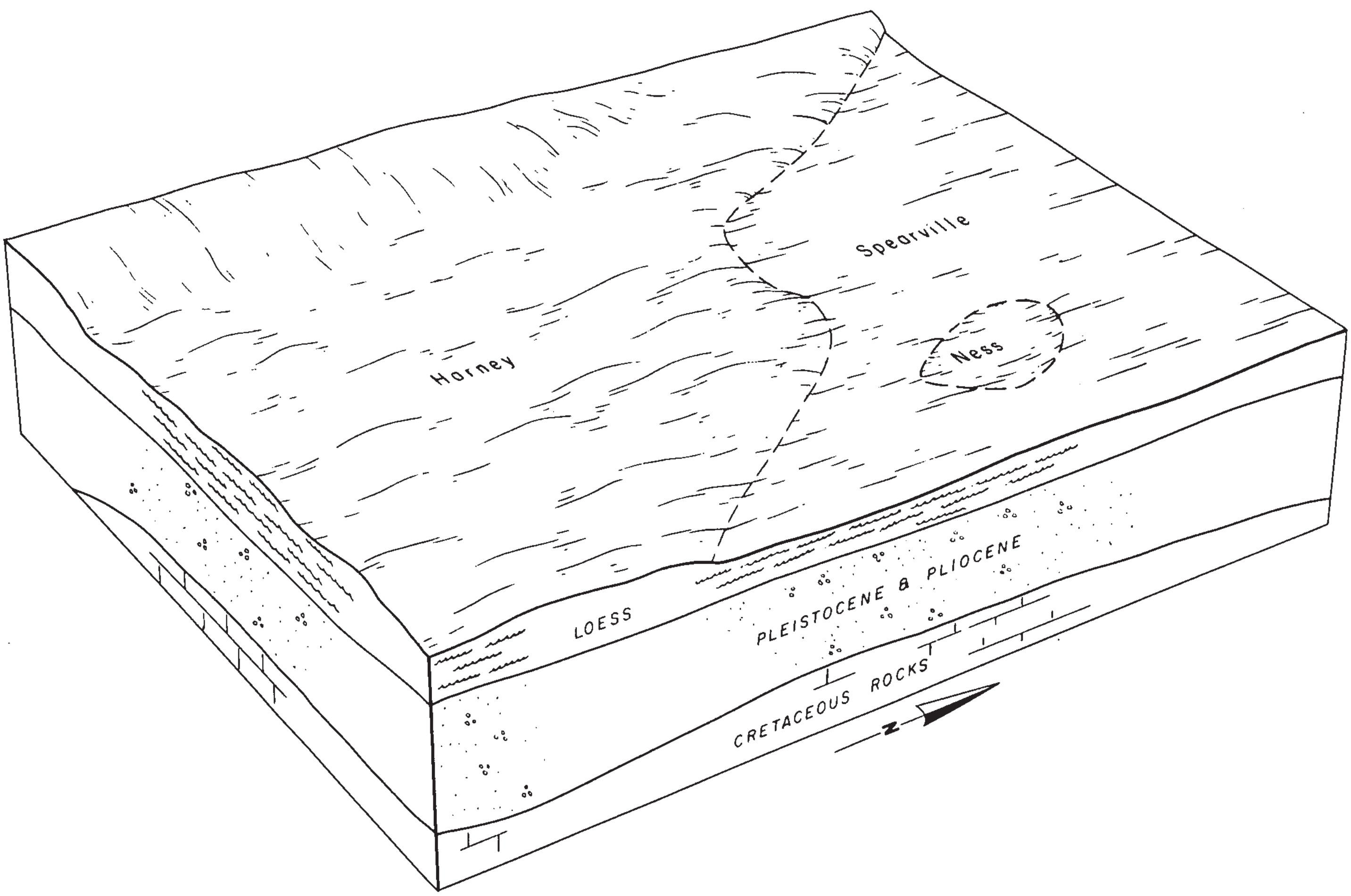

Figure 2.—**Diagram of soils of the Harney-Spearville association.**

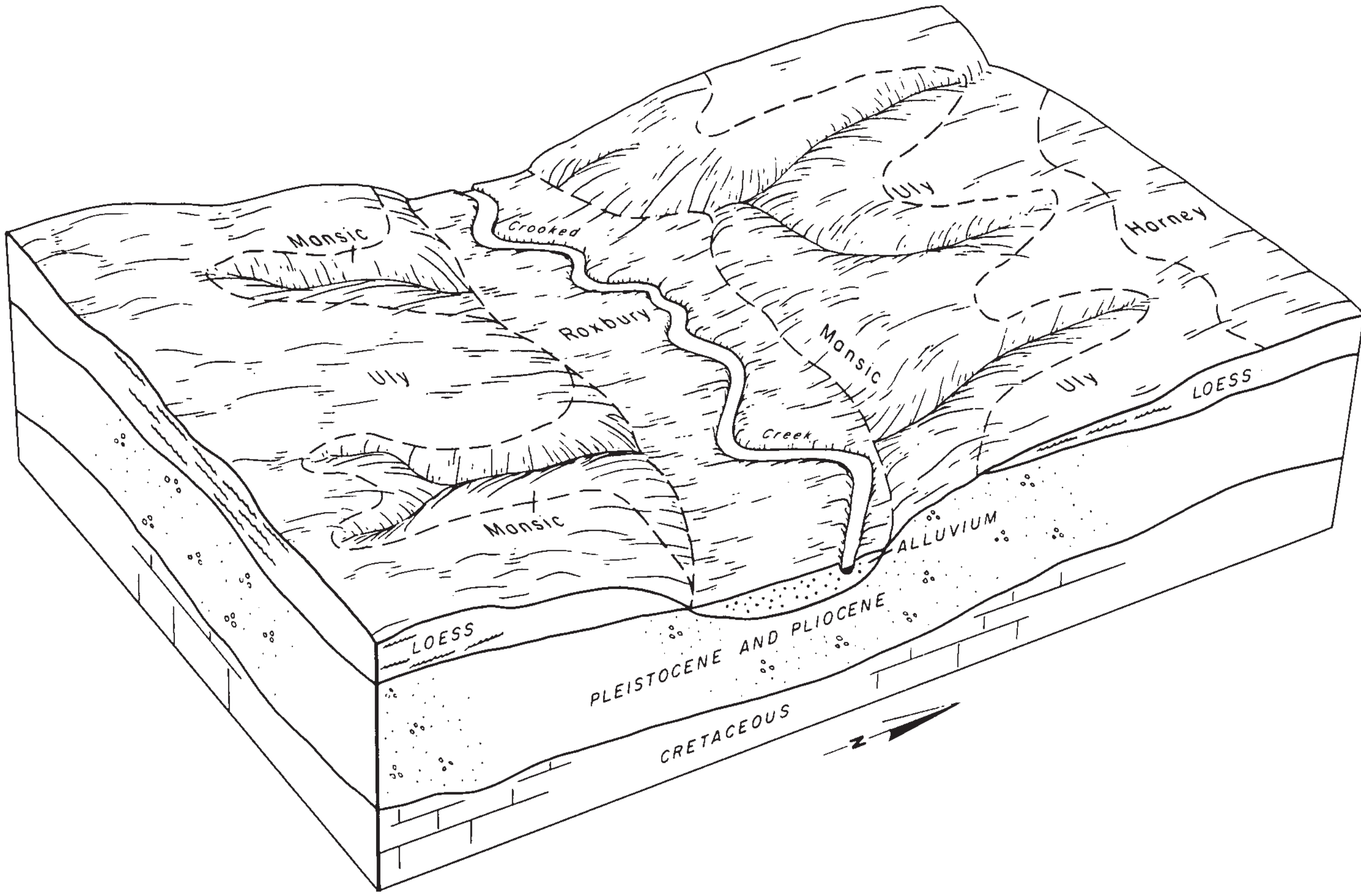

Figure 3.—**Diagram of soils of the Uly-Mansic association in the Crooked Creek drainage area.**

ture, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

Soil association names and delineations on the general soil map do not fully agree with those of the general soil maps in adjacent counties published at a different date. Differences in the maps are the result of improvement in the classification or refinements in soil series concepts.

The terms for texture used in the title of the associations apply to the texture of the surface layer. For example, in the title of Roxbury-Leshara-Likes association, the words "loamy and sandy" refer to the texture of the surface layer.

The seven soil associations in Meade County are described in the following paragraphs.

1. Harney-Spearville Association

Deep, nearly level to gently sloping loamy soils of the uplands

This soil association is on broad areas that have weakly defined drainageways and small depressions (fig. 2). It is dominantly nearly level.

This association makes up about 36 percent of the county. It is about 69 percent Harney soils, 17 percent Spearville soils, and 14 percent minor soils.

Harney soils are well-drained, nearly level to gently sloping soils on convex areas of the plains. The surface layer is grayish-brown silt loam about 6 inches thick. The subsoil, about 23 inches thick, is dark grayish-brown to brown silty clay loam in the upper part and brown to pale-brown silty clay loam in the lower part. The underlying material is light yellowish-brown silt loam.

Spearville soils are well drained and moderately well drained, nearly level soils on the broad areas where drainageways are poorly defined. The surface layer is grayish-brown silty clay loam about 6 inches thick. The subsoil, about 18 inches thick, is dark grayish-brown silty clay in the upper part and grayish-brown silty clay loam in the lower part. The underlying material is pale-brown silty clay loam and silt loam.

The minor soils of this association consist of Ness and Uly soils. Ness soils are nearly level on the floors of undrained depressions throughout the association. Uly soils are nearly level to gently sloping on the gentle side slopes and are also on small nearly level areas.

Most of this association is used for both dryfarmed and irrigated crops. Some areas are in native grasses. Wheat and grain sorghum are the main dryfarmed crops. Wheat, corn, grain, and forage sorghum are the main irrigated crops. Soil blowing is a hazard on the nearly level soils, and water erosion and soil blowing are hazards on the gently sloping soils. Conservation of water is needed on all the soils of this association to obtain favorable yields.

2. Uly-Mansic Association

Deep, gently sloping to strongly sloping loamy soils of the uplands

This association is mostly along the west side of the Crooked Creek north of Meade. It is dominantly gently sloping to strongly sloping, but in places the sides of the valley are steep (fig. 3).

This association makes up about 8 percent of the county. It is about 34 percent Uly soils, 26 percent Mansic soils, and 40 percent minor soils.

Uly soils are well-drained, gently sloping and sloping soils. The surface layer is grayish-brown silt loam about 6 inches thick. The subsoil, about 8 inches thick, is dark grayish-brown silty clay loam. The underlying material is pale-brown silt loam.

Mansic soils are well-drained, sloping and strongly sloping soils along the drainageways that empty into Crooked Creek. The surface layer is dark grayish-brown clay loam about 17 inches thick. The subsoil, about 10 inches thick, is pale-brown clay loam. The underlying material is very pale brown clay loam.

The minor soils of this association consist of Harney, Campus, Canlon, and Roxbury soils. Harney soils are nearly level to gently sloping soils on areas between the tributaries of Crooked Creek. The closely intermingled Campus and Canlon soils are on the steeper parts of the association. Roxbury soils are nearly level on stream flood plains.

Most areas of the gently sloping and sloping soils of this association are cultivated. Wheat and grain sorghum are the main dryfarmed crops. Soil blowing and water erosion are serious hazards. Conservation of water is needed to obtain favorable yields. The strongly sloping, more broken slopes are in native grasses and used for grazing.

3. Roxbury-Leshara-Likes Association

Deep, nearly level to gently sloping loamy and sandy soils on flood plains and terraces

This soil association is on flood plains, low terraces, and alluvial fans in the valleys of the major streams throughout the county. It is nearly level to gently sloping.

This association makes up about 6 percent of the county. It is about 21 percent Roxbury soils, 19 percent Leshara soils, 19 percent Likes soils, and 41 percent minor soils.

Roxbury soils are well-drained, nearly level soils on low stream terraces. The surface layer is grayish-brown silt loam. The underlying material is very pale brown to pale-brown silty clay loam.

Leshara soils are somewhat poorly drained, nearly level soils on flood plains. They are occasionally subject to flooding. The surface layer is grayish-brown clay loam about 12 inches thick. The next layer, about 14 inches thick, is gray clay loam. The underlying material is pale-brown clay loam.

Likes soils are excessively drained, nearly level to gently sloping soils on alluvial fans. The surface layer is brown loamy sand about 8 inches thick. The underlying material is very pale brown loamy sand.

The minor soils of this association consist of Kanza, Lesho, Lincoln, Wann, and Yahola soils. Kanza soils are on the lowest part of the flood plains. Lincoln soils are next to the channel of the river and streams. Lesho and Wann soils are on flood plains. Yahola soils are gently sloping on alluvial fans.

The Roxbury soils of this association are used for dryfarmed and irrigated crops. Wheat, sorghum, and alfalfa are the main dryfarmed crops. Wheat, corn, grain, and forage sorghum are the main irrigated crops. Most areas of the Leshara, Likes, and minor soils are used for range. The Kanza soils are also used for meadow.

4. Harney-Missler Association

Deep, nearly level to sloping loamy soils of the uplands

This soil association is on a broad area north and west of Fowler. This area is locally called the Artesian Valley because of the Artesian conditions that prevailed at one time. The association is nearly level.

This association makes up about 4 percent of the county. It is about 45 percent Harney soils, 42 percent Missler soils, and 13 percent minor soils.

Harney soils are well-drained, nearly level soils. The surface layer is grayish-brown silt loam about 6 inches thick. The subsoil, about 23 inches thick, is dark grayish-brown to brown silty clay loam in the upper part and brown to pale-brown silty clay loam in the lower part. The underlying material is light yellowish-brown silt loam.

Missler soils are well-drained, nearly level to sloping soils on broad areas and side slopes. The surface layer is grayish brown silty clay loam about 13 inches thick. The subsoil, about 11 inches thick, is grayish-brown silty clay loam. The underlying material is pale-brown silty clay loam.

The minor soils of this association consist of Ness and Uly soils. Uly soils are gently sloping in small areas of this association, and Ness soils are in depressions.

The soils of this association are used for dryfarmed and irrigated crops. Wheat and grain sorghum are the main dryfarmed crops. Wheat, corn, alfalfa, grain, and forage sorghum are the main irrigated crops. Soil blowing is a serious hazard on the level soils, and water erosion and soil blowing are hazards on the sloping soils. Conservation of water is needed on all the soils of this association to obtain favorable yields.

5. Manter-Satanta Association

Deep, nearly level to gently sloping or gently undulating loamy soils of the uplands

This soil association is in an area between the sandhills and the nearly level tablelands. Concave and convex slopes are intermingled in the nearly level to gently undulating landscape (fig. 4).

This association makes up about 6 percent of the county. It is about 43 percent Manter soils, 15 percent Satanta soils, and 40 percent minor soils.

Manter soils are well-drained, nearly level to gently sloping or gently undulating soils in areas next to the Pratt soils. The soil is brown fine sandy loam throughout.

Satanta soils are well-drained, nearly level to gently sloping or gently undulating soils. The surface layer is grayish-brown loam about 6 inches thick. The subsoil, about 23 inches thick, is dark grayish-brown clay loam in the upper part and brown to pale-brown clay loam in the lower part. The underlying material is pale-brown clay loam.

The minor soils of this association consist of Pratt, Harney, Otero, and Mansic soils. Pratt soils are undulating in areas next to hummocky sandhills. Harney and Mansic soils are nearly level in areas away from the sandhills.

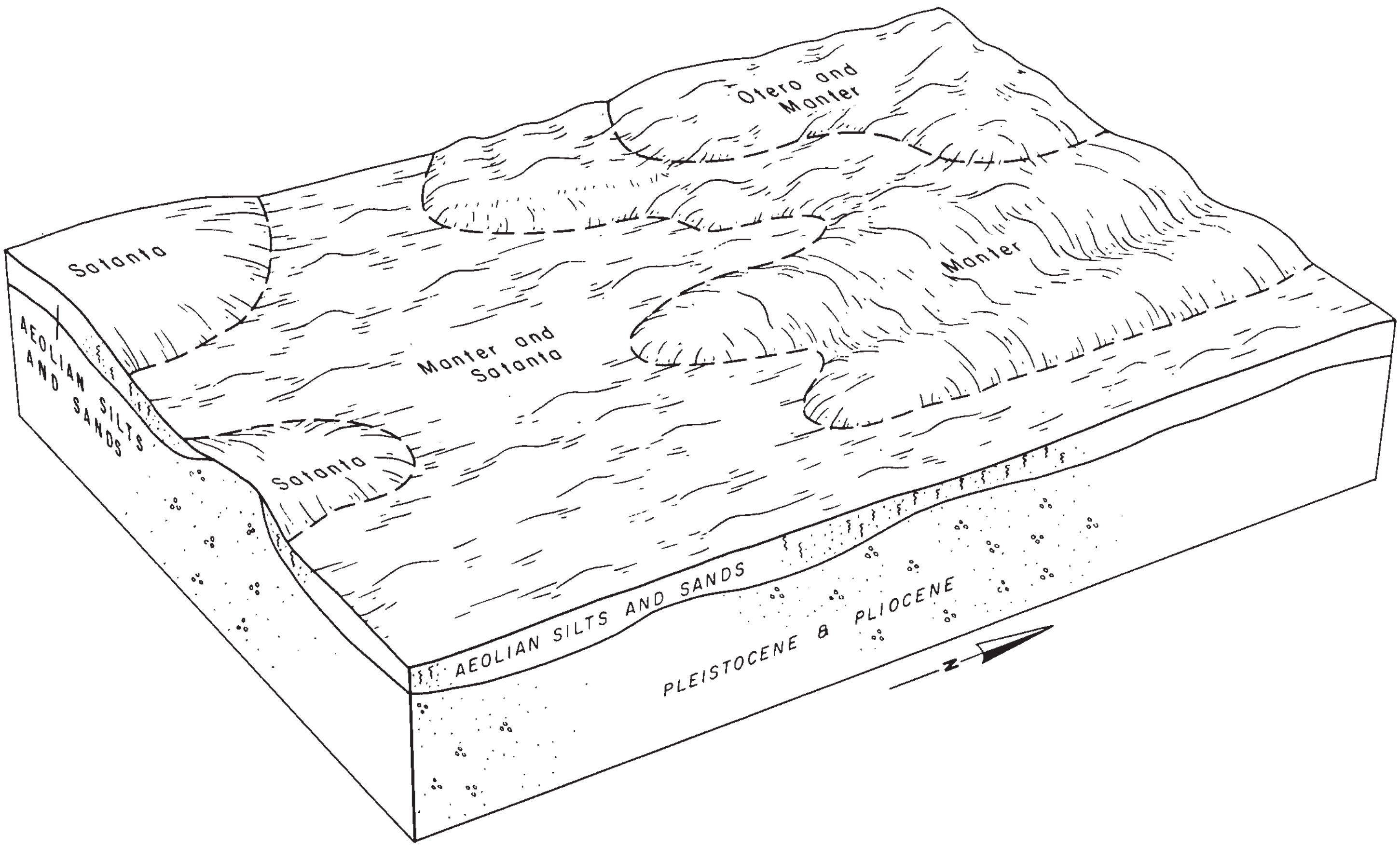

Figure 4.—**Diagram of soils of the Manter-Satanta association in the transition area between the sandhills and nearly level tableland.**

Otero soils are on convex ridges and knolls.

Most of this association is used for sorghum and wheat. Soil blowing is a hazard throughout the association and is particularly serious on the more sandy soils. Water erosion is also a hazard on the gently sloping loamy soils. Careful management is needed to control erosion and conserve water on all the soils of this association.

6. Pratt-Tivoli Association

Deep, nearly level to steep sandy soils of the uplands.

This soil association is on sandhills. It is undulating to hummocky.

This association makes up about 11 percent of the county. It is about 50 percent Pratt soils, 5 percent Tivoli soils, and 45 percent minor soils.

Pratt soils are well-drained, nearly level to rolling soils. The surface layer is brown loamy fine sand about 8 inches thick. The subsoil, about 16 inches thick, is yellowish-brown loamy fine sand. The underlying material is very pale brown loamy fine sand.

Tivoli soils are excessively drained, rolling to steep and hummocky soils on sandhills. They have a surface layer of brown fine sand about 4 inches thick. Below this is light yellowish-brown fine sand.

The minor soils of this association consist of Blown-out land and Mansic, Manter, and Otero soils. Small areas of Blown-out land occur where soil blowing has been active. Otero and Manter soils are undulating in areas between the hummocky, more sloping soils. Mansic soils are on low flats between the undulating soils.

Most of this association is in permanent grasses and used for range. Some areas of Pratt soils are cultivated. Soil blowing is the main hazard on the soils of this association. Under good management, mixed stands of tall and mid grasses produce enough forage for grazing and also help control soil blowing.

7. Mansic-Campus-Otero Association

Deep, sloping to steep, calcareous loamy soils of the uplands

This association is in a large area that is part of the drainage basin of Crooked Creek, the Cimarron River, and Sand Creek. It is dominantly sloping to steep (fig. 5).

This association makes up about 29 percent of the county. It is about 56 percent Mansic soils, 20 percent Campus soils, 13 percent Otero soils, and 11 percent minor soils.

Mansic soils are well-drained, sloping to steep soils on side slopes along drainageways. The surface layer is dark grayish-brown clay loam about 17 inches thick. The subsoil, about 10 inches thick, is pale-brown clay loam. The underlying material is very pale brown clay loam.

Campus soils are well-drained, sloping to strongly sloping soils that are closely intermingled with Canlon soils along drainageways and intermittent streams. The surface layer is dark grayish-brown clay loam about 7 inches thick. The subsoil, about 7 inches thick, is grayish-brown clay

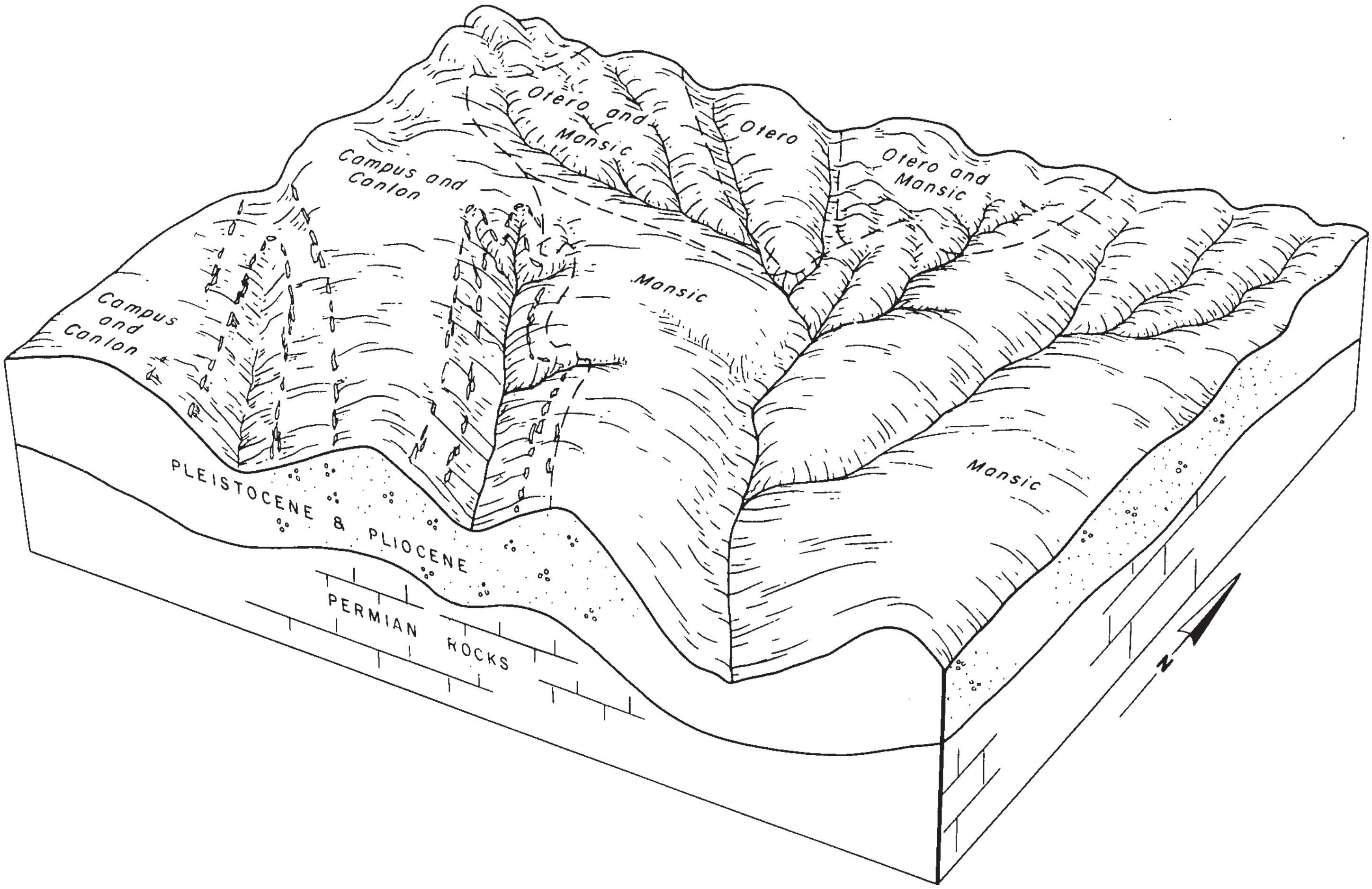

Figure 5.—**Diagram of soils of the Mansic-Campus-Otero association in the Cimarron River drainage area.**

loam. The underlying material is very pale brown to pale-brown clay loam.

Otero soils are well-drained to somewhat excessively drained, sloping to strongly sloping soils on side slopes along drainageways. The surface layer is brown fine sandy loam about 8 inches thick. The next layer, about 21 inches thick, is pale-brown fine sandy loam. The underlying material is pale-brown sandy loam.

The minor soils of this association consist of Canlon and Uly soils and gravelly soils. Canlon soils are on the strongly sloping areas and on the steeper and more broken slopes. Uly soils are gently sloping and nearly level in areas between the tributaries of Crooked Creek and Sand Creek. The gravelly soils are steeper and are hilly.

Most of this association is in native grasses and used for grazing. The gently sloping soils and some of the sloping soils are cultivated. Wheat and grain sorghum are the main dryfarmed crops. Crop failure is common, and yields are profitable only during years of most favorable weather. The hazards of soil blowing and water erosion are severe in cultivated areas. Conservation of water is needed to obtain favorable yields.

Descriptions of the Soils

In this section the soils of Meade County are described in detail, and their use and management are discussed. Each soil series is first described in detail, and then, briefly, the mapping units in that series are described. Unless specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is more detailed and is for those who need to make thorough and precise studies of soils. Color terms are for dry soil unless otherwise stated. The profile described in the soil series is representative of mapping units in that series. If a given mapping unit has a profile in some ways different from the one described as representative of the series, these differences are stated in the description of the mapping unit, or they are apparent in the name of the mapping unit. The description of each mapping unit contains suggestions about how the soil can be managed. The general management of soils in this county is discussed in the section "Use and Management of the Soils."

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series.

Alluvial land, loamy, for example, does not belong to a soil series, but it is listed in alphabetic order along with the soil series.

Preceding the name of each mapping unit is a symbol that identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit are the capability unit, range site, and windbreak suitability group to which the mapping unit has been assigned. The pages on which the range sites and windbreak suitability groups are described are shown in the "Guide to Mapping Units" at the back of this survey.

The approximate acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the "Glossary," and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual *(11)*.[1]

The names, descriptions, and delineations of soils in this published soil survey do not always agree or join fully with soil maps of adjoining counties published at an earlier date. Differences are the result of better knowledge about soils or modification and refinements in soil series concepts. In addition, the correlation of a recognized soil is based upon the acreage of that soil and the dissimilarity to adjacent soils within the survey area. Frequently, it is more feasible to include soils that are small in extent along with similar soils, if management and response are similar, rather than to map them separately. The soil descriptions reflect such combinations. Other differences are brought about by the predominance of different soils in taxonomic units made up of two or three series. Still another difference may be caused by the range in slope allowed within the mapping unit for each survey.

[1] Italic numbers in parentheses refer to Literature Cited, p. 62.

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

Soil	Acres	Percent
Alluvial land, loamy	1,637	0.3
Blown-out land	1,060	.2
Campus-Canlon complex, 5 to 15 percent slopes	47,951	7.7
Harney silt loam, 0 to 1 percent slopes	157,030	25.1
Harney silt loam, 1 to 3 percent slopes	16,821	2.7
Harney silty clay loam, 1 to 3 percent slopes, eroded	4,720	.8
Kanza soils	4,611	.7
Leshara clay loam	6,970	1.1
Lesho clay loam	1,913	.3
Likes loamy sand	12,843	2.0
Lincoln soils	3,000	.5
Mansic clay loam, 0 to 1 percent slopes	7,268	1.2
Mansic clay loam, 1 to 3 percent slopes	20,105	3.2
Mansic clay loam, 3 to 6 percent slopes	17,188	2.7
Mansic clay loam, 3 to 6 percent slopes, eroded	6,041	1.0
Mansic clay loam, 6 to 15 percent slopes	40,801	6.5
Mansic-Manter complex, 1 to 4 percent slopes	6,513	1.0
Manter fine sandy loam, 0 to 1 percent slopes	2,383	.4
Manter fine sandy loam, 1 to 3 percent slopes	5,975	1.0
Manter fine sandy loam, 1 to 3 percent slopes, eroded	5,603	.9
Manter-Satanta fine sandy loams, 1 to 4 percent slopes	7,882	1.3
Missler silty clay loam, 0 to 1 percent slopes	9,879	1.6
Missler silty clay loam, 1 to 6 percent slopes	4,028	.6
Ness silty clay	10,404	1.7
Otero fine sandy loam, 6 to 15 percent slopes	9,661	1.5
Otero-Mansic complex, 5 to 25 percent slopes	40,807	6.5
Otero-Manter fine sandy loams, 3 to 6 percent slopes	4,896	.8
Pratt soils, 0 to 5 percent slopes	25,489	4.1
Pratt soils, 5 to 15 percent slopes	32,326	5.2
Rough broken land	3,120	.5
Roxbury silt loam	8,960	1.4
Satanta fine sandy loam, 0 to 2 percent slopes	3,785	.6
Satanta loam, 0 to 1 percent slopes	5,081	.8
Satanta loam, 1 to 3 percent slopes	2,627	.4
Spearville silty clay loam, 0 to 1 percent slopes	36,060	5.7
Tivoli fine sand, 10 to 25 percent slopes	2,885	.4
Uly silt loam, 0 to 1 percent slopes	8,197	1.3
Uly silt loam, 1 to 3 percent slopes	20,298	3.2
Uly silt loam, 1 to 3 percent slopes, eroded	2,597	.4
Uly silt loam, 3 to 6 percent slopes	4,258	.7
Uly silt loam, 3 to 6 percent slopes, eroded	3,709	.6
Wann loam	2,181	.3
Yahola sandy loam	4,417	.7
Intermittent lake	1,175	.2
River	1,213	.2
Total	626,368	100.0

Alluvial Land, Loamy

An—Alluvial land, loamy (0 to 1 percent slopes). This land type is on flood plains that are cut by meandering channels of intermittent streams in the uplands. The floors of the valleys are more than 150 feet wide. The soil material is mainly stratified calcareous loam and clay loam and, in places, thin layers of sandy loam.

Nearly all the acreage of Alluvial land, loamy, is in native grasses and used for range. It is well suited to this use. It generally is not suitable for cultivation because it is occasionally subject to flooding and because in most places it is bordered by sloping soils that are not suitable for cultivation. Grazing must be managed to encourage the growth of the best native forage plants. This can be done by using a proper stocking rate and practicing deferred grazing or rotation grazing. Proper location of fences, salt, and water helps distribute livestock over the range. Capability unit VIw-1 dryland; Loamy Lowland range site; Lowland windbreak suitability group.

Blown-out Land

Bo—Blown-out land (5 to 15 percent slopes). This land type is on severely eroded areas and areas where loamy fine sand and sand have been deposited and continue to blow. The blowouts and eroded areas commonly form a trough-like or bowl-like design. The sides and bottom of the blowouts are mostly sand. Where the sand has been swept away, the bottom is calcareous sandy loam or clay loam. Blown-out land occurs mainly within areas of Pratt and Tivoli soils. Areas less than 20 acres in size within areas of Pratt and Tivoli soils and areas less than 5 acres in size within areas of Manter soils are shown on the detailed soil map by blowout symbols.

Vegetation is sparse over much of the area. The blowouts are barren or nearly barren, and the areas covered by deposited material are in annual weeds and grasses. Blown-out land is not suited to crops. Reseeding to native grass is about the only suitable practice. The areas need to be

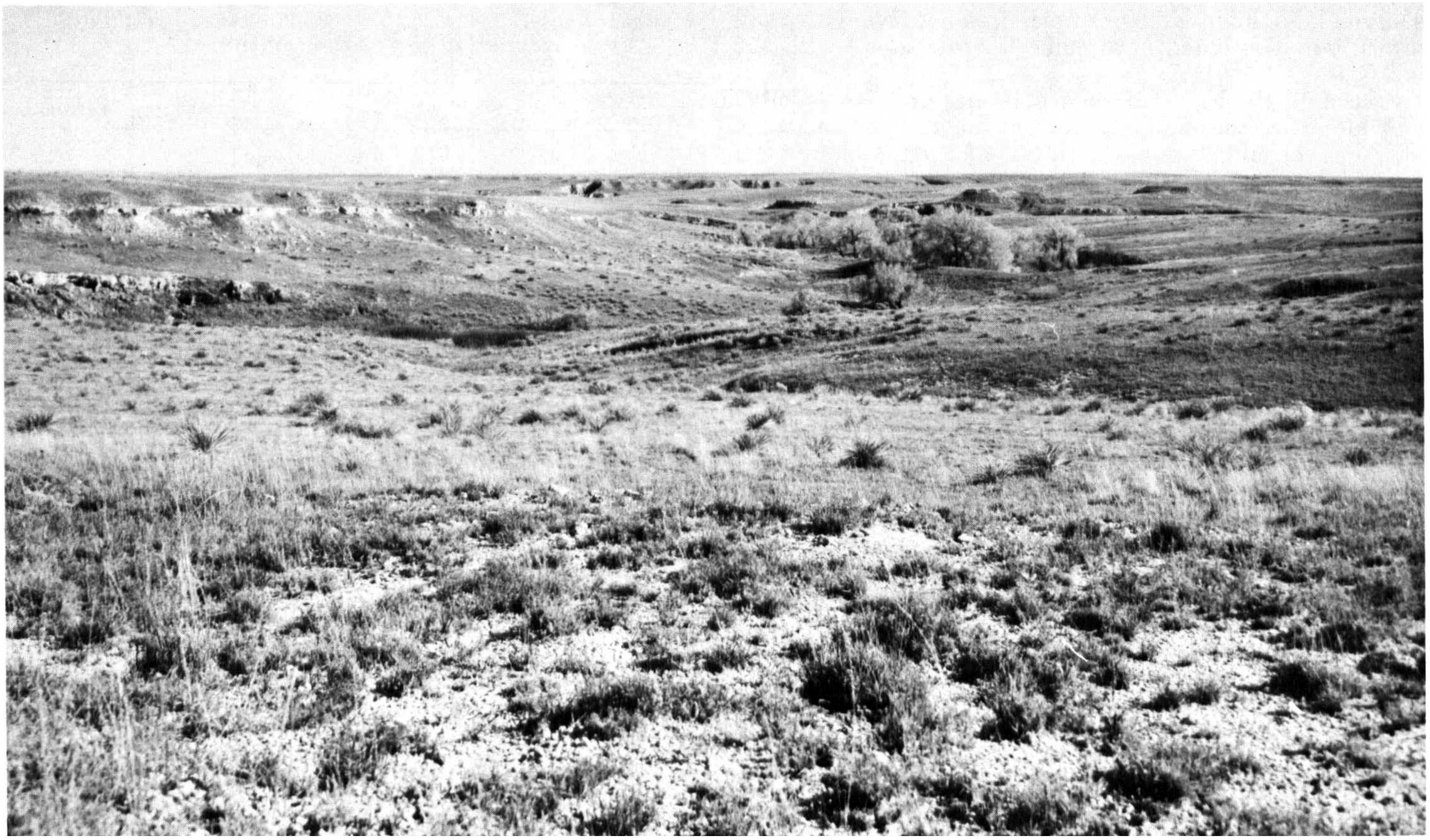

Figure 6.—**Typical landscape of Campus-Canlon complex, 5 to 15 percent slopes.**

fenced off until the vegetation is well established. Capability unit VIIe-1 dryland; Choppy Sands range site; not assigned to a windbreak suitability group.

Campus Series

The Campus series consists of deep, well-drained, sloping soils on uplands. These soils formed in calcareous, partly consolidated old alluvium. The native vegetation is short and mid grasses.

In a representative profile the surface layer is dark grayish-brown, calcareous clay loam about 7 inches thick. The subsoil, about 7 inches thick, is grayish-brown, calcareous, friable clay loam. The underlying material is very pale brown and pale-brown, calcareous clay loam. The upper part contains numerous concretions of calcium carbonate; the lower part contains few concretions of calcium carbonate.

Permeability is moderate, and available water capacity is high. Fertility is medium. Runoff is medium to rapid.

Most of the acreage is in native grass.

Representative profile of Campus clay loam in an area of Campus-Canlon complex, 5 to 15 percent slopes, about 780 feet north and 660 feet east of the southwest corner of the southeast quarter of sec. 29, T. 33 S., R. 26 W.:

A1—0 to 7 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, granular structure; hard, friable; many roots; slight effervescence; moderately alkaline; gradual, smooth boundary.

B2—7 to 14 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; weak, medium, granular structure; hard, friable; many roots; few small, strongly cemented concretions of calcium carbonate; slight effervescence; moderately alkaline; diffuse, wavy boundary.

C1ca—14 to 30 inches, very pale brown (10YR 8/3) clay loam, very pale brown (10YR 7/3) moist; weak, medium, subangular blocky structure; slightly hard, friable; few roots; about 50 percent, by volume, weakly cemented concretions of calcium carbonate; strong effervescence; moderately alkaline; diffuse, wavy boundary.

C2—30 to 60 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; massive; hard, friable; about 15 percent, by volume, concretions of calcium carbonate, mostly coatings and soft powdery masses; slight effervescence; moderately alkaline.

The A horizon ranges from dark grayish brown to grayish brown. The Cca horizon ranges from light brownish-gray to white loam or clay loam.

Campus soils are near Canlon and Mansic soils. They are deeper over beds of indurated caliche than Canlon soils. They have a stronger zone of calcium carbonate accumulation than Mansic soils.

Cc—Campus-Canlon complex, 5 to 15 percent slopes. This complex consists of sloping and strongly sloping soils along well-entrenched upland drainageways and intermittent streams. It is about 50 percent Campus clay loam, 25 percent Canlon loam, and 25 percent Mansic clay loam.

Campus clay loam is sloping on side slopes, and Mansic clay loam is sloping and strongly sloping along drainageways. Canlon loam is strongly sloping on the more broken slopes. Outcrops of slightly weathered caliche are common in the area.

The soils of this complex are nonarable. They are better suited to range than to other uses (fig. 6). The soils are productive, however, if they are properly managed. Grazing must be managed to encourage growth of the best native forage plants. This can be done by using a proper stocking rate and practicing deferred grazing or rotation deferred grazing. Proper location of fences, salt, and water helps distribute livestock over the range. Capability unit VIe-4 dryland; Campus soil in Limy Upland range site and Canlon soil in Shallow Limy range site; not assigned to a windbreak suitability group.

Canlon Series

The Canlon series consists of shallow, well-drained and somewhat excessively drained, strongly sloping soils on uplands. These soils formed in material weathered from caliche. The native vegetation is mid grass.

In a representative profile the surface layer is grayish-brown, calcareous loam about 6 inches thick. The underlying material is white, hard or semihard caliche.

Permeability is moderate, and available water capacity is very low. Fertility is low. Runoff is medium to rapid.

Most of the acreage is in native grass.

Representative profile of Canlon loam in an area of Campus-Canlon complex, 5 to 15 percent slopes, about 420 feet south and 30 feet east of the northwest corner of the northeast quarter of sec. 28, T. 33 S., R. 26 W.:

A1—0 to 6 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) moist; weak, fine, granular structure; hard, friable; many roots; scattered fragments of hard caliche; strong effervescence; moderately alkaline; clear, wavy boundary.

C—6 to 12 inches, white (10YR 8/2) caliche; about 60 percent, by volume, caliche fragments that range from 1 inch to 4 inches on the long axis; about 40 percent, by volume, soft powdery caliche and loamy material.

R—12 inches, white, hard caliche.

Depth to caliche ranges from 10 to 20 inches. The A horizon ranges from grayish brown to very pale brown.

Canlon soils are near Campus soils. They are shallower over beds of indurated caliche than Campus soils.

In Meade County, Canlon soils are mapped only with Campus soils.

Harney Series

The Harney series consists of deep, well-drained, nearly level to gently sloping soils that occur on uplands throughout the county. These soils formed in loess.

In a representative profile (fig. 7) the surface layer is grayish-brown silt loam about 6 inches thick. The subsoil is about 23 inches thick. It is dark grayish-brown, friable silty clay loam in the upper part; brown, friable silty clay loam in the middle; and pale-brown, calcareous, firm and friable silty clay loam in the lower part. The underlying material is light yellowish-brown, calcareous silt loam.

Permeability is moderately slow, and available water capacity is high. Fertility is high. Runoff is slow to medium.

Most areas of Harney soils are used for dryfarmed and irrigated crops. The soils are suited to all crops commonly grown in the county (fig. 8).

Representative profile of Harney silt loam, 0 to 1 percent slopes, in native grass, about 330 feet east and 165 feet north of the southwest corner of sec. 30, T. 32 S., R. 27 W.:

A1—0 to 6 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak, medium, granular structure; slightly hard, friable; slightly acid; gradual, smooth boundary.

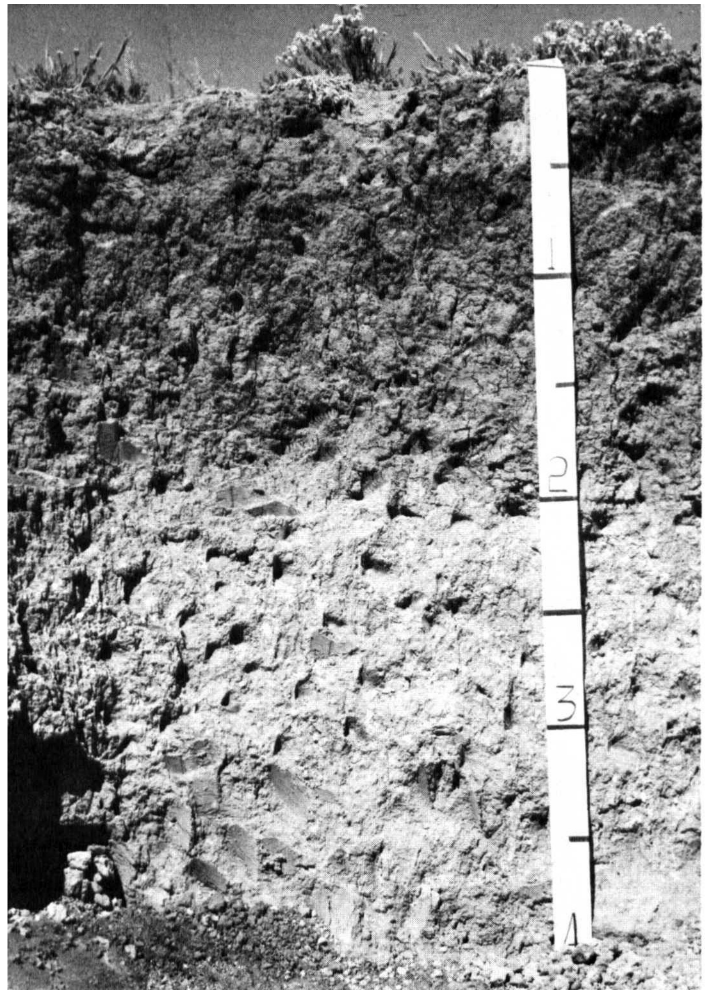

Figure 7.—**Profile of a Harney silt loam.**

B1—6 to 10 inches, dark grayish-brown (10YR 4/2) silty clay loam, dark brown (10YR 3/3) moist; moderate, medium, granular structure; hard, friable; neutral; gradual, smooth boundary.

B21t—10 to 15 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) moist; moderate, medium, subangular blocky structure; hard, friable; mildly alkaline; gradual, smooth boundary.

B22t—15 to 20 inches, brown (10YR 5/3) heavy silty clay loam, dark brown (10YR 3/3) moist; moderate, medium, subangular blocky structure; hard, firm; moderately alkaline; gradual, smooth boundary.

B3ca—20 to 29 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; weak, medium, subangular blocky structure; hard, friable; strong effervescence; moderately alkaline; gradual, smooth boundary.

Cca—29 to 34 inches, light yellowish-brown (10YR 6/4) silt loam, brown (10YR 5/3) moist; weak, medium, granular structure; slightly hard, friable; strong effervescence; moderately alkaline; gradual, smooth boundary.

C—34 to 60 inches, light yellowish-brown (10YR 6/4) silt loam, dark yellowish brown (10YR 4/4) moist; massive; slightly hard, friable; slight effervescence; moderately alkaline.

The solum ranges from 25 to 40 inches in thickness. Reaction in the solum ranges from neutral to moderately alkaline, and depth to calcareous material ranges from 18 to 30 inches.

The A horizon ranges from 6 to 10 inches in thickness. It is dark grayish-brown to brown silt loam or silty clay loam. The B horizon ranges from dark grayish brown to brown. The B22t horizon ranges from silty clay loam to silty clay.

Harney soils in Meade County in mapping units Hb and Hc have a thinner solum and are shallower over lime than the defined range for

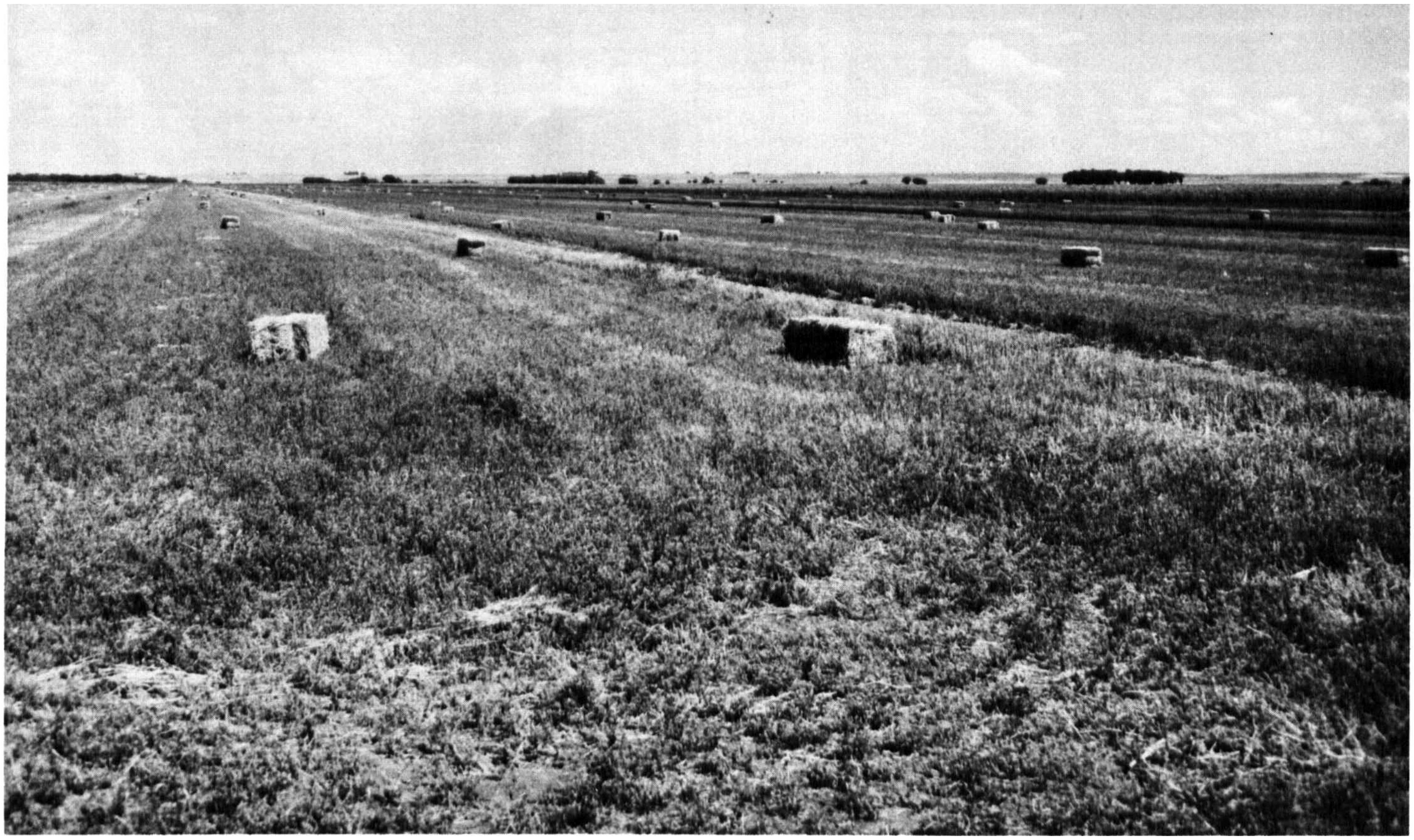

Figure 8.—**Harvesting alfalfa on an irrigated Harney silt loam.**

the series, but this difference does not alter the usefulness or behavior of the soils.

Harney soils are near Satanta, Spearville, and Uly soils. They have a more clayey B horizon than Satanta soils. They have a thicker transition between the A1 horizon and the B2t horizon than Spearville soils. They are more clayey in the B horizon and deeper over calcareous material than Uly soils.

Ha—Harney silt loam, 0 to 1 percent slopes. This nearly level soil is on broad areas in the uplands. It has the profile described as representative of the series.

Included with this soil in mapping were small areas of Spearville soils, soils that are similar to this Harney soil but that range from 12 to 18 inches deep over calcareous material, and small depressional areas of Ness soils.

This soil is well suited to dryfarmed and irrigated crops. Wheat and grain sorghum are suitable dryfarmed crops. Inadequate rainfall is the main limitation. Conserving moisture and controlling soil blowing are concerns of management. Summer fallowing is essential for storage of moisture, and stubble mulching is needed to reduce soil blowing. Contour farming, stripcropping, and terracing are also desirable.

In irrigated areas suitable crops are wheat, sorghum, corn, alfalfa, beans, and apple and peach orchards. Good management of this soil under irrigation includes the maintenance or improvement of fertility and tilth, the use of crop residue to maintain organic matter, and the application of commercial fertilizer as needed. Management that produces the most efficient use of irrigation water should be used. Land leveling is commonly needed to prepare soil for gravity irrigation. Managing runoff from adjacent higher areas is a concern on some fields. Capability units IIc-1 dryland, I-1 irrigated; Loamy Upland range site; Silty Upland windbreak suitability group.

Hb—Harney silt loam, 1 to 3 percent slopes. This gently sloping soil is on uplands throughout the county. It has a profile similar to the one described as representative of the series, but the surface layer and subsoil are slightly thinner and free carbonates are at a shallower depth. Included in mapping were small areas of Uly soils.

This Harney soil is well suited to dryfarmed and irrigated crops. Wheat and grain sorghum are suitable dryfarmed crops. Controlling water erosion and soil blowing and conserving moisture are concerns of management. Terracing, contour farming, and good management of crop residue help control erosion and conserve moisture.

In irrigated areas suitable crops are corn, grain sorghum, wheat, and alfalfa. Good management of irrigated areas includes control of erosion, efficient use of water, and maintenance of fertility and tilth. The use of a cropping system that includes close-growing crops and deep-rooted legumes, the use of crop residue, and the use of commercial fertilizer and manure help maintain and improve fertility and tilth. Land leveling and irrigating on the contour help reduce erosion and increase the efficiency with which water is used. Underground pipelines help to eliminate ditches and to reduce the loss of water. Capability units IIe-1 dryland, IIe-1 irrigated; Loamy Upland range site; Silty Upland windbreak suitability group.

Hc—Harney silty clay loam, 1 to 3 percent slopes, eroded. This gently sloping soil is mainly on side slopes along drainageways. In about 50 to 75 percent of the area, the soil has been so eroded that ordinary tillage has mixed subsoil material with the remaining surface layer. In these areas the surface layer is silty clay loam and has calcareous material closer to the surface than the surface layer in the profile described as representative of the series. Included in mapping were small areas of Uly soils.

Most of the acreage of this Harney soil is dryfarmed, but some small areas are irrigated. Because this soil is susceptible to further damage by erosion, careful management is needed to conserve moisture and control soil blowing and water erosion. Terracing, contour farming, and leaving crop residue on the surface are essential. Stripcropping is also beneficial.

In irrigated areas this soil is commonly irrigated along with the surrounding soils. Corn, grain sorghum, and wheat are suitable irrigated crops. Good management of irrigated areas includes control of erosion and maintenance of fertility and tilth. The use of a cropping system that includes close-growing crops and deep-rooted legumes, the use of crop residue, and the use of commercial fertilizer and manure help improve fertility and tilth. Land leveling and irrigating on the contour help reduce erosion and increase the efficiency with which water is used. Underground pipelines help to eliminate ditches and to reduce the loss of water. Capability units IIIe-1 dryland, IIe-1 irrigated; Loamy Upland range site; Silty Upland windbreak suitability group.

Kanza Series

The Kanza series consists of deep, poorly drained to somewhat poorly drained, nearly level soils on the flood plains of Crooked Creek and the Cimarron River. These soils formed in alluvial sediment. The native vegetation is mid and tall grasses.

In a representative profile the surface layer is grayish-brown, calcareous clay loam about 6 inches thick. The next layer, about 34 inches thick, is light-gray, calcareous loamy fine sand that has distinct yellowish-brown mottles. The underlying material is white sand.

Permeability is rapid, and available water capacity is low. Fertility is low. These soils have a fluctuating water table.

These soils are used mainly for range. They are not suitable for cultivation.

Representative profile of Kanza clay loam in an area of Kanza soils, in grassland, about 1,500 feet east and 300 feet north of the center of sec. 6, T. 35 S., R. 30 W.:

A1—0 to 6 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; moderate, medium, granular structure; hard, friable; slight effervescence; mildly alkaline; clear, smooth boundary.

AC—6 to 40 inches, light-gray (10YR 7/2) heavy loamy fine sand, grayish brown (10YR 5/2) moist; common, fine, distinct, yellowish-brown mottles; single grained; soft, very friable; slight effervescence; moderately alkaline; gradual, smooth boundary.

C—40 to 50 inches, white (10YR 8/2) sand, light gray (10YR 7/2) moist; single grained; loose.

The solum ranges from 15 to 50 inches in thickness. Depth to yellowish-brown mottles ranges from 8 to 24 inches.

The A horizon ranges from dark gray to grayish brown. Thinly stratified sand and clay loam are common in the AC horizon.

Kanza soils are near Leshara and Wann soils. They are more sandy and more poorly drained than those soils.

Kz—Kanza soils. These nearly level soils are on the flood plains of the Cimarron River and Crooked Creek in the southeastern part of the county. They are subject to recurrent flooding and deposition of fresh soil material. Slopes are 0 to 1 percent. The areas have numerous microridges of sand and low marshy areas, or depressions, that roughly parallel the river. The water table normally fluctuates between depths of 3 and 6 feet, but it may be higher or lower during seasons of extreme variations in amount of precipitation and streamflow. This soil has a profile similar to the one described as representative of the series, but in places the surface layer is loamy fine sand.

These soils are used mainly for range. The vegetation consists of a sparse growth of tall and mid grasses and tamarisk. Capability unit Vw-1 dryland; Subirrigated range site; not assigned to a windbreak suitability group.

Leshara Series

The Leshara series consists of deep, somewhat poorly drained, nearly level soils on the flood plains of Crooked Creek and the Cimarron River. These soils formed in calcareous alluvium. The native vegetation is mid and tall grasses.

In a representative profile the surface layer is grayish-brown, calcareous clay loam about 12 inches thick. The next layer, about 14 inches thick, is gray, calcareous, firm clay loam that has faint yellowish-brown mottles. The underlying material is pale-brown, calcareous clay loam that has yellowish-brown mottles.

Permeability is moderate, and available water capacity is high. Fertility is medium. Runoff is slow. These soils are occasionally subject to flooding.

Most of the acreage is in native range, but some is cultivated. These soils are suited to all crops commonly grown in the county.

Representative profile of Leshara clay loam, in grassland, about 170 feet east and 20 feet north of the center of sec. 24, T. 31 S., R. 28 W.:

A1—0 to 12 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak, medium, granular structure; slightly hard, friable; slight effervescence; mildly alkaline; gradual, smooth boundary.

AC—12 to 26 inches, gray (10YR 5/1) clay loam, dark gray (10YR 4/1) moist; few, fine, faint, yellowish-brown mottles; moderate, medium, granular structure; hard, firm; strong effervescence; moderately alkaline; gradual, smooth boundary.

C—26 to 60 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; few, fine, faint, yellowish-brown mottles; massive; very hard, firm; strong effervescence; moderately alkaline.

The A horizon ranges from 10 to 20 inches in thickness and is grayish brown to dark gray. The AC horizon ranges from light brownish gray to dark gray.

Leshara soils in Meade County are shallower over calcareous material than the defined range for the series, but this difference does not alter the usefulness or behavior of the soils.

Leshara soils are near Kanza, Lesho, and Wann soils. They are more clayey than Kanza and Wann soils. They are deeper over coarse sand and gravel than Lesho soils.

Le—Leshara clay loam. This nearly level soil is on the flood plains of Crooked Creek and the Cimarron River. Slopes are 0 to 1 percent. Included in mapping were small areas of Lesho and Wann soils and meandering stream channels.

Flooding and stream deposition are the major concerns of management. This Leshara soil is well suited to crops if adequately protected from flooding. Good management of this soil for crops includes control of flooding and the use of crop residue to conserve moisture and to help control soil blowing. Wheat and grain sorghum are suitable dryfarmed crops.

In irrigated areas this soil is suited to wheat, grain sorghum, alfalfa, corn, and tame grasses. Good management of this soil under irrigation includes the maintenance or improvement of fertility and tilth, control of salinity, and the efficient use of water. The use of a cropping system that includes a deep-rooted legume, the use of crop residue, and the use of commercial fertilizer improve fertility, the content of organic matter, and tilth. Management that produces the most efficient use of irrigation water should be used. Land leveling is commonly needed to prepare soils for gravity irrigation.

Where this soil is used for range, it produces abundant forage from suitable native grasses. Good range management includes using a proper stocking rate and practicing deferred grazing or rotation deferred grazing. Proper location of fences, salt, and water helps distribute livestock over the range. Capability unit IIw-1 dryland, IIw-1 irrigated; Subirrigated range site; Subirrigated Lowland windbreak suitability group.

Lesho Series

The Lesho series consists of somewhat poorly drained, nearly level soils that are moderately deep over sand. These soils are on the flood plains of Crooked Creek. They formed in calcareous alluvium. The native vegetation is mid and tall grasses.

In a representative profile the surface layer is grayish-brown, calcareous clay loam about 19 inches thick. The underlying material is light brownish-gray, calcareous clay loam about 11 inches thick. Below this is very pale brown fine and medium sand.

Permeability is moderately slow, and available water capacity is moderate. Fertility is medium. Runoff is slow. These soils have a fluctuating water table.

Most of the acreage is in native grass and is well suited to that use. Some areas are cultivated.

Representative profile of Lesho clay loam, in a cultivated field, about 990 feet south and 180 feet east of the northwest corner of sec. 21, T. 32 S., R. 28 W.:

A11—0 to 8 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, granular structure; hard, friable; slight effervescence; moderately alkaline; gradual, smooth boundary.

A12—8 to 19 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; few, fine, faint, brown mottles; moderate, medium, granular structure; hard, friable; numerous wormcasts; strong effervescence; moderately alkaline; gradual, smooth boundary.

C—19 to 30 inches, light brownish-gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) moist; common, fine, distinct, strong-brown mottles; moderate, medium, granular structure; hard, friable; few wormcasts; strong effervescence; moderately alkaline; gradual, smooth boundary.

IIC—30 to 40 inches, very pale brown (10YR 7/3) fine and medium sand, light yellowish brown (10YR 6/4) moist; single grained; loose; slight effervescence; moderately alkaline.

Depth to fine and medium sand ranges from 18 to 40 inches.

The A horizon ranges from 8 to 20 inches in thickness and is grayish brown to dark grayish brown. The C horizon ranges from grayish brown to pale brown.

Lesho soils are near Leshara, Lincoln, and Wann soils. They are shallower over coarse sand and gravel than Leshara soils. They are more clayey than Lincoln and Wann soils.

Lh—Lesho clay loam. This nearly level soil is on the flood plains of Crooked Creek. Slopes are 0 to 1 percent. Included in mapping were small areas of Leshara and Wann soils and saline spots scattered throughout the area.

This Lesho soil is moderately well suited to irrigated crops if it is irrigated late in summer when moisture is lacking. It is not well suited to dry-farmed crops. Wheat and grain sorghum are the main crops grown. The root zone is limited in depth, and the fluctuating water table is detrimental to deep-rooted crops, such as alfalfa. Conserving moisture and controlling soil blowing are also concerns of management. Good management of crop residue is the most effective way to conserve moisture and control soil blowing on this soil.

Under irrigation this soil is suited to wheat, grain sorghum, and corn. Good management is needed to maintain and improve fertility and tilth and to control salinity. The use of a cropping system that includes legumes, the use of crop residue, and the use of commercial fertilizer help improve fertility and tilth and increase the content of organic matter. Management that produces the most efficient use of irrigation water is needed. Land leveling is commonly needed to prepare soils for gravity irrigation.

Where this soil is used for range, it produces abundant forage from suitable native grasses. Good range management includes using a proper stocking rate and practicing deferred grazing. Proper location of fences, salt, and water helps distribute livestock over the range. Capability unit IIIw-3 dryland, IIIw-3 irrigated; Subirrigated range site; Subirrigated Lowland windbreak suitability group.

Likes Series

The Likes series consists of deep, excessively drained, gently sloping soils. These soils are in concave areas of foot slopes and alluvial fans where drainageways from the uplands empty onto low terraces. They formed in colluvial-alluvial sediment that washed from nearby uplands. The native vegetation is mid and tall grasses.

In a representative profile the surface layer is brown, calcareous loamy sand about 8 inches thick. It is underlain by very pale brown, calcareous loamy sand.

Permeability is moderately rapid, and available water capacity is low. Fertility is low. Runoff is slow.

These soils are used mainly for range. They are not suitable for cultivation.

Representative profile of Likes loamy sand, in grassland, about 990 feet east and 330 feet north of the center of sec. 7, T. 35 S., R. 29 W.:

A1—0 to 8 inches, brown (10YR 5/3) loamy sand, dark brown (10YR 4/3) moist; single grained; soft, very friable; slight effervescence; moderately alkaline; gradual, smooth boundary.

C—8 to 60 inches, very pale brown (10YR 7/4) loamy sand, yellowish brown (10YR 5/4) moist; single grained; soft, very friable; strong effervescence; moderately alkaline.

Depth to calcareous material ranges from 0 to 24 inches.

The A horizon ranges from grayish brown to pale brown. The C horizon ranges from light yellowish-brown to very pale brown fine sand to loamy sand.

Likes soils are near Yahola soils. They are coarser textured than those soils.

Lk—Likes loamy sand. This gently sloping soil is on foot slopes and fans between areas of the Otero-Mansic complex on uplands and areas of Kanza soils on the flood plains. Slopes are 0 to 3 percent. Included in mapping were small areas of Tivoli and Yahola soils.

This Likes soil is not suitable for dryland crops because of the low available water capacity and the susceptibility to soil blowing. Most of the acreage is in native grass and used for range. Proper range use and deferred grazing are needed to maintain or improve the desirable native grasses on this soil. Capability unit VIe-2 dryland; Sands range site; Sandy Upland windbreak suitability group.

Lincoln Series

The Lincoln series consists of deep, somewhat excessively drained, nearly level to gently undulating soils on the flood plains of Crooked Creek and other smaller creeks in the county. These soils formed in recent sandy alluvial sediment. The native vegetation is mid and tall grasses.

In a representative profile the surface layer is pale-brown, calcareous loamy fine sand about 5 inches thick. It is underlain by very pale brown, calcareous sand that is thinly stratified with loamy fine sand.

Permeability is rapid, and available water capacity is low. Fertility is low. Runoff is slow.

These soils are used mainly for range. They are not suitable for cultivation.

Representative profile of Lincoln loamy fine sand, in an area of Lincoln soils, in grassland, about 1,320 feet east of the center of sec. 17, T. 33 S., R. 26 W.:

A1—0 to 5 inches, pale-brown (10YR 6/3) loamy fine sand, brown (10YR 5/3) moist; single grained; loose; slight effervescence; moderately alkaline; gradual, smooth boundary.

C—5 to 60 inches, very pale brown (10YR 8/3) sand thinly stratified with loamy fine sand, very pale brown (10YR 7/3) moist; single grained; loose; slight effervescence; moderately alkaline.

Depth to sand is generally less than 18 inches. Stratification, in layers less than 1 inch thick, is common in the underlying material.

The A horizon ranges from grayish-brown to very pale brown loamy fine sand to sand.

Lincoln soils are near Lesho and Wann soils. They are more sandy than those soils.

Ln—Lincoln soils. These soils are on the narrow lower parts of the flood plain adjacent to the channel of Crooked Creek and other smaller creeks in the county. Slopes are 0 to 3 percent. Included in mapping were small areas of gravel bars and riverwash that are outside the present river channel.

These soils are used mainly for range. The vegetation consists of a sparse growth of tall and mid grasses, groves of cottonwood trees, and, in places, a dense growth of tamarisk and willow trees. Soil blowing is a hazard unless the surface is covered by growing plants. Capability unit Vw-1 dryland; Sandy Lowland range site; not assigned to a windbreak suitability group.

Mansic Series

The Mansic series consists of deep, well-drained, nearly level to steep soils on uplands. These soils formed in calcareous outwash sediment. The native vegetation is short and mid grasses.

In a representative profile (fig. 9) the surface layer is dark grayish-brown, calcareous clay loam about 17 inches thick. The subsoil is pale-brown, calcareous, friable clay loam about 10 inches thick. It contains films and numerous threads and soft rounded bodies of carbonate. The underlying material is very pale brown clay loam that contains a few small, hard and soft concretions of carbonate.

Permeability is moderate, and available water capacity is high. Fertility is medium. Runoff is slow to rapid.

Most areas of nearly level, gently sloping, and sloping soils are cultivated, but some are used for pasture. The strongly sloping and steep soils are mostly used for native grass.

Representative profile of Mansic clay loam, 6 to 15 percent slopes, in native grass, about 1,590 feet east and 510 feet north of the southwest corner of sec. 7, T. 34 S., R. 28 W.:

A11—0 to 10 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, granular structure; hard, friable; many roots; few wormcasts; slight effervescence; mildly alkaline; gradual, smooth boundary.

A12—10 to 17 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, granular structure; hard, friable; few roots; many wormcasts; strong effervescence; moderately alkaline; gradual, smooth boundary.

B2ca—17 to 27 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; moderate, medium, granular structure; hard, friable; about 20 percent, by volume, films, threads, and soft bodies of calcium carbonate; strong effervescence; moderately alkaline; gradual, smooth boundary.

Cca—27 to 60 inches, very pale brown (10YR 7/4) clay loam, light yellowish brown (10YR 6/4) moist; weak, coarse, prismatic structure breaking to weak, coarse, granular; hard, friable; about 5

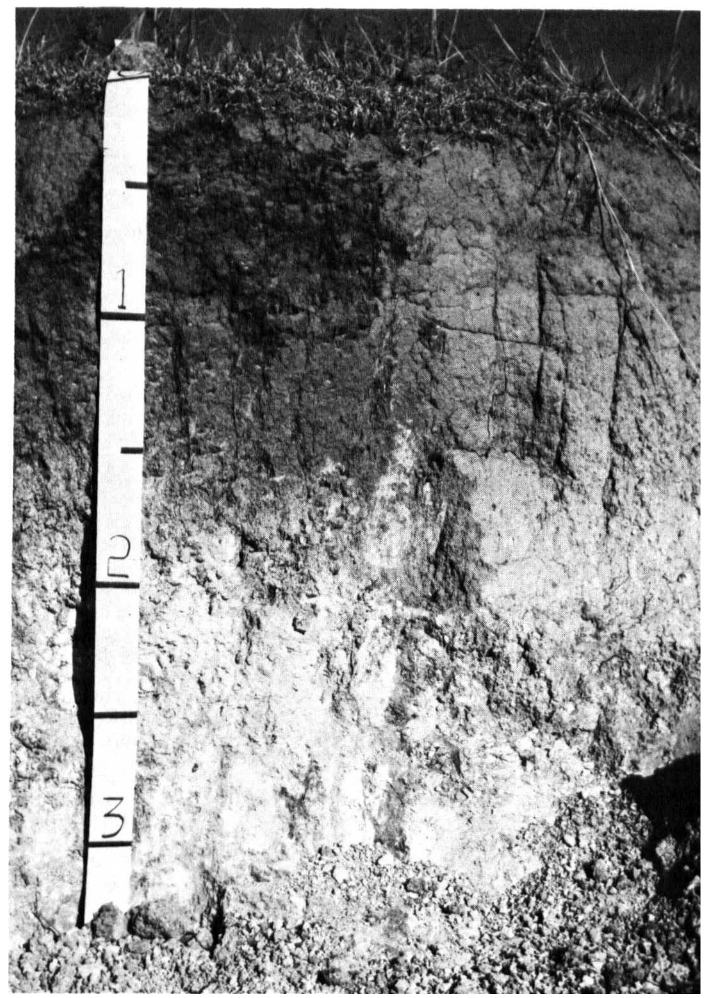

Figure 9.—**Profile of a Mansic clay loam.**

Figure 10.—**Subsurface tillage keeps wheat stubble on the surface and provides a protective cover for the soil in this area of Mansic clay loam, 3 to 6 percent slopes.**

percent, by volume, concretions of calcium carbonate; strong effervescence; moderately alkaline.

Reaction in the solum ranges from mildly alkaline to moderately alkaline, and depth to calcareous material ranges from 0 to 6 inches. Visible calcium carbonate in the form of concretions, films, and threads make up 15 to 20 percent, by volume, of the soil material. There is less calcium carbonate in the lower part of the C horizon than there is above it.

The A horizon ranges from 12 to 24 inches in thickness and is very dark grayish brown to brown. The C horizon is brown, yellowish brown, pale brown, or reddish yellow.

Mansic soils are near Campus, Canlon, Harney, Otero, Roxbury, and Uly soils. They do not have the strong accumulation of lime that is typical of Campus soils. They do not have the beds of indurated caliche that are typical of Canlon soils. They have a less clayey, more poorly defined B horizon than Harney soils. They are more clayey throughout than Otero soils. They have a thinner A horizon and dark colors that extend to a lesser depth than Roxbury soils. They have more sandy A and B horizons and a stronger zone of lime accumulation in the C horizon than Uly soils.

Ma—Mansic clay loam, 0 to 1 percent slopes. This nearly level soil is on uplands in the southern half and in the eastern part of the county. It has a profile similar to the one described as representative of the series, but the surface layer and subsoil are slightly thicker. Included in mapping were small areas of Manter and Harney soils.

This Mansic soil is well suited to dryfarmed and irrigated crops. Wheat and grain sorghum are suitable dryfarmed crops. Inadequate rainfall is the main limitation. Conserving moisture and controlling soil blowing are concerns of management. Summer fallowing is essential for storage of moisture, and stubble mulching is needed to reduce soil blowing. Contour farming, stripcropping, and terracing are also desirable.

In irrigated areas suitable crops are corn, grain sorghum, and wheat. Alfalfa, beans, and tame grasses are also suited. Good management of this soil under irrigation includes the maintenance or improvement of fertility and tilth, the use of crop residue to maintain organic matter, and the application of commercial fertilizer as needed. Management that produces the most efficient use of irrigation water should be used. Land leveling is commonly needed to prepare soils for gravity irrigation. Capability units IIc-1 dryland, I-1 irrigated; Limy Upland range site; Silty Upland windbreak suitability group.

Mb—Mansic clay loam, 1 to 3 percent slopes. This gently sloping soil is on uplands throughout the county. It has a profile similar to the one described as representative of the series, but the surface layer and subsoil are slightly thicker. Included in mapping were small areas of Uly and Manter soils.

This Mansic soil is well suited to dryfarmed crops but not to irrigated crops. Suitable dryfarmed crops are wheat and grain sorghum, but in some areas grain sorghum shows signs of chlorosis during early growth. Controlling water erosion and conserving moisture are the main concerns of management. Soil blowing is a hazard unless the soil is protected by vegetation or crop residue. Terracing, contour farming, and keeping crop residue on the surface help control runoff and erosion and conserve moisture.

Although this soil is not well suited to irrigation, irrigated crops can be grown. Suitable irrigated crops are corn, grain sorghum, and wheat. Good management of irrigated areas includes control of erosion, efficient use of water, and maintenance of fertility and tilth. The use of a cropping system that includes close-growing crops and deep-rooted legumes, the use of crop residue, and the use of commercial fertilizer and manure help maintain and improve fertility and tilth. Land leveling, irrigating on the contour, and irrigating with a sprinkler system supplemented with terraces help reduce erosion. Underground pipelines help to eliminate ditches and to reduce the loss of water. Capability units IIIe-1 dryland, IIe-3 irrigated; Limy Upland range site; Silty Upland windbreak suitability group.

Mc—Mansic clay loam, 3 to 6 percent slopes. This sloping soil is on side slopes along intermittent streams in the uplands. It has a profile similar to the one described as representative of the series, but the surface layer and subsoil are slightly thicker. Included in mapping were small areas of Uly and Otero soils.

Most of this soil is in native short grasses and used for grazing. In cultivated areas wheat and grain sorghum are the main crops. Control of water erosion and conservation of moisture are the main concerns of management. Soil blowing is a hazard unless the soil is protected by vegetation or crop residue. Terracing, contour farming, and keeping crop residue on the surface (fig. 10) help control erosion and conserve moisture.

No areas of this sloping soil are now irrigated in the county. If the soils were irrigated, good management would provide control of erosion, efficient use of water, and maintenance of fertility and tilth. The use of a cropping system that includes close-growing crops and deep-rooted legumes, the use of crop residue, and the use of commercial fertilizer and manure help maintain and improve fertility and tilth. Land leveling, irrigating on the contour, and irrigating with a sprinkler system supplemented with terraces help reduce erosion. Underground pipelines help to eliminate ditches and to reduce the loss of water. Capability units IIIe-1 dryland, IIIe-1 irrigated; Limy Upland range site; Silty Upland windbreak suitability group.

Mf—Mansic clay loam, 3 to 6 percent slopes, eroded. This sloping soil is on side slopes along intermittent streams and on convex slopes between intermittent streams in the uplands. In about 55 percent of the area, the soil has been so eroded that the surface layer is thinner, has numerous lime concretions scattered on it, and is lighter colored than the surface layer in the profile described as representative of the series. Included in mapping were small areas of Campus and Otero soils.

Although this soil is not well suited to crops, most of the acreage is cultivated. Wheat and grain sorghum are the main crops. Some areas have been abandoned or reseeded to grass. Runoff is excessive because of slope and the sealing and slicking of the soil surface during rainstorms. As a result, rills and shallow gullies have formed at the bottoms of the slopes. In dry seasons, the unprotected soil blows easily. Terracing, contour farming, and leaving crop residue on the surface conserve moisture and prevent further erosion and soil blowing.

No areas of this soil in the county are now irrigated. If this soil were irrigated, good management would provide control of erosion, efficient use of water, and maintenance of fertility and tilth. The use of a cropping system that includes close-growing crops and deep-rooted legumes and the use of commercial fertilizer and manure help maintain and improve fertility and tilth. Land leveling, irrigating on the contour, and irrigating with a sprinkler system supplemented with terraces help reduce erosion. Underground pipelines help to eliminate ditches and to reduce the loss of water. Capability units IVe-2 dryland, IIIe-1 irrigated; Limy Upland range site; Silty Upland windbreak suitability group.

Mg—Mansic clay loam, 6 to 15 percent slopes. This strongly sloping soil is on steeper side slopes and irregular catsteps along intermittent drainageways throughout the county. It has the profile described as representative of the series.

Included with this soil in mapping were small areas of Campus and Otero soils and soils that are similar to this Mansic soil but that do not have the dark grayish-brown surface layer.

Most of the acreage is in native short grasses and used for grazing. Grazing must be managed, however, to encourage growth of the best native forage plants. This can be done by using a proper stocking rate and practicing deferred grazing or rotation deferred grazing. Proper location of fences, salt, and water helps distribute livestock over the range. This soil is suitable for the construction of ponds (fig. 11). Capability unit VIe-1 dryland; Limy Upland range site; Silty Upland windbreak suitability group.

Mm—Mansic-Manter complex, 1 to 4 percent slopes. This complex is on undulating areas of many small hills and ridges and on nearly level areas between the hills. It is about 55 percent Mansic clay loam; 25 percent uneroded Manter fine sandy loam; 10 percent eroded Manter fine sandy loam; 5 percent Pratt loamy fine sand; and 5 percent Harney silt loam.

Mansic clay loam and Harney silt loam are nearly level to weakly concave and are in the areas between small hills. The uneroded Manter fine sandy loam is gently sloping and ranges from weakly convex to weakly concave. The eroded Manter fine sandy loam and the Pratt loamy fine sand are on the most convex knobs and ridges.

Most areas of this complex are in native grasses and used for grazing. In cultivated areas wheat and grain sorghum are the main crops. Soil blowing is a serious hazard unless the soil is protected by an adequate cover. Maintaining continuous and adequate crop residue on the surface of the soil helps conserve moisture and control soil blowing. Stripcropping is also desirable.

Most crops suited to these soils can be grown under irrigation. Good management of these soils in irrigated areas must provide control of erosion, efficient use of water, and maintenance of fertility and tilth. The use of a cropping system that includes a deep-rooted legume, the use of crop residue, and the use of commercial fertilizer help maintain and improve fertility and tilth. Bench leveling, contour irrigation, and sprinkler irrigation are aids to the efficient application of water. Underground pipe or gated pipe helps control erosion and reduce loss of water. Capability units IIe-2 dryland, IIe-2 irrigated. Mansic soils in Limy Upland

Figure 11.—**Stockwater pond on Mansic clay loam, 6 to 15 percent slopes. The pond is stocked with fish, and it provides water for livestock and for recreational facilities.**

range site; Silty Upland windbreak suitability group. Manter soils in Sandy range site; Sandy Upland windbreak suitability group.

Manter Series

The Manter series consists of deep, well-drained, nearly level and undulating soils on uplands. These soils formed in sandy eolian sediment. The native vegetation is mid and tall grasses.

In a representative profile the surface layer is brown fine sandy loam about 9 inches thick. The subsoil, about 14 inches thick, is brown, friable fine sandy loam. The underlying material is brown, calcareous fine sandy loam. The upper part contains threads of calcium carbonate and is more calcareous than the lower part.

Permeability is rapid, and available water capacity is moderate. Fertility is high. Runoff is slow.

Most areas are used for cultivated crops, mainly sorghum and wheat.

Representative profile of Manter fine sandy loam, 1 to 3 percent slopes, in grassland, about 600 feet west and 30 feet north of the center of sec. 32, T. 33 S., R. 29 W.:

A1—0 to 9 inches, brown (7.5YR 4/2) fine sandy loam, dark brown (7.5YR 3/2) moist; weak, medium, granular structure; hard, very friable; many roots; mildly alkaline; gradual, smooth boundary.

B2t—9 to 23 inches, brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak, medium, subangular blocky structure; hard, very friable; few roots; few wormcasts; mildly alkaline; gradual, smooth boundary.

Cca—23 to 32 inches, brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak, coarse, subangular blocky structure; slightly hard, very friable; few roots; few wormcasts; threads of calcium carbonate; strong effervescence; moderately alkaline; gradual, smooth boundary.

C—32 to 60 inches, brown (7.5YR 5/4) fine sandy loam, dark brown (7.5 YR 4/4) moist; weak, coarse, subangular blocky structure; slightly hard, very friable; few roots; slight effervescence; moderately alkaline.

Reaction in the solum ranges from mildly alkaline to moderately alkaline, and depth to calcareous material ranges from 15 to 30 inches.

The A horizon ranges from 7 to 12 inches in thickness and is dark grayish brown to brown. The B2t horizon ranges from dark brown to light yellowish brown.

Manter soils are near Pratt and Satanta soils. They have a darker colored surface layer and are less sandy than Pratt soils. They are more sandy than Satanta soils.

Mr—Manter fine sandy loam, 0 to 1 percent slopes. This nearly level soil is between sandhills and hardlands. It has a profile similar to the one described as representative of the series, but the surface layer and subsoil are slightly thicker. Included in mapping were small areas of Satanta soils and eroded Manter soils that have slopes of 1 to 3 percent.

This Manter soil is well suited to dryfarmed and irrigated crops. Wheat, grain sorghum, and forage sorghum are suitable dryfarmed crops. Soil blowing is a serious hazard, particularly if the soil is in summer fallow without protective cover. Maintaining continuous and adequate crop residue on the surface controls or minimizes soil blowing and helps conserve moisture. Contour farming, stripcropping, and terracing are also desirable.

In irrigated areas suitable crops are wheat, grain sorghum, alfalfa, and tame grasses for hay and pasture. Good management of this soil under irrigation includes the maintenance or improvement of fertility and tilth. The use of a cropping system that includes legumes and the use of crop residue help maintain and improve fertility and tilth. Management that produces the most efficient use of irrigation water should be used. Land leveling is commonly needed for uniform distribution of water. Underground pipe prevents water loss and increases the efficiency of the system. Capability units IIIe-4 dryland, IIs-1 irrigated; Sandy range site; Sandy Upland windbreak suitability group.

Ms—Manter fine sandy loam, 1 to 3 percent slopes. This gently sloping soil is on undulating areas of the uplands. It has the profile described as representative of the series. Included in mapping were small areas of Satanta soils and eroded Manter soils that have slopes of 1 to 3 percent.

This Manter soil is mostly dryfarmed. Grain sorghum and wheat are suitable dryfarmed crops. Soil blowing is a serious hazard unless the surface is protected by an adequate vegetative cover. Maintaining continuous and adequate crop residue on the surface of the soil conserves moisture and helps control erosion. Stripcropping is also desirable.

Although this soil is suited to irrigated wheat, sorghum, alfalfa, and tame grasses, only a small acreage is irrigated. Good management of this soil under irrigation includes the control of erosion, the efficient use of water, and the maintenance of fertility and tilth. The use of a cropping system that includes a deep-rooted legume, the use of crop residue, and the use of commercial fertilizer help maintain and improve fertility and tilth. Land leveling, irrigating on the contour, and using sprinkler irrigation on close-growing crops help control erosion and conserve water. Capability units IIIe-4 dryland, IIe-2 irrigated; Sandy range site; Sandy Upland windbreak suitability group.

Mt—Manter fine sandy loam, 1 to 3 percent slopes, eroded. This gently sloping soil is on undulating areas of the uplands. It has a profile similar to the one described as representative of the series, but the surface layer and subsoil are thinner, in many cultivated areas a 2- to 4-inch surface layer of loamy fine sand or light fine sandy loam is present, and in places the soil is calcareous at the surface. Included in mapping were small areas of Mansic soils.

This Manter soil is mostly dryfarmed, but a few areas have been seeded to native grass. Grain sorghum and wheat are suitable dryfarmed crops. Soil blowing is a serious hazard unless the surface is protected by an adequate vegetative cover. Maintaining continuous and adequate crop residue on the soil conserves moisture and helps control erosion. Stripcropping is also desirable.

Although this soil is suited to irrigated wheat, sorghum, alfalfa, and tame grasses, only a small acreage is irrigated. Good management of this soil under irrigation includes control of erosion, the efficient use of water, and the maintenance of fertility and tilth. The use of a cropping system that includes a deep-rooted legume, the use of crop residue, and the use of commercial fertilizer help maintain and improve fertility and tilth. Land leveling, irrigating on the contour, and using sprinkler irrigation help control erosion and conserve water. Capability units IIIe-4 dryland, IIe-2 irrigated; Sandy range site; Sandy Upland windbreak suitability group.

Mu—Manter-Satanta fine sandy loams, 1 to 4 percent slopes. This undifferentiated unit is on gently undulating ridges and mounds and on low, nearly level areas between the mounds. It is about 55 percent uneroded Manter fine sandy loam, 25 percent Satanta fine sandy loam, 10 percent eroded Manter fine sandy loam, and 10 percent Harney silt loam.

The uneroded Manter fine sandy loam is gently sloping on areas that range from weakly convex to weakly concave. The eroded Manter fine sandy loam is on the most convex knobs and ridges. Harney silt loam and Satanta fine sandy loam are on the low, nearly level areas between the mounds.

Much of the acreage is used for dryfarmed wheat and sorghum. Soil blowing is a serious hazard unless the surface is protected by an adequate cover. Maintaining continuous and adequate crop residue on the surface of the soil conserves moisture and helps control soil blowing. Stripcropping is also desirable.

Although these soils are suited to irrigated wheat, sorghum, alfalfa, and tame grasses, only a small acreage is irrigated. Good management of the soils under irrigation includes control of erosion, the efficient use of water, and the maintenance of fertility and tilth. The use of a cropping system that includes a deep-rooted legume, the use of crop residue, and the use of commercial fertilizer help maintain and improve fertility and tilth. Bench leveling, irrigating on the contour, and using sprinkler irrigation help control erosion and conserve water. Capability units IIe-2 dryland, IIe-2 irrigated; Sandy range site; Sandy Upland windbreak suitability group.

Missler Series

The Missler series consists of deep, well-drained, nearly level to sloping soils on uplands. These soils formed in calcareous fine-textured sediment. The native vegetation is short and mid grasses.

In a representative profile the surface layer is grayish-brown silty clay loam about 13 inches thick. The subsoil, about 11 inches thick, is grayish-brown, calcareous, firm heavy silty clay loam. The underlying material is pale-brown, calcareous silty clay loam.

Permeability is moderately slow, and available water capacity is high. Fertility is high. Runoff is slow to medium.

Most areas are used for dryfarmed and irrigated crops. These soils are suited to all crops commonly grown in the county.

Representative profile of Missler silty clay loam, 0 to 1 percent slopes, about 1,320 feet west and 600 feet north of the southeast corner of sec. 26, T. 30 S., R. 27 W.:

A1—0 to 13 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak, medium, granular structure; slightly hard, friable; few fine roots; mildly alkaline; gradual, smooth boundary.

B2—13 to 24 inches, grayish-brown (10YR 5/2) heavy silty clay loam, dark grayish brown (10YR 4/2) moist; moderate, medium, granular structure; hard, firm; few fine roots and pores; few worm-casts; slight effervescence; moderately alkaline; gradual, smooth boundary.

C—24 to 60 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; weak, medium, granular structure; hard, firm; many pores; few threads of calcium carbonate; strong effervescence; moderately alkaline.

The solum ranges from 19 to 30 inches in thickness. Reaction in the solum ranges from mildly alkaline to moderately alkaline, and depth to calcareous material ranges from 0 to 15 inches.

The A horizon ranges from 8 to 15 inches in thickness and is dark gray to grayish brown. The B2 horizon ranges from grayish-brown to pale-brown silty clay loam or silty clay.

Missler soils are near Harney, Leshara, Ness, and Roxbury soils. They have a less clayey, more poorly defined B2 horizon and are shallower over lime than Harney soils. They are better drained than Leshara soils. They are less clayey than Ness soils, which are in shallow depressions. They are more clayey and are not dark colored to so great a depth as Roxbury soils.

Mx—Missler silty clay loam, 0 to 1 percent slopes. This nearly level soil is on uplands in the northeastern part of the county. It has the profile described as representative of the series. Included in mapping were small areas of Mansic soils.

This Missler soil is well suited to dryfarmed and irrigated crops. Wheat and grain sorghum are suitable dryfarmed crops. Inadequate rainfall is the main limitation. Conserving moisture and controlling soil blowing are concerns of management. Summer fallowing is essential for storage of moisture, and stubble mulching is needed to reduce soil blowing. Contour farming, stripcropping, and terracing are also desirable.

In irrigated areas suitable crops are wheat, sorghum, corn; alfalfa, and beans. Good management of this soil under irrigation includes the maintenance or improvement of fertility and tilth, the use of crop residue to maintain organic matter, and the application of commercial fertilizer as needed. Management that produces the most efficient use of irrigation water should be used. Land leveling is commonly needed to prepare soils for gravity irrigation. Capability units IIc-1 dryland, I-1 irrigated; Clay Upland range site; Silty Upland windbreak suitability group.

Mz—Missler silty clay loam, 1 to 6 percent slopes. This gently sloping to sloping soil is along the flood plain of Crooked Creek in the northeastern part of the county. It has a profile similar to the one described as representative of the series, but it is slightly thinner. Included in mapping were small areas of Mansic soils.

This Missler soil is well suited to dryfarmed crops but not to irrigated crops. Suitable dryfarmed crops are wheat and grain sorghum. Controlling water erosion and conserving moisture are the main concerns of management. Soil blowing is a hazard unless the soil is protected by vegetation or crop residue. Terracing, contour farming, and keeping crop residue on the surface help control runoff and erosion and conserve moisture.

Although this soil is not well suited to irrigation, irrigated crops can be grown. Suitable irrigated crops are corn, grain sorghum, and wheat. Good management of irrigated areas includes control of erosion, efficient use of water, and maintenance of fertility and tilth. The use of a cropping system that includes close-growing crops and deep-rooted legumes, the use of crop residue, and the use of commercial fertilizer and manure help maintain and improve fertility and tilth. Land leveling and irrigating on the contour minimize the danger of erosion. Underground pipelines help to eliminate ditches and to reduce the loss of water. Capability units IIIe-1 dryland, IIIe-1 irrigated; Clay Upland range site; Silty Upland windbreak suitability group.

Ness Series

The Ness series consists of deep, poorly drained, nearly level soils. These soils are on the floor of depressions throughout the uplands and terraces. They formed in calcareous fine-textured sediment. Locally, the depressions are called potholes or buffalo wallows. Because they are enclosed and have no outlet, they hold water for periods of several days to a week or more, or until the water soaks into the soil or evaporates. The native vegetation is mostly annual and perennial weeds and a smaller amount of mid grasses.

In a representative profile the gray surface layer is about 32 inches thick. The upper part is silty clay, and the lower part is clay. The underlying material is grayish-brown, calcareous silty clay loam.

Permeability is very slow, and available water capacity is high. Fertility is high. Runoff is ponded in many places.

Most large areas are used for range. The smaller areas are generally cultivated along with the surrounding soils.

Representative profile of Ness silty clay, about 990 feet north and 600 feet west of the southeast corner of sec. 10, T. 33 S., R. 28 W.:

A11—0 to 5 inches, gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) moist; moderate, medium, granular structure; very hard, very firm; mildly alkaline; clear, smooth boundary.

A12—5 to 32 inches, gray (10YR 5/1) clay, very dark gray (10YR 3/1) moist; weak, fine, blocky structure; extremely hard, very firm; mildly alkaline; gradual, smooth boundary.

C—32 to 60 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; massive; hard, friable; slight effervescence; moderately alkaline.

The A horizon ranges from 24 to 40 inches in thickness and is gray to dark gray. The C horizon ranges from silty clay loam to silt loam.

Ness soils are near Harney, Leshara, and Spearville soils. They have a darker colored, more clayey A horizon and are more poorly drained than those soils.

Ns—Ness silty clay. This nearly level soil is in upland depressions throughout the county. Slopes are 0 to 1 percent. Areas range from 8 to 100 acres in size. Included in mapping were areas of soils that are similar to this Ness soil but that are calcareous throughout and occur on the flood plains of Crooked Creek.

This soil is generally farmed along with adjoining soils. During seasons of high rainfall, it is ponded long enough to delay planting and harvesting. Crops are frequently drowned out and are either replanted or lost. Soil blowing is a hazard unless sufficient crop residue is kept on the surface to protect the soil.

Ponding is also a hazard to native grasses. Most areas of this soil that are not cultivated are either bare or have a sparse stand of western wheatgrass. This soil is not suitable for range because the kind and amount of vegetation are too variable. If pits are dug, they fill with water that can be used by wildlife and fish. Capability units VIw-2 dryland, IVs-1 irrigated; not assigned to a range site or windbreak suitability group.

Otero Series

The Otero series consists of deep, well-drained to somewhat excessively drained, sloping and strongly sloping soils on uplands. These soils formed in sandy eolian sediment. The native vegetation is tall and short grasses.

In a representative profile the surface layer is brown, calcareous fine sandy loam about 8 inches thick. The next layer, about 21 inches thick, is pale-brown, calcareous, very friable fine sandy loam. The underlying material is pale-brown, calcareous light sandy loam.

Permeability is rapid, and available water capacity is moderate. Fertility is medium. Runoff is slow.

The sloping soils are cultivated, and the strongly sloping soils are mostly in native grass.

Representative profile of Otero fine sandy loam, 6 to 15 percent slopes, in grassland, about 990 feet west of the center of sec. 34, T. 34 S., R. 26 W.:

A1—0 to 8 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) moist; weak, granular structure; slightly hard, very friable; few roots; slight effervescence; moderately alkaline; gradual, smooth boundary.

AC—8 to 29 inches, pale-brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) moist; weak, fine, granular structure; slightly hard, very friable; few roots; slight effervescence; moderately alkaline; gradual, smooth boundary.

C—29 to 60 inches, pale-brown (10YR 6/3) light sandy loam, brown (10YR 5/3) moist; massive; soft, very friable; slight effervescence; moderately alkaline.

The A horizon ranges from 4 to 8 inches in thickness and is grayish brown to pale brown. The C horizon ranges from brown to very pale brown.

Otero soils are near Mansic soils. They are more sandy than those soils.

Ot—Otero fine sandy loam, 6 to 15 percent slopes. This strongly sloping soil is mainly along upland drainageways in the southern part of the county. It has the profile described as representative of the series. Included in mapping were small areas of gravelly soils and Mansic soils.

Most of this Otero soil is in native grasses and used for grazing. Grazing must be managed, however, to encourage growth of the native grasses. This can be done by using a proper stocking rate and practicing deferred grazing or rotation deferred grazing. Proper location of fences, salt, and water helps distribute livestock over the range. Capability unit VIe-3 dryland; Sandy range site; Sandy Upland windbreak suitability group.

Ov—Otero-Mansic complex, 5 to 25 percent slopes. This complex is on steep, broken side slopes of well-entrenched drainageways and on convex ridges that finger back in the uplands. It is about 40 percent Otero fine sandy loam, 30 percent Mansic clay loam, 15 percent soils that are similar to Otero fine sandy loam and Mansic clay loam, and 15 percent Canlon soils and gravelly soils.

Otero fine sandy loam is sloping on side slopes, Mansic clay loam is sloping and steep on side slopes of intermittent drainageways, and the gravelly soils are steep on side slopes and convex ridges or knobs. The soils that are similar to the Otero soil in this complex have a darker colored, thicker surface layer and are on side slopes. The soils that are similar to the Mansic soil do not have the dark grayish-brown surface layer that is typical of Mansic soils. These soils are on steeper, broken side slopes along well entrenched intermittent drainageways. The gravelly soils are extremely variable. The surface layer ranges from 6 to 12 inches in thickness and from gravelly sandy loam to sandy loam in texture, and it is underlain by fine, medium, and coarse sand and gravel.

All of the acreage is in native grass and used for range. The soils are well suited to grazing. Grazing must be managed, however, to encourage growth of the native grasses. This can be done by using a proper stocking rate and practicing deferred grazing or rotation deferred grazing. Proper location of fences, salt, and water helps distribute livestock over the range. Capability unit VIe-5 dryland; Otero soil in Sandy range site, Mansic soil in Limy Upland range site; not assigned to a windbreak suitability group.

Oz—Otero-Manter fine sandy loams, 3 to 6 percent slopes. This complex is on gently rolling ridges and mounds and on low areas between the mounds. It is about 50 percent Otero fine sandy loam, 35 percent Manter fine sandy loam, 10 percent Mansic clay loam, and 5 percent Harney silt loam.

Otero fine sandy loam is on the more sloping, convex knobs and ridges. Manter fine sandy loam is on the less sloping areas that range from weakly convex to weakly concave. Mansic clay loam and Harney silt loam are on the low areas between the mounds.

Much of the acreage of this complex is used for dry-farmed wheat and sorghum. Soil blowing is a serious hazard unless the surface is protected by an adequate cover. Maintaining continuous and adequate crop residue on the surface of the soil helps conserve moisture and control soil blowing. Stripcropping is also desirable. Terracing is generally impractical because the slopes are too complex.

Most crops suited to these soils can be grown under irrigation. Good management of these soils in irrigated areas must provide control of erosion, efficient use of water, and maintenance of fertility and tilth. The use of a cropping system that includes a deep-rooted legume, the use of crop residue, and the use of commercial fertilizer help maintain and improve fertility and tilth. Bench leveling, contour irrigation, and sprinkler irrigation help control erosion and conserve water. Capability units IVe-3 dryland, IIIe-3 irrigated; Sandy range site; Sandy Upland windbreak suitability group.

Pratt Series

The Pratt series consists of deep, well-drained, nearly level to rolling sandy soils in the uplands. These soils formed in sandy eolian deposits. The native vegetation is mid and tall grasses.

In a representative profile the surface layer is brown loamy fine sand about 8 inches thick. The subsoil, about 16 inches thick, is yellowish-brown, very friable heavy loamy fine sand. The underlying material is very pale brown loamy fine sand.

Permeability is rapid, and available water capacity is low. Fertility is medium to low. Runoff is slow.

Most areas are in native range.

Representative profile of Pratt loamy fine sand in an area of Pratt soils, 0 to 5 percent slopes, about 900 feet south and 150 feet east of the northeast corner of sec. 35, T. 34 S., R. 28 W.:

A1—0 to 8 inches, brown (10YR 5/3) loamy fine sand, dark brown (10YR 4/3) moist; single grained; loose; neutral; clear, smooth boundary.

B2t—8 to 24 inches, yellowish-brown (10YR 5/4) heavy loamy fine sand, dark yellowish brown (10YR 4/4) moist; weak, medium, granular structure; slightly hard, very friable; neutral; gradual, smooth boundary.

C—24 to 60 inches, very pale brown (10YR 7/4) loamy fine sand, light yellowish brown (10YR 6/4) moist; single grained; loose; mildly alkaline.

The solum ranges from 24 to 34 inches in thickness.

The A horizon ranges from 7 to 19 inches in thickness and is grayish brown to pale brown. The B horizon ranges from brown to light yellowish-brown loamy fine sand or loamy sand.

Pratt soils are near Manter and Tivoli soils. They are more sandy than Manter soils and are less sandy than Tivoli soils.

Pr—Pratt soils, 0 to 5 percent slopes. These nearly level to gently rolling soils are on undulating to slightly hummocky areas in the southern and northeastern parts of the county. They have a profile similar to the one described as representative of the series, but in places the surface layer is fine sand.

Included with these soils in mapping were areas of soils that are similar to these Pratt soils but that are calcareous within 12 inches of the surface and have a more sandy surface layer. Also included were small areas of Manter soils.

These Pratt soils are not well suited to crops, particularly wheat, because of the low available water capacity and the high susceptibility to soil blowing. They can be cultivated safely, however, if soil blowing is controlled. Grain sorghum is the main crop grown on these soils. The low available water capacity and the susceptibility to soil blowing limit the effectiveness of summer fallow. Maintaining continuous and adequate crop residue is essential.

Although these soils are suited to irrigated forage sorghum, grain sorghum, and corn, only a small acreage is irrigated. Good management of these soils under irrigation must provide for control of soil blowing, efficient use of water, and maintenance of fertility and tilth. Sprinkler irrigation is the only practical method of irrigation on these soils. Capability units IVe-1 dryland, IIIe-2 irrigated; Sands range site; Sandy Upland windbreak suitability group.

Pt—Pratt soils, 5 to 15 percent slopes. These gently rolling to rolling soils are on hummocky areas in the southern and northeastern parts of the county. They have a profile similar to the one described as representative of the series, but the surface layer is fine sand. Included in mapping were small areas of Tivoli soils and small blowouts less than 10 acres in size.

These Pratt soils are not suited to dryfarmed crops because of the low available water capacity and the susceptibility to erosion. Most of the acreage is in native grasses. A moderate to large amount of forage is produced on these soils where grazing management is good. Using a proper stocking rate is essential, and practicing deferred grazing or rotation deferred grazing is desirable. Proper location of fences, salt, and water helps distribute livestock over the range.

Although these soils are suited to irrigated forage sorghum and corn, no areas of the soils are now irrigated in the county. If the soils were irrigated, good management can provide control of soil blowing and maintenance of fertility and tilth. Sprinkler irrigation is the only practical method of irrigation on these soils. Capability units VIe-2 dryland, IVe-4 irrigated; Sands range site; Sandy Upland windbreak suitability group.

Rough Broken Land

Rb—Rough broken land. This land type is on very steep, broken slopes along the north side of the Cimarron River Valley. It is mainly in deeply dissected, intermittent drainageways. Some slopes are nearly vertical, and others have a succession of short, vertical exposures. This land consists of soft limestone or caliche underlain by sandy, gravelly, and clayey material that is thinly interbedded with limestone. Included in mapping were small areas of Otero and Mansic soils and gravelly soils. Runoff is rapid, and geologic erosion is active.

All of the acreage of Rough broken land is in range that consists of a moderate to sparse stand of mid and tall native grasses. The areas can be grazed if care is taken to prevent overgrazing, which results in erosion. Grazing must be managed to encourage growth of the best native forage plants. This can be done by using a proper stocking rate and practicing deferred grazing or rotation deferred grazing. Proper location of fences, salt, and water helps distribute livestock over the range. Capability unit VIIs-1 dryland; Shallow Limy range site; not assigned to a windbreak suitability group.

Roxbury Series

The Roxbury series consists of deep, well-drained nearly level soils on alluvial fans and terraces along Crooked Creek. These soils formed in somewhat stratified loamy alluvium. The native vegetation is mid and tall grasses.

In a representative profile the surface layer is grayish-brown, calcareous silt loam about 20 inches thick. The subsoil, about 8 inches thick, is dark grayish-brown, calcareous, friable silty clay loam. The underlying material is very pale brown and pale-brown, calcareous silty clay loam.

Permeability is moderate, and available water capacity is very high. Fertility is high. Runoff is medium to slow. Crops generally benefit from the extra moisture gained through the accumulation of runoff from adjacent areas, but occasionally they are damaged by flash floods.

Most areas are used for cultivated crops, mainly sorghum, wheat, and alfalfa.

Representative profile of Roxbury silt loam, about 350 feet west and 10 feet south of the center of sec. 11, T. 31 S., R. 27 W.:

A1—0 to 20 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak, granular structure; slightly hard, friable; slight effervescence; moderately alkaline; gradual, smooth boundary.

B2—20 to 28 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, granular structure; hard, friable; few wormcasts; slight effervescence; moderately alkaline; gradual, smooth boundary.

C1—28 to 42 inches, very pale brown (10YR 7/3) silty clay loam, pale brown (10YR 6/3) moist; massive; hard, friable; strong effervescence; moderately alkaline; gradual, smooth boundary.

C2—42 to 60 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; massive; hard, firm; few small concretions of calcium carbonate; strong effervescence; moderately alkaline.

Reaction in the solum ranges from mildly alkaline to moderately alkaline, and depth to calcareous material ranges from 0 to 15 inches.

The A horizon ranges from 20 to 30 inches in thickness and is dark gray to grayish brown. The B horizon ranges from silt loam to silty clay loam.

Roxbury soils are near Mansic and Missler soils. They have a thicker A horizon than Mansic soils and do not have the strong accumulation of calcium carbonate that is common in those soils. They are less clayey and are dark colored to a greater depth than Missler soils.

Rx—Roxbury silt loam. This nearly level soil is on terraces and alluvial fans along Crooked Creek and in upland swales adjacent to the Crooked Creek Valley. Slopes are 0 to 1 percent. Included in mapping were small areas of Leshara soils.

Roxbury soils are among the most productive soils in the county and are well suited to dryfarmed and irrigated crops. Wheat and grain sorghum are suitable dryfarmed crops.

Alfalfa is also grown in some areas. Although some extra moisture is received in the form of runoff from adjacent areas inadequate rainfall is the main limitation. Conserving moisture and controlling soil blowing also are concerns of management on this soil. Summer fallowing is essential for storage of moisture, and stubble mulching is needed to reduce soil blowing. Stripcropping is also desirable. In suitable areas contour farming and terracing can be used.

Roxbury soils are among the most productive soils in the soils and are well suited to dryfarmed and irrigated crops. Wheat and grain sorghum are suitable dryfarmed crops. Alfalfa is also grown in some areas. Although some extra moisture is received in the form of runoff from adjacent areas inadequate rainfall is the main limitation. Conserving moisture and controlling soil blowing also are concerns of management on this soil. Summer fallowing is essential for storage of moisture, and stubble mulching is needed to reduce soil blowing. Stripcropping is also desirable. In suitable areas contour farming and terracing can be used.

In irrigated areas suitable crops are wheat, grain sorghum, corn, alfalfa, and soybeans. Good management of this soil under irrigation includes the maintenance or improvement of fertility and tilth, the use of crop residue to maintain organic matter, and the application of commercial fertilizer as needed. Management that produces the most efficient use of irrigation water should be used. Land leveling is commonly needed to prepare soils for gravity irrigation. Runoff from adjacent higher areas is a concern of management on some fields. Capability units IIc-2 dryland, I-1 irrigated; Loamy Terrace range site; Lowland windbreak suitability group.

Satanta Series

The Satanta series consists of deep, well-drained, nearly level to gently undulating or gently sloping soils on uplands. These soils formed in loamy eolian material. The native vegetation is short and mid grasses.

In a representative profile the surface layer is grayish-brown loam about 6 inches thick. The subsoil is about 23 inches thick. The upper part is dark grayish-brown, friable clay loam; the middle is brown, friable clay loam; and the lower part is pale-brown, friable clay loam that is calcareous and contains a few threads of calcium carbonate. The underlying material is pale-brown, calcareous clay loam.

Permeability is moderate, and available water capacity is high. Fertility is high. Runoff is slow to medium.

Most areas are used for cultivated crops, mainly wheat and sorghum.

Representative profile of Satanta loam, 0 to 1 percent slopes, about 1,590 feet east of the center of sec. 32, T. 31 S., R. 26 W.:

Ap—0 to 6 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak, medium, granular structure; hard, friable; neutral; clear, smooth boundary.

B1—6 to 12 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak and moderate, medium, granular structure; hard, friable; neutral; gradual, smooth boundary.

B2t—12 to 23 inches, brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; moderate, medium, granular structure; hard, friable; mildly alkaline; gradual, smooth boundary.

B3ca—23 to 29 inches, pale-brown (10YR 6/3) clay loam, dark brown (10YR 4/3) moist; weak, medium, granular structure; hard, friable; few threads of calcium carbonate; strong effervescence; moderately alkaline; gradual, smooth boundary.

C—29 to 60 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; massive; hard, friable; strong effervescence; moderately alkaline.

The solum ranges from 24 to 36 inches in thickness. Reaction in the solum ranges from neutral to moderately alkaline, and depth to calcareous material ranges from 18 to 36 inches.

The A horizon ranges from 6 to 12 inches in thickness. It is dark grayish-brown to brown loam or fine sandy loam. The B horizon ranges from dark grayish-brown to pale-brown loam to sandy clay loam.

Satanta soils are near Harney and Manter soils. They have a more sandy A horizon and a less clayey B horizon than Harney soils. They have a more clayey B horizon than Manter soils.

Sa—Satanta fine sandy loam, 0 to 2 percent slopes. This nearly level to gently undulating soil is on uplands. It has a profile similar to the one described as representative of the series, but the surface layer is fine sandy loam and the subsoil is sandy clay loam. Included in mapping were small areas of uneroded Manter soils, eroded Manter soils, Harney soils, and Mansic soils.

This Satanta soil is well suited to dryfarmed and irrigated crops. Wheat and grain sorghum are suitable dryfarmed crops. Controlling soil blowing and conserving moisture are the main concerns of management. Water erosion is also a hazard on the sloping areas. Maintaining continuous and adequate crop residue on the surface of the soil helps control soil blowing and conserve moisture. Contour farming, stripcropping, and terracing are also desirable.

In irrigated areas suitable crops are grain sorghum, forage sorghum, corn, wheat, and alfalfa. Good management of this soil under irrigation includes control of erosion, efficient use of water, and maintenance of fertility and tilth. The use of crop residue to maintain organic matter and the application of commercial fertilizer help maintain and improve fertility and tilth. Erosion can be controlled and water efficiently used by land leveling, irrigating on the contour, and using sprinkler irrigation on close-growing crops. Capability units IIe-2 dryland, IIe-2 irrigated; Sandy range site; Sandy Upland windbreak suitability group.

Sb—Satanta loam, 0 to 1 percent slopes. This nearly level soil is on uplands. It is inextensive but widely scattered throughout the county. It has the profile described as representative of the series. Included in mapping were small areas of Uly and Harney soils.

This Satanta soil is well suited to dryfarmed and irrigated crops. Wheat and grain sorghum are suitable dryfarmed crops. Inadequate rainfall is the main limitation. Conserving moisture and controlling soil blowing are concerns of management. Summer fallowing is essential for storage of moisture, and stubble mulching is needed to reduce soil blowing. Contour farming, stripcropping, and terracing are also desirable.

In irrigated areas suitable crops are grain sorghum, corn, wheat, and alfalfa. Good management of this soil under irrigation includes the maintenance or improvement of fertility and tilth, the use of crop residue to maintain organic matter, and the application of commercial fertilizer as needed. Management that produces the most efficient use of irrigation water should be used. Land leveling is commonly needed to prepare soils for gravity irrigation. Capability units IIc-1 dryland, I-1 irrigated; Loamy Upland range site; Silty Upland windbreak suitability group.

Sc—Satanta loam, 1 to 3 percent slopes. This gently sloping soil is on uplands. It has a profile similar to the one

Figure 12.—**Profile of a Spearville silty clay loam. The slowly permeable subsoil is below a depth of about 6 inches.**

described as representative of the series, but the surface layer and subsoil are slightly thinner and free lime is at a shallower depth. Included in mapping were small areas of Harney and Uly soils.

This Satanta soil is well suited to dryfarmed and irrigated crops. Wheat and grain sorghum are suitable dryfarmed crops. Controlling water erosion and soil blowing and conserving moisture are concerns of management. Terracing, contour farming, and keeping crop residue on the surface help control erosion and conserve moisture.

No areas of this gently sloping soil are now irrigated in the county. If the soil were irrigated, it would be suited to grain sorghum, corn, wheat, and alfalfa. Good management of irrigated areas includes control of erosion, efficient use of water, and maintenance of fertility and tilth. The use of crop residue and the use of commercial fertilizer and manure help maintain and improve fertility and tilth. Bench leveling, irrigating on the contour, and irrigating with a sprinkler system supplemented with terraces help reduce erosion. Underground pipe prevents loss of water. Capability units IIe-1 dryland, IIe-1 irrigated; Loamy Upland range site; Silty Upland windbreak suitability group.

Spearville Series

The Spearville series consists of deep, well drained to moderately well drained, nearly level soils on uplands. These soils formed in loess. The native vegetation is short and mid grasses.

In a representative profile (fig. 12) the surface layer is grayish-brown silty clay loam about 6 inches thick. The subsoil is about 18 inches thick. The upper part is dark grayish-brown, very firm silty clay; the lower part is grayish-brown, firm silty clay loam that is calcareous and contains a few small concretions and threads of calcium carbonate. The underlying material is pale-brown, calcareous silty clay loam and silt loam.

Permeability is slow, and available water capacity is high. Fertility is high. Runoff is slow to very slow.

Most areas are used for cultivated crops.

Representative profile of Spearville silty clay loam, 0 to 1 percent slopes, in a cultivated field, about 300 feet south and 100 feet east of the northwest corner of sec. 21, T. 30 S., R. 28 W.:

Ap—0 to 6 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak, medium, granular structure; hard, friable; neutral; clear, smooth boundary.

B2t—6 to 18 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate and weak, medium, blocky structure; very hard, very firm; mildly alkaline; gradual, smooth boundary.

B3ca—18 to 24 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate, medium, blocky structure; hard, firm; few, small, soft masses and threads of calcium carbonate; strong effervescence; moderately alkaline; gradual, smooth boundary.

Cca—24 to 30 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; moderate, medium, granular structure; hard, firm; thin films and streaks of segregated calcium carbonate; strong effervescence; moderately alkaline; gradual, smooth boundary.

C—30 to 60 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; weak, medium, subangular blocky structure; slightly hard, friable; strong effervescence; moderately alkaline.

The solum ranges from 20 to 33 inches in thickness. Reaction in the solum ranges from neutral to moderately alkaline, and depth to calcareous material ranges from 15 to 24 inches.

The A and B horizons range from dark grayish brown to grayish brown.

Spearville soils are near Harney and Ness soils. They have a thinner A horizon and a more clayey B2t horizon than Harney soils. They have a less clayey A horizon and are better drained than Ness soils.

Sp—Spearville silty clay loam, 0 to 1 percent slopes. This nearly level soil is on broad, smooth uplands, mostly in the northwestern part of the county. Included in mapping were small areas of Harney soils and small depressional areas of Ness soils.

Winter wheat and grain sorghum are the main dryfarmed crops, but this Spearville soil is better suited to wheat because the clayey subsoil is likely to be dry and hard in summer, when grain sorghum needs the most water. Careful management is needed to maintain favorable structure and good tilth in the surface layer. Conserving moisture and controlling soil blowing are also concerns of management. Summer fallowing is essential for storage of moisture, and stubble mulching is needed to reduce soil blowing and improve tilth. Terracing, contour farming, and stripcropping are also desirable.

Crops respond well to irrigation under careful management, and many fields are irrigated with excellent results (fig. 13). Suitable irrigated crops are wheat, corn, sorghum, and alfalfa. Good management of this soil under irrigation

Figure 13.—An excellent crop of irrigated corn on Spearville silty clay loam, 0 to 1 percent slopes.

includes the maintenance or improvement of soil structure, fertility, and tilth; the use of crop residue to maintain organic matter and tilth; the application of commercial fertilizer and manure; and proper irrigation management. Proper design of the irrigation system is necessary for maximum use of water (fig. 14). Some land leveling is commonly needed to prepare soils for gravity irrigation. A longer irrigation time is needed to properly irrigate this soil. Also, a drainage system to remove excess runoff after heavy rain is needed. Capability units IIs-2 dryland, IIs-2 irrigated; Clay Upland range site; Silty Upland windbreak suitability group.

Tivoli Series

The Tivoli series consists of deep, excessively drained, rolling to steep soils on uplands. These soils formed in sandy eolian deposits. The native vegetation is mid and tall grasses.

In a representative profile (fig. 15) the surface layer is brown fine sand about 4 inches thick. The underlying material is light yellowish-brown fine sand.

Permeability is rapid, and available water capacity is very low. Fertility is low. Runoff is very slow.

Most areas are in native range.

Representative profile of Tivoli fine sand, 10 to 25 percent slopes, in native grass, about 740 feet east and 300 feet south of the northwest corner of sec. 9, T. 34 S., R. 30 W.:

A1—0 to 4 inches, brown (10YR 5/3) fine sand, dark brown (10YR 4/3) moist; single grained; loose; neutral; clear, smooth boundary.

C—4 to 60 inches, light yellowish-brown (10YR 6/4) fine sand, yellowish brown (10YR 5/4) moist; single grained; loose; neutral.

The A horizon ranges from grayish-brown to light yellowish-brown loamy fine sand or fine sand. The C horizon ranges from light yellowish brown to very pale brown.

Tivoli soils are near Pratt soils. They are more sandy throughout than those soils.

Tv—Tivoli fine sand, 10 to 25 percent slopes. This rolling to steep soil is on hummocky to steep, dunelike areas in the southern and northeastern parts of the county. Included in mapping were small areas of Pratt soils and small blowouts less than 20 acres in size.

This Tivoli soil is not suitable for cultivated crops. Most of the acreage is in native grasses and sand sagebrush. Soil blowing is a hazard unless an adequate cover of vegetation is maintained. This soil produces a fair to good stand of native grasses and is good for grazing. Grazing management, however, must include using a proper stocking rate and practicing deferred grazing or rotation deferred grazing. Proper location of fences, salt, and water helps distribute livestock over the range. Fencing the blow-out areas to keep livestock out and reseeding to native grasses help stabilize the blowouts. Capability unit VIIe-1 dryland;

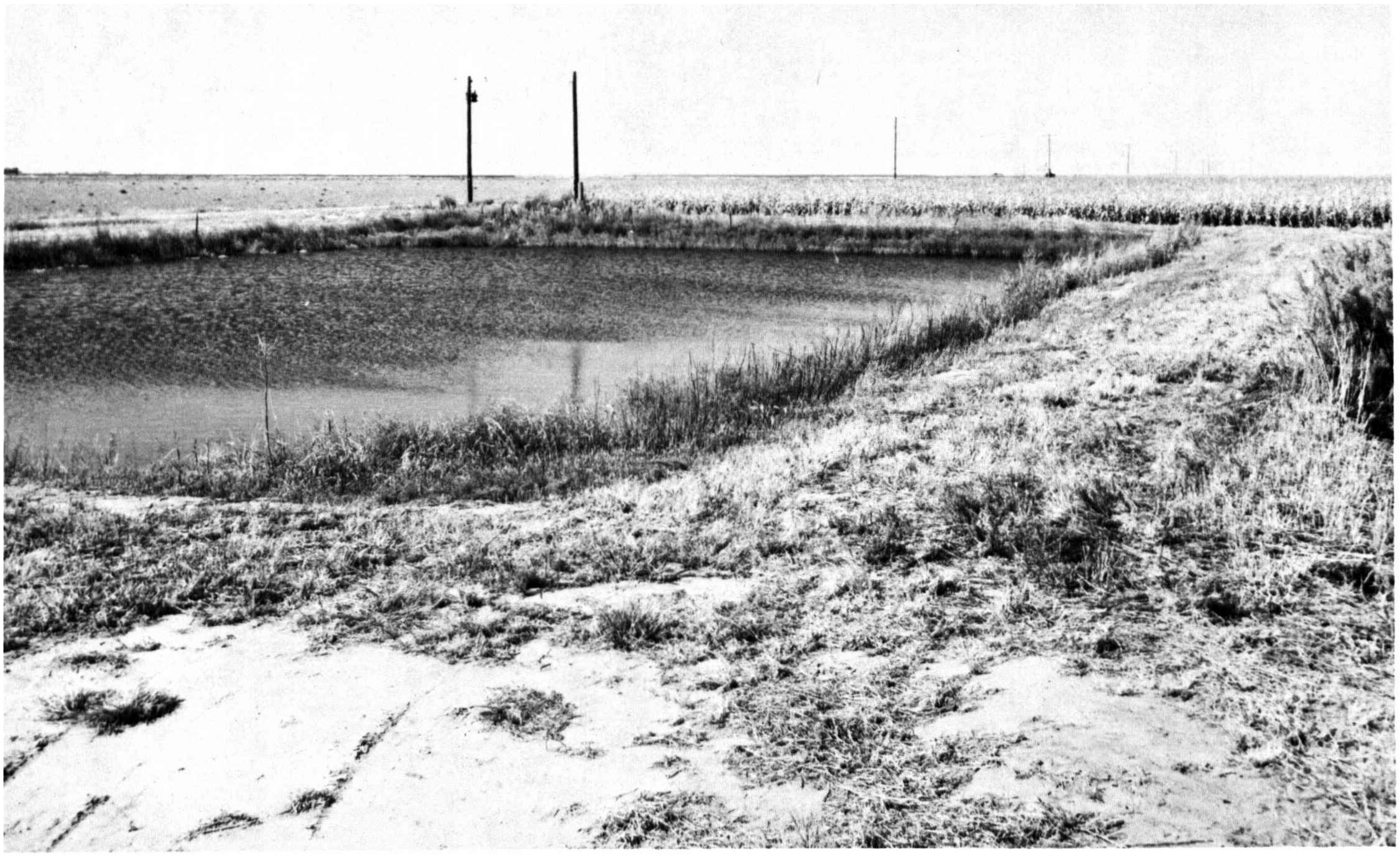

Figure 14.—**Tailwater recovery pit on Spearville silty clay loam, 0 to 1 percent slopes. The pit conserves water as it collects irrigation tailwater for reuse.**

Choppy Sands range site; not assigned to a windbreak suitability group.

Uly Series

The Uly series consists of deep, well-drained, nearly level to sloping soils on uplands throughout the county. These soils formed in calcareous loess. The native vegetation is short, mid, and tall grasses.

In a representative profile the surface layer is grayish-brown silt loam about 6 inches thick. The subsoil, about 8 inches thick, is dark grayish-brown, friable light silty clay loam. The underlying material is pale-brown, calcareous silt loam.

Permeability is moderate, and available water capacity is high. Fertility is high. Runoff is slow to rapid.

Most areas are cultivated, but some of the sloping soils are in native grass.

Representative profile of Uly silt loam, 0 to 1 percent slopes, in a cultivated field, about 1,170 feet west and 990 feet north of the southeast corner of sec. 22, T. 30 S., R. 30 W.:

Ap—0 to 6 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak, medium, granular structure; slightly hard, friable; neutral; clear, smooth boundary.

B2—6 to 14 inches, dark grayish-brown (10YR 4/2) light silty clay loam, very dark grayish brown (10YR 3/2) moist; weak, medium, subangular blocky structure; hard, friable; few wormcasts; mildly alkaline; gradual, smooth boundary.

C—14 to 60 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; massive; soft, very friable; strong effervescence; moderately alkaline.

The solum ranges from 12 to 24 inches in thickness. Depth to calcareous material ranges from 8 to 15 inches. The A horizon ranges from dark grayish brown to grayish brown.

Uly soils are near Harney and Mansic soils. They have a less clayey B horizon and are shallower over calcareous material than Harney soils. They have more silty A and B horizons than Mansic soils.

Ua—Uly silt loam, 0 to 1 percent slopes. This nearly level soil is on uplands throughout the county. It has the profile described as representative of the series. Included in mapping were small areas of Harney soils.

This Uly soil is well suited to dryfarmed and irrigated crops. Wheat and grain sorghum are suitable dryfarmed crops. Inadequate rainfall is the main limitation. Conserving moisture and controlling soil blowing are concerns of management. Summer fallowing is essential for storage of moisture, and stubble mulching is needed to reduce soil blowing. Contour farming, stripcropping, and terracing are also desirable.

In irrigated areas suitable crops are corn, grain sorghum, and wheat. Alfalfa, soybeans, and tame grasses are also suited. Good management of this soil under irrigation includes the maintenance or improvement of fertility and tilth, the use of crop residue to maintain organic matter, and the application of commercial fertilizer as needed. Management that produces the most efficient use of irrigation water should be used. Land leveling is commonly needed to prepare soils for gravity irrigation. Capability units IIc-1 dryland, I-1 irrigated; Loamy Upland range site; Silty Upland windbreak suitability group.

Ub—Uly silt loam, 1 to 3 percent slopes. This gently sloping soil is on uplands, mostly in the northern half of the county. It has a profile similar to the one described as representative of the series, but the surface layer and subsoil are slightly thinner. Included in mapping were small areas of Harney soils.

This Uly soil is well suited to dryfarmed crops but not to irrigated crops. Suitable dryfarmed crops are wheat and grain sorghum. Controlling water erosion and conserving moisture are the main concerns of management. Soil blowing is a hazard unless the soil is protected by vegetation or crop residue. Terracing, contour farming (fig. 16), and keeping crop residue on the surface help control runoff and erosion and conserve moisture.

Although this soil is not well suited to irrigation, irrigated crops can be grown. Suitable irrigated crops are corn, grain sorghum, and wheat. Good management of irrigated areas includes control of erosion, efficient use of water, and maintenance of fertility and tilth. The use of a cropping system that includes close-growing crops and deep-rooted legumes, the use of crop residue, and the use of commercial fertilizer and manure help maintain and improve fertility and tilth. Land leveling, irrigating on the contour, and irrigating with a sprinkler system supplemented with terraces help reduce erosion. Underground pipe and gated pipe prevent loss of water by evaporation and deep percolation. Capability units IIe-3 dryland, IIe-3 irrigated; Loamy Upland range site; Silty Upland windbreak suitability group.

Uc—Uly silt loam, 1 to 3 percent slopes, eroded. This gently sloping soil is on convex ridges of the uplands. In about 25 percent of the area, the soil has been so eroded that the surface layer is thinner, is lighter colored, and has calcareous material at a shallower depth than the surface layer in the profile described as representative of the series. Included in mapping were areas of Harney and Mansic soils.

Most of the acreage of this Uly soil is dryfarmed, but a few areas are irrigated. Wheat and grain sorghum are the main crops. In calcareous areas grain sorghum shows signs of chlorosis during early growth. Controlling water erosion and conserving moisture are the main concerns of management. Soil blowing is a hazard unless the soil is protected by vegetation or crop residue. Terracing, contour farming, and keeping crop residue on the surface help control runoff and erosion and conserve moisture.

Although this gently sloping soil is not well suited to irrigation, some areas are irrigated. Good management of this soil in irrigated areas includes control of erosion, efficient use of water, and maintenance of fertility and tilth. The use of a cropping system that includes close-growing crops and deep-rooted legumes, the use of crop residue, and the use of commercial fertilizer and manure help maintain and improve fertility and tilth. Land leveling, irrigating on the contour, and irrigating with a sprinkler system supplemented with terraces help reduce erosion. Underground pipe and gated pipe prevent loss of water by evaporation and deep percolation. Capability units IIIe-1 dryland, IIe-3 irrigated; Limy Upland range site; Silty Upland windbreak suitability group.

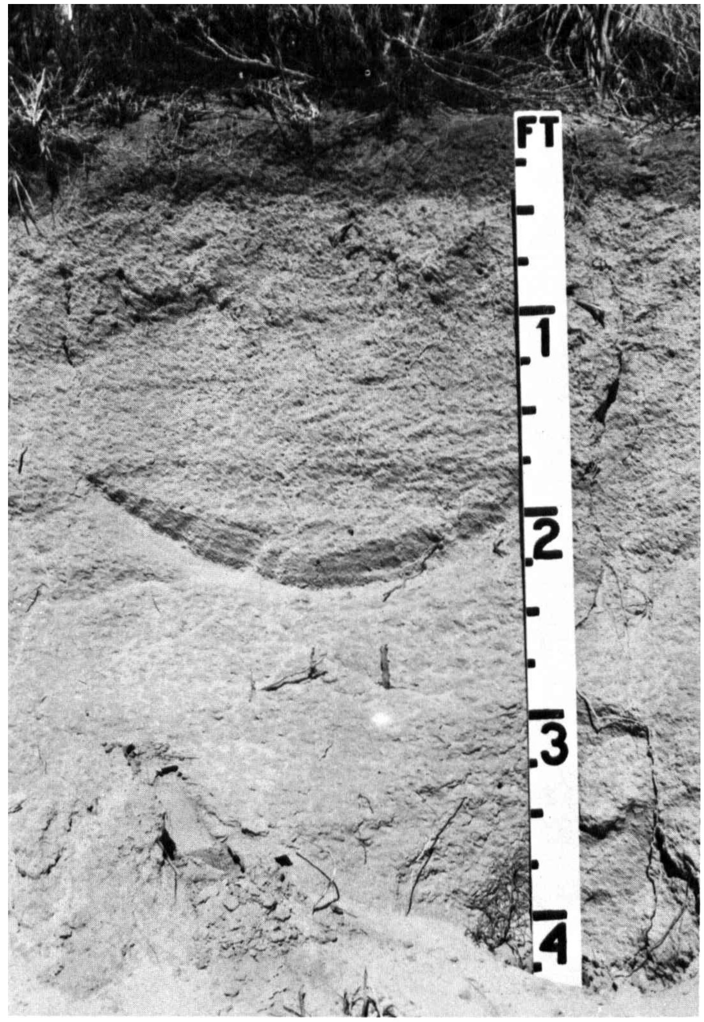

Figure 15.—**Profile of a Tivoli fine sand. The thin, dark-colored surface layer is underlain by sand.**

Us—Uly silt loam, 3 to 6 percent slopes. This sloping soil is on convex side slopes adjacent to the deeper drainageways in the uplands. It has a profile similar to the one described as representative of the series, but the surface layer and subsoil are slightly thinner and has calcareous material at a shallower depth. Included in mapping were small areas of eroded Uly soils and Mansic soils.

Most of this Uly soil is still in native short grasses and used for grazing. In cultivated areas wheat and grain sorghum are the main crops. Runoff is excessive because of slope, and water erosion is a serious hazard. Soil blowing is also a hazard unless the soil is protected by vegetation or crop residue. Terracing, contour farming, and keeping crop residue on the surface help control runoff and erosion and conserve moisture.

No areas of this sloping soil in the county are now irrigated. If the soil were irrigated, good management would provide control of erosion, efficient use of water, and maintenance of fertility and tilth. The use of a cropping system that includes close-growing crops and deep-rooted legumes,

Figure 16.—Wheat being sown on the contour on Uly silt loam, 1 to 3 percent slopes.

the use of crop residue, and the use of commerical fertilizer and manure help maintain and improve fertility and tilth. Land leveling, irrigating on the contour, and irrigating with a sprinkler system supplemented with terraces help reduce erosion. Underground pipelines help to eliminate ditches and to reduce the loss of water. Capability units IIIe-1 dryland, IIIe-1 irrigated; Loamy Upland range site; Silty Upland windbreak suitability group.

Ut—Uly silt loam, 3 to 6 percent slopes, eroded. This sloping soil is on long, sloping side slopes adjacent to the deeper drainageways and on convex side slopes along tributaries of Crooked Creek. In about 35 percent of the area, the soil has been so eroded that the surface layer is thinner, is lighter colored, and has calcareous material at a shallower depth than the surface layer in the profile described as representative of the series. Included in mapping were areas of Mansic soils.

Most of this Uly soil is cultivated. Wheat and grain sorghum are the main crops. In calcareous areas grain sorghum shows signs of chlorosis during early growth. Runoff is excessive because of slope, and water erosion is a serious hazard. Soil blowing is also a serious hazard unless the soil is protected by vegetation or crop residue. Terracing, contour farming, and keeping crop residue on the surface conserve moisture and prevent further erosion.

Although this sloping is not well suited to irrigation, some areas are irrigated. Good management of this soil under irrigation must provide control of erosion, efficient use of water, and maintenance of fertility and tilth. The use of a cropping system that includes close-growing crops and deep-rooted legumes, the use of crop residue, and the use of commercial fertilizer and manure help maintain and improve fertility and tilth. Land leveling, irrigating on the contour, and irrigating with a sprinkler system supplemented with terraces help reduce erosion. Underground pipelines help to eliminate ditches and to reduce the loss of water. Capability units IVe-2 dryland, IIIe-1 irrigated; Limy Upland range site; Silty Upland windbreak suitability group.

Wann Series

The Wann series consists of deep, somewhat poorly drained, nearly level soils on the flood plains of Crooked Creek and the Cimarron River. These soils formed in stratified calcareous alluvium. The native vegetation is mid and tall grasses.

In a representative profile the surface layer is grayish-brown, calcareous loam about 13 inches thick. The underlying material is light-gray, calcareous fine sandy loam that has faint, yellowish-brown mottles.

Permeability is moderately rapid, and available water capacity is high. Fertility is medium. Runoff is slow. These soils have a fluctuating water table. They are occasionally subject to flooding.

Most of the acreage is in native grasses and used for range. Some areas are cultivated.

Representative profile of Wann loam, in grassland, about

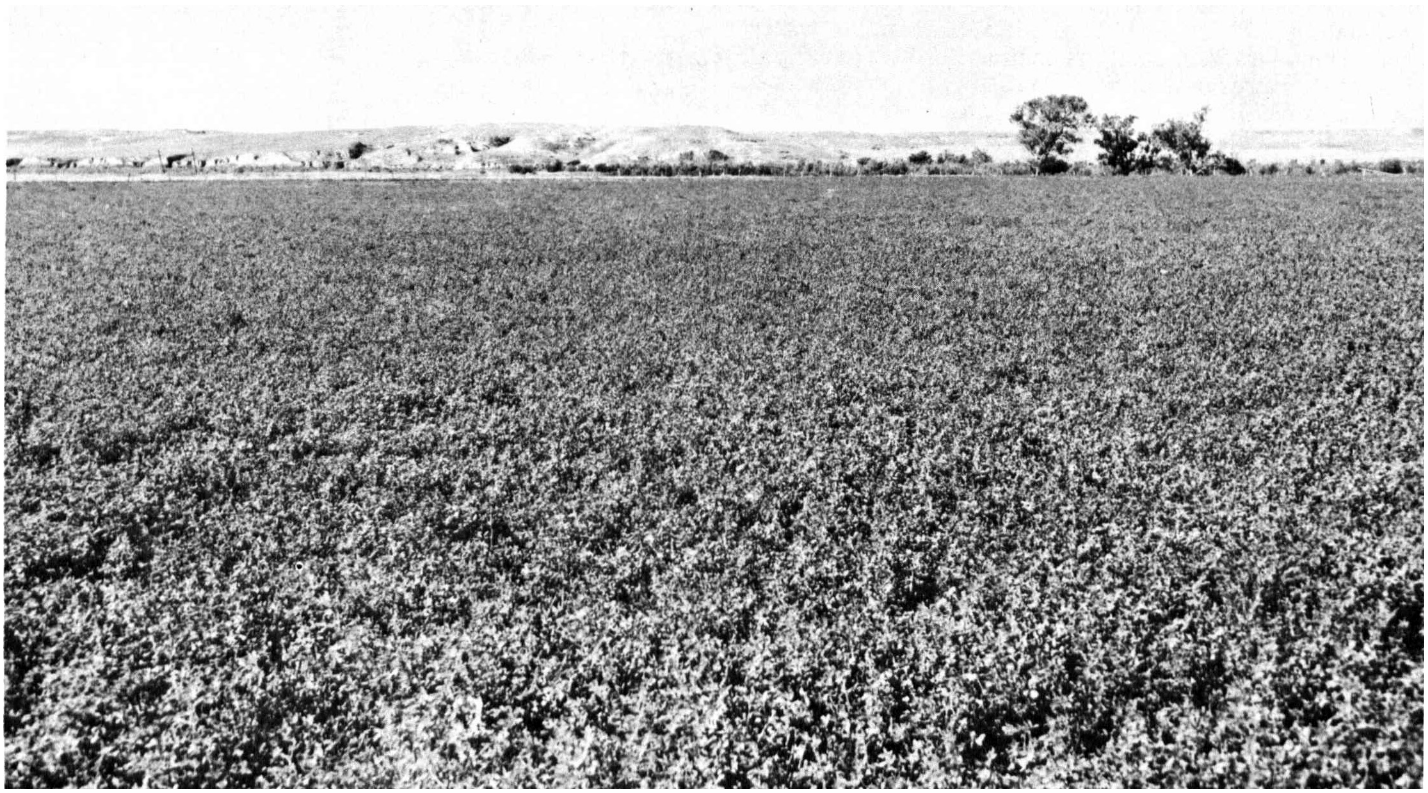

Figure 17.—**Irrigated alfalfa growing on Yahola sandy loam. The Otero-Mansic complex, 5 to 25 percent slopes, is in the background.**

660 feet north and 90 feet west of the southeast corner of sec. 22, T. 32 S., R. 28 W.:

A1—0 to 13 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, granular structure; hard, friable; few wormcasts; slight effervescence; moderately alkaline; clear, smooth boundary.

C—13 to 60 inches, light-gray (10YR 7/2) fine sandy loam, grayish brown (10YR 5/2) moist; few, fine, faint, yellowish-brown mottles; slightly hard, very friable; strong effervescence; moderately alkaline.

Depth to mottles ranges from 12 to 24 inches.

The A horizon ranges from 10 to 20 inches in thickness and is dark grayish brown to grayish brown. The C horizon is commonly thinly stratified with somewhat more sandy or loamy material.

Wann soils are near Kanza, Leshara, Lesho, and Lincoln soils. They are more clayey throughout than Kanza and Lincoln soils. They are more sandy than Leshara and Lesho soils.

Wn—Wann loam. This nearly level soil is on the flood plains of Crooked Creek and the Cimarron River. Slopes are 0 to 1 percent. Included in mapping were small areas of Leshara and Lesho soils and soils that are similar to this Wann soil, but the surface layer is sandy loam.

This soil is not well suited to crops, and crops grown on it may be damaged by occasional flooding. Wheat and grain sorghum are the main crops. Occasional flooding is the major hazard. Conserving moisture and controlling soil blowing are concerns of management. Keeping crop residue on the surface is the most effective way of conserving moisture and controlling soil blowing. On suitable sites wind stripcropping can also be used to help control soil blowing.

Under irrigation this soil is suited to wheat and sorghum. Good management of irrigated areas includes maintenance and improvement of fertility, efficient use of irrigation water, and control of salinity. The use of a cropping system that includes a deep-rooted legume, the use of crop residue, and the use of commercial fertilizer help maintain and improve fertility. Occasional leaching of the soil by irrigation when the water table is low helps control salinity. Proper design of the irrigation system and other management practices that produce the most efficient use of irrigation water should be used. Some land leveling is needed to prepare the soil for gravity irrigation, but irrigating with a sprinkler system is more suitable because of the rapid water intake and moderately rapid permeability.

If this soil is used for range, it produces abundant forage from suitable native grasses. Using a proper stocking rate and practicing deferred grazing or rotation deferred grazing are essential. Proper location of fences, salt, and water helps distribute livestock over the range. Capability units IIw-2 dryland, IIw-2 irrigated; Subirrigated range site; Subirrigated Lowland windbreak suitability group.

Yahola Series

The Yahola series consists of deep, well-drained, gently sloping soils. These soils are on colluvial-alluvial foot slopes and fans along the valleys of the Cimarron River and Sand Creek. They formed in slightly altered, loamy, calcareous alluvium. The native vegetation is mid and tall grasses.

In a representative profile the surface layer is grayish-brown, calcareous sandy loam about 5 inches thick. The underlying material is light brownish-gray and very pale brown, calcareous sandy loam.

Permeability is moderately rapid, and available water capacity is moderate. Fertility is medium. Runoff is slow.

Most of the acreage is in native grasses. Some areas are cultivated. Most of the native grasses have been grazed so close that the tall grasses have been grazed out.

Representative profile of Yahola sandy loam, about 330 feet west and 330 feet south of the northeast corner of the southeast quarter of sec. 10, T. 35 S., R. 30 W :

A1—0 to 5 inches, grayish-brown (10YR 5/2) sandy loam, dark grayish brown (10YR 4/2) moist; weak, fine, granular structure; hard, friable; slight effervescence; moderately alkaline; gradual, smooth boundary.

C1—5 to 18 inches, light brownish-gray (10YR 6/2) sandy loam, dark grayish brown (10YR 4/2) moist; weak, medium, granular structure; hard, friable; slight effervescence; moderately alkaline; gradual, smooth boundary.

C2—18 to 60 inches, very pale brown (10YR 7/3) sandy loam, pale brown (10YR 6/3) moist; massive; slightly hard, friable; strong effervescence; moderately alkaline.

The A horizon ranges from 4 to 16 inches in thickness and is dark grayish brown to brown. Stratified fine sandy loam and loamy sand, in layers less than 5 inches thick, are common in the C horizon.

Yahola soils in Meade County are less red than the defined range for the series, but this difference does not alter the usefulness or behavior of the soils.

Yahola soils are near Likes soils. They are less sandy than those soils.

Yo—Yahola sandy loam. This gently sloping soil is on the high terrace along the valley of the Cimarron River and Sand Creek. Slopes are 1 to 3 percent. Included in mapping were small areas of Likes soils.

Most of this Yahola soil is in native grasses and used for grazing. In cultivated areas grain sorghum is a suitable dryfarmed crop. Soil blowing is a serious hazard unless the land is protected by an adequate vegetative cover. Maintaining continuous and adequate crop residue on the surface of the soil conserves moisture and helps control erosion. Stripcropping is also desirable.

In irrigated areas suitable crops are wheat, sorghum, alfalfa (fig. 17), and tame grasses. Good management of this soil under irrigation must provide control of erosion, efficient use of water, and maintenance of fertility and tilth. The use of crop residue and the use of commercial fertilizer help maintain and improve fertility and tilth. Sprinkler irrigation is the only practical type of irrigation because of the very rapid water intake and moderately rapid permeability.

If this soil is used for range, grazing must be managed so that the growth of the native grasses will be encouraged. This can be done by using a proper stocking rate and practicing deferred grazing or rotation deferred grazing. Proper location of fences, salt, and water helps distribute livestock over the range. Capability units IIIe-4 dryland, IIs-1 irrigated; Sandy Terrace range site; Sandy Upland windbreak suitability group.

Use and Management of the Soils

This section consists of several parts. The first describes the capability classification used by the Soil Conservation Service. The second part explains the principles of management for dryland and irrigated cropland and shows predicted yields of the principal crops grown under dryland and irrigation farming. Next, the range management, windbreak management, wildlife management, and engineering uses of the soils are described.

Capability Grouping

Some readers, particularly those who farm on a large scale, may find it practical to use and manage alike some of the different kinds of soil on their farm. These readers can make good use of the capability classification system, a grouping that shows, in a general way, the suitability of soils for most kinds of farming.

The grouping is based on permanent limitations of soils when they are used for field crops, the risk of damage when they are farmed, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations for range, for forest trees, or for engineering.

In the capability system, all kinds of soil are grouped at three levels: the class, the subclass, and the unit. The broadest grouping, the capability class, is designated by Roman numerals I to VIII. In class I are the soils that have the fewest 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 subclass indicates major kinds of limitations within the classes. Within most of the classes there can be as many as four subclasses. The subclasses are indicated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral; for example, *IIe*. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* means that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c* 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 the subclasses w, s, and c, because the soils are subject to little or no erosion but have other limitations that confine their use largely to pasture, range, or wildlife habitat.

Subclasses are further divided into capability units. These are groups of soils that are so much alike that they are suited to the same crops and pasture plants, require about the same management, and have generally similar productivity and other responses to management. Capability units are generally identified by numbers assigned locally; for example, *IIe-1* or *IIs-1*.

The eight classes in the capability system in Meade County and their subclasses and units are described in the list that follows. The unit designation for each soil is in the "Guide to Mapping Units."

Class I. Soils have few limitations that restrict their use. The low rainfall in Meade County restricts this class to irrigated soils.

Unit I-1. Deep, nearly level, well-drained soils that have a surface layer of loam, silt loam, clay loam, or silty clay loam and a subsoil of silty clay loam or clay loam.

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

Subclass IIe. Soils on uplands that are subject to moderate erosion unless protected.

Unit IIe-1. Deep, gently sloping, well-drained soils that have a surface layer of loam, silt loam, or silty clay loam and a subsoil of silty clay loam or clay loam.

Unit IIe-2. Deep, nearly level and gently sloping or gently undulating, well-drained soils that have a surface layer of fine sandy loam and clay loam and a subsoil of fine sandy loam, clay loam, or sandy clay loam.

Unit IIe-3. Deep, gently sloping, well-drained soils that have a surface layer of silt loam or clay loam and a subsoil of calcareous silty clay loam or clay loam.

Subclass IIw. Soils on flood plains that have moderate limitations because of excess water.

Unit IIw-1. Deep, nearly level, somewhat poorly drained soils that have a surface layer and subsoil of clay loam.

Unit IIw-2. Deep, nearly level, somewhat poorly drained soils that have a surface layer of loam and a subsoil of fine sandy loam.

Subclass IIs. Soils on uplands that have moderate limitations because of limited moisture capacity or slow permeability.

Unit IIs-1. Deep, nearly level to gently sloping, well-drained soils that have a surface layer and subsoil of fine sandy loam or sandy loam.

Unit IIs-2. Deep, nearly level, well-drained soils that have a surface layer of silty clay loam and a subsoil of silty clay.

Subclass IIc. Soils on uplands that are limited only by climate.

Unit IIc-1. Deep, nearly level, well-drained soils that have a surface layer of loam, silt loam, clay loam, or silty clay loam and a subsoil of silty clay loam or clay loam.

Unit IIc-2. Deep, nearly level, well-drained soils that have a surface layer of silt loam and a subsoil of silty clay loam.

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

Subclass IIIe. Soils on uplands that are subject to severe erosion if they are cultivated and not protected.

Unit IIIe-1. Deep, gently sloping and sloping, well-drained and somewhat excessively drained soils that have a surface layer of calcareous silt loam, clay loam, and silty clay loam and a subsoil of calcareous silty clay loam or clay loam.

Unit IIIe-2. Deep, nearly level to gently rolling, well-drained soils that have a surface layer and subsoil of loamy fine sand.

Unit IIIe-3. Deep, gently rolling, well-drained soils that have a surface layer and subsoil of fine sandy loam.

Unit IIIe-4. Deep, gently sloping, well-drained soils that have a surface layer and subsoil of sandy loam.

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

Unit IIIw-3. Moderately deep, nearly level, somewhat poorly drained soils that have a surface layer and subsoil of clay loam and a substratum of sand.

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

Subclass IVe. Soils on uplands that are subject to very severe erosion if they are cultivated and not protected.

Unit IVe-1. Deep, gently rolling, well-drained soils that have a surface layer and subsoil of loamy fine sand.

Unit IVe-2. Deep, sloping, well-drained, eroded, calcareous soils that have a surface layer and subsoil of clay loam or silty clay loam.

Unit IVe-3. Deep, gently rolling, well-drained soils that have a surface layer and subsoil of fine sandy loam.

Unit IVe-4. Deep, gently rolling to rolling, well-drained soils that have a surface layer of fine sand and a subsoil of loamy fine sand.

Subclass IVw. Soils on flood plains that have very severe limitations because of excess water. None in Meade County.

Subclass IVs. Soils that have very severe limitations because of very slow permeability or poor tilth.

Unit IVs-1. Deep, nearly level, poorly drained, compact clay soils.

Class V. Soils are subject to little or no erosion but have other characteristics that limit their use largely to pasture or range, woodland, or wildlife habitat.

Subclass Vw. Soils on flood plains that have severe limitations because of excess water.

Unit Vw-1. Moderately deep to deep, nearly level and channeled, frequently flooded soils that have a surface layer of clay loam or loamy fine sand and underlying material of loamy fine sand or sand.

Class VI. Soils have severe limitations that make them unsuited to cultivation and restrict their use largely to pasture or range, woodland, or wildlife habitat.

Subclass VIe. Soils that have severe limitations, chiefly because of hazard of erosion unless protective cover is maintained.

Unit VIe-1. Deep, strongly sloping, well-drained soils that have a surface layer and subsoil of clay loam.

Unit VIe-2. Deep, gently sloping to rolling loamy fine sands.

Unit VIe-3. Deep, strongly sloping, somewhat excessively drained soils that have a surface layer and subsoil of fine sandy loam.

Unit VIe-4. Shallow and deep, strongly sloping, well-drained and somewhat excessively drained soils that are calcareous loam over caliche.

Unit VIe—5. Strongly sloping to steep, calcareous sandy loams and clay loams.

Subclass VIw. Soils that have severe limitations because of excess water and are generally unsuitable for cultivation.

Unit VIw-1. Deep, nearly level and channeled, frequently flooded loamy soils.

Unit IVw-2. Deep, poorly drained, compact clay soils in upland depressions.

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

Subclass VIIe. Soils that have very severe limitations because of the hazard of soil blowing, the low available water capacity, and the low natural fertility.

Unit VIIe-1. Deep, excessively drained, fine sands on hills.

Subclass VIIs. Soils that have very severe limitations because of steep slopes and rough, broken topography.

Unit VIIs-1. Steep, rough, broken, eroded material and some shallow soils.

Class VIII. Soils and landforms have limitations that preclude their use for commercial crops and restrict their use to recreation, wildlife habitat, water supply, or esthetic purposes. (None in Meade County.)

Managing Dryland Soils [2]

In Meade County the management of soils for dryland crops involves a combination of practices that reduce water erosion and soil blowing, help maintain good soil structure, help maintain adequate organic-matter content, and conserve as much rainfall as possible. Control of erosion and conservation of water are most successful if a proper combination of practices is used.

Terracing and contour farming can be used to reduce water erosion and help conserve rainfall on all of the sloping soils in the county. These practices, alone or in combination, can also be beneficial on some nearly level soils that have long slopes. Each row planted on the contour acts as a miniature terrace by holding back water and letting it soak into the soil. The water that is saved by terracing and contouring increases crop growth, which in turn adds to the amount of residue available to protect the soil against erosion.

Crop residue should be kept on the surface of all the soils in Meade County. Proper management of crop residue helps maintain good soil structure, increases the infiltration rate, and helps control both water erosion and soil blowing.

Minimum or reduced tillage helps prevent the breakdown of soil aggregates and maintains more residue on the surface. Tilling when the soil is too wet results in the formation of a tillage pan, particularly in the loam and silt loam soils.

Stripcropping is another measure that can be used to control soil blowing. Stripcropping is generally used in combination with good management of crop residue, minimum tillage, and a good fertility program. Stripcropping is especially applicable to some of the nearly level soils that have a surface layer of sandy loam or loam.

Wheat and grain sorghum are the major crops grown in Meade County. Some alfalfa is also grown. It is mainly grown on bottom land, but some is grown on uplands. Forage sorghum is also grown. The sequence of crops that are grown affects the combination of practices needed on a particular soil. Close-growing crops, such as wheat, provide more protection for the soil than row crops.

Predicted yields of dryland crops

The predicted average yields per acre that can be expected for the principal dryland crops grown in Meade County are shown in table 2. These yields do not apply to any specific field in any particular year. Rather, they indicate what can be expected as an average yield over a period of years. The estimates in the table were made on the basis of information obtained from local farmers, various farm agencies, demonstration plots, and research data.

Only soils that are commonly used for crops are listed in table 2. The predicted yields are for a high level of management. Such management includes the following:

1. Crop varieties suited to the area.
2. Proper seeding rates and suitable and timely methods of planting and harvesting.
3. Full and timely use of practices for controlling weeds, diseases, and insects.
4. Timely tillage.
5. Fertility program based on requirements for optimum efficiency in production of crops.
6. Use of terraces, contour farming, grassed water-

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

[Only arable soils are listed]

Soils	Wheat	Grain sorghum
	Bu	*Bu*
Harney silt loam, 0 to 1 percent slopes	28	43
Harney silt loam, 1 to 3 percent slopes	26	40
Harney silty clay loam, 1 to 3 percent slopes, eroded	22	34
Leshara clay loam	22	36
Lesho clay loam	18	25
Mansic clay loam, 0 to 1 percent slopes	22	29
Mansic clay loam, 1 to 3 percent slopes	20	27
Mansic clay loam, 3 to 6 percent slopes	17	23
Mansic clay loam, 3 to 6 percent slopes, eroded	15	20
Mansic-Manter complex, 1 to 4 percent slopes	21	33
Manter fine sandy loam, 0 to 1 percent slopes	24	44
Manter fine sandy loam, 1 to 3 percent slopes	22	42
Manter fine sandy loam, 1 to 3 percent slopes, eroded	20	38
Manter-Satanta fine sandy loams, 1 to 4 percent slopes	22	43
Missler silty clay loam, 0 to 1 percent slopes	22	31
Missler silty clay loam, 1 to 6 percent slopes	18	28
Otero-Manter fine sandy loams, 3 to 6 percent slopes	18	37
Pratt soils, 0 to 5 percent slopes	22	39
Roxbury silt loam	30	48
Satanta fine sandy loam, 0 to 2 percent slopes	24	44
Satanta loam, 0 to 1 percent slopes	26	42
Satanta loam, 1 to 3 percent slopes	24	40
Spearville silty clay loam, 0 to 1 percent slopes	22	30
Uly silt loam, 0 to 1 percent slopes	24	40
Uly silt loam, 1 to 3 percent slopes	22	38
Uly silt loam, 1 to 3 percent slopes, eroded	20	34
Uly silt loam, 3 to 6 percent slopes	20	32
Uly silt loam, 3 to 6 percent slopes, eroded	18	28
Wann loam	24	40
Yahola sandy loam	22	38

[2] By EARL J. BONDY, agronomist, Soil Conservation Service, Salina, Kansas.

ways, stubble-mulch tillage, and summer fallow to conserve moisture and control runoff.
7. Use of a cropping system and management of crop residue to control water erosion and soil blowing and to keep soil in good physical condition.

Managing Irrigated Soils [3]

The factors to be considered in planning an irrigation system are (1) the characteristics and properties of the soil, (2) the quality and quantity of irrigation water available, (3) the crops to be irrigated, and (4) the type of system to be used for irrigation (fig. 18). It is especially important to know the quality of the irrigation water so that the long-time effect of irrigation on the soil can be evaluated. All natural waters used for irrigation contain some soluble salts. If water of poor quality is used on a soil that is slowly permeable, harmful salts are likely to accumulate in the soil if some leaching is not done. This requires an application of water in excess of the needs of the crops so that some of the water passes through the root zone.

Some of the soil factors that are important to irrigation are depth, available water capacity, permeability, drainage, slope, and susceptibility to stream overflow. All of these must be considered in designing the irrigation system. The frequency of irrigation depends on the requirements of the crop and the available water capacity of the soil. The available water capacity is determined mainly by the depth and texture of the soil. Permeability affects the rate at which water enters the soil and, also, the internal drainage. The rate of water intake is also affected by the condition of the surface layer.

The soil survey has determined the characteristics of each soil in the county. Permeability and available water capacity are listed for each soil in table 6 in the section "Engineering Uses of the Soils." Soil features affecting the use of soils for irrigation are shown in table 7 in the same section.

Wheat, corn, grain sorghum (fig. 19), forage sorghum, and alfalfa are the main crops grown under irrigation in Meade County.

Predicted yields of irrigated crops

The predicted average yields per acre that can be expected for the principal irrigated crops grown in Meade County are shown in table 3. The predicted yields of these soils are based on information obtained from local farmers and other farm workers.

Only soils that are most commonly irrigated are listed in table 3. The predicted yields are for a high level of management. Such management includes the following:

1. An irrigation system that provides uniform penetration of water and, also, control of erosion. Land leveling, contour furrowing, and using gated pipe and underground pipe are among the practices applied.
2. Timely tillage.
3. A cropping system that includes legumes, close-growing crops, and row crops.
4. Adapted crop varieties.

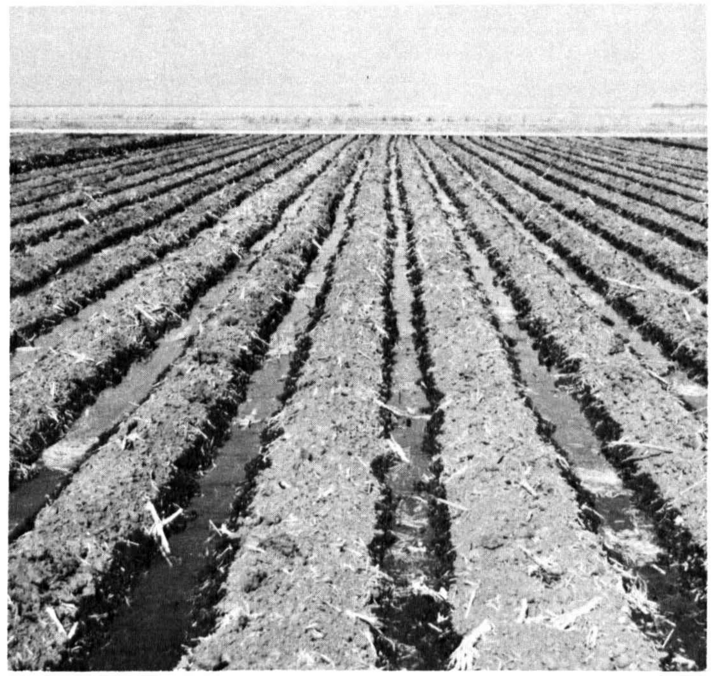

Figure 18.—Preirrigation prior to seeding on a freshly worked field. The soil is Harney silt loam, 0 to 1 percent slopes.

5. Seeding at a rate that insures a maximum plant population.
6. Properly applied irrigation water.
7. Amounts and kinds of fertilizer that produce the level of fertility needed for optimum yields of the particular crop.
8. Manure, when available, is used to maintain the organic-matter content.

Range Management [4]

Range makes up about 263,500 acres, or 43 percent of the total area of Meade County. Predominant areas of range are in the southern half and the northeastern part of the county. The balance of range occurs in smaller units throughout the county. Range is used mainly by domestic livestock. Yearling cattle operations outnumber cow-calf users. A small acreage is used for hay.

In addition to domestic livestock, a variety of native wildlife species make use of the range. Some of the wildlife that make multiple use of range are white-tailed deer, muledeer, lesser prairie chicken, Rio Grande turkeys, quail, and ringneck pheasants. Most of them depend on range to some extent for their survival and protection.

Range sites and condition classes

A range site is a distinctive kind of range that differs from other kinds of range in its potential to produce native plants. Major differences result from differences in soil depth, texture, permeability, and topography.

[3] By EARL J. BONDY, agronomist, Soil Conservation Service, Salina, Kansas.

[4] By LOREN J. PEARSON, range conservationist, Soil Conservation Service.

Figure 19.—Irrigated grain sorghum on Spearville silty clay loam, 0 to 1 percent slopes.

In the absence of abnormal disturbances, a range site supports a mixture of native plants best adapted to the soil and the environmental conditions of the site. This plant cover is called the natural potential, or climax, plant community. The climax vegetation is generally the most productive combination of range plants that a site is capable of growing under natural conditions.

Under proper grazing management, a mixture of plants representative of the climax community can be maintained indefinitely. If a site is subjected to continuous excessive grazing, however, the climax cover is altered. Plants within the climax vegetation are not equally palatable to grazing animals. Livestock graze selectively, continually seeking the more palatable plants. Unless grazing is regulated, these preferred plants become overgrazed. All range plants are placed in three categories: decreasers, increasers, and invaders. These categories are based on response of the plants to continuous overgrazing.

Decreaser plants are the most palatable plants in the climax community. They decrease in abundance if the site is subject to continued excessive grazing. Increaser plants are less palatable plants in the climax community that increase in abundance if the site is continually overgrazed. Under prolonged excessive grazing, decreaser plants are largely eliminated and increaser plants may dominate the site. Invader plants are not present in the climax plant community for the site. They invade as a result of various kinds of disturbances on the site, such as prolonged excessive grazing, drought, fire, and infestations of rodents and insects.

Changes in the vegetation within each range site can be determined by comparing the present vegetation to the climax vegetation for that site. This is expressed as *range condition.* It provides a measure of the changes that have taken place in the plant cover and provides a basis for predicting the amount of improvement that can be expected in

TABLE 3.—*Predicted average yields per acre of the principal irrigated crops on soils most commonly irrigated*

Soil	Wheat	Grain sorghum	Forage sorghum	Alfalfa	Corn
	Bu	*Bu*	*Tons*	*Tons*	*Bu*
Harney silt loam, 0 to 1 percent slopes	50	115	22	6	120
Satanta loam, 0 to 1 percent slopes	50	115	24	6	120
Spearville silty clay loam, 0 to 1 percent slopes	45	100	21	6	105
Uly silt loam, 0 to 1 percent slopes	50	115	23	6	120

the plant community from proper management.

Four range condition classes are recognized. A range site is in *excellent* condition if 76 to 100 percent of the climax vegetation is present on the site; in *good* condition if 51 to 75 percent is present; in *fair* condition if 26 to 50 percent is present; and in *poor* condition if 0 to 25 percent is present.

Major changes or trends in range vegetation take place so gradually that they are often overlooked unless the operator is familiar with the characteristics of the range sites and the response of different kinds of plants to grazing. Sometimes, during periods of favorable rainfall, plant growth is stimulated, giving the appearance of range improvement when actually the long-term trend is toward less palatable grasses and lower production. On the other hand, a dry season may result in overgrazing of a healthy range and cause it to appear degraded when actually the setback is only seasonal or temporary.

Descriptions of range sites

On the following pages the range sites of Meade County are described and the climax plants and principal invaders on the sites are named. Also shown is an estimate of the potential annual yield of air-dry herbage for each site if it is in excellent condition. The soils in each site can be determined by referring to the Guide to Mapping Units at the back of this soil survey.

CLAY UPLAND RANGE SITE

This range site consists of soils in the Missler and Spearville series. These are deep soils that have a surface layer of silty clay loam and a subsoil of silty clay or silty clay loam. The density of these soils restricts the downward movement of water, making this site droughty. Careful management of the soils generally maintains the site in a productive state.

If this site is in excellent condition, such decreasers as side-oats grama and western wheatgrass make up as much as 70 percent of the total production, and increasers account for the rest. The common decreaser plants growing on this site are side-oats grama, western wheatgrass, big bluestem, slimflower scurf-pea, and dotted gayfeather. Increasers are blue grama, buffalograss, red three-awn, tall dropseed, western ragweed, prairie coneflower, and pricklypear. The common invaders are silver bluestem, windmillgrass, tumblegrass, and annuals.

If this site is in excellent condition, the average annual yield of air-dry herbage is about 2,400 pounds per acre. Production ranges from 4,000 pounds per acre in favorable years to 800 pounds in unfavorable years.

Generally, this site is in fair condition and buffalograss and blue grama provide most of the forage.

LOAMY LOWLAND RANGE SITE

Only Alluvial land, loamy, is in this range site. This is a deep, loamy, alluvial soil. Fertility is generally high, making this a highly productive site, especially during periods of above-average rainfall. Additional water from adjacent stream overflow also adds to productivity.

If this site is in excellent condition, such decreasers as big bluestem and indiangrass make up as much as 90 percent of the total production, and increasers account for the rest. The common decreaser plants growing on this site are big bluestem, indiangrass, little bluestem, switchgrass, and Canada wildrye. Increasers are western wheatgrass, side-oats grama, blue grama, tall dropseed, buffalograss, western ragweed, and vine-mesquite. The common invaders are Kentucky bluegrass, silver bluestem, windmillgrass, tumblegrass, kochia, common sunflower, and annuals.

If this site is in excellent condition, the average annual yield of air-dry herbage is about 4,800 pounds per acre. Production ranges from 6,000 pounds in favorable years to 3,800 pounds in unfavorable years. This potential production makes this one of the better range sites in the county.

LOAMY TERRACE RANGE SITE

Only Roxbury silt loam is in this range site. This is a deep soil that has a surface layer of silt loam and a subsoil of silty clay loam. It receives some runoff from nearby uplands.

If this site is in excellent condition, such decreasers as big bluestem and indiangrass make up as much as 80 percent of the total production, and increasers account for the rest. The common decreaser plants growing on this site are switchgrass, big bluestem, indiangrass, little bluestem, Canada wildrye, and ashy goldenrod. Increasers are western wheatgrass, side-oats grama, blue grama, buffalograss, tall dropseed, western ragweed, heath aster, and vine-mesquite. The common invaders are silver bluestem, windmillgrass, tumblegrass, and other annuals.

If this site is in excellent condition, the average annual yield of air-dry herbage is about 3,500 pounds per acre. This production ranges from 4,500 pounds in favorable years to 2,500 pounds in unfavorable years. This site generally produces more forage than the Loamy Upland range sites and less than the Loamy Lowland range site.

LOAMY UPLAND RANGE SITE

This range site consists of soils in the Harney, Satanta, and Uly series. These are deep soils that have a surface layer of silt loam or loam and a subsoil of silty clay loam or clay loam.

If this site is in excellent condition, such decreasers as big bluestem and little bluestem make up as much as 60 percent of the total production, and increasers account for the rest. The common decreaser plants growing on this site are big bluestem, little bluestem, side-oats grama, Canada wildrye, and dotted gayfeather. Increasers are blue grama, buffalograss, western wheatgrass, tall dropseed, western ragweed, prairie coneflower, and pricklypear. The common invaders are windmillgrass, tumblegrass, silver bluestem, and other annuals.

If this site is in excellent condition, the average annual yield of air-dry herbage is about 2,400 pounds per acre. Production ranges from 4,000 pounds in favorable years to 1,000 pounds in unfavorable years.

Generally, this site is in fair condition and buffalograss and blue grama provide most of the forage.

LIMY UPLAND RANGE SITE

This range site consists of soils in the Campus, Mansic, and Uly series. These are deep soils that have a surface layer of clay loam or silt loam and a subsoil of clay loam or silty clay loam (fig. 20).

If this site is in excellent condition, such decreasers as side-oats grama and little bluestem make up as much as 75 percent of the total production, and increasers account for the rest. The common decreaser plants growing on this site are bluestem, little bluestem, side-oats grama, switchgrass, indiangrass, Canada wildrye, and prairie-clover.

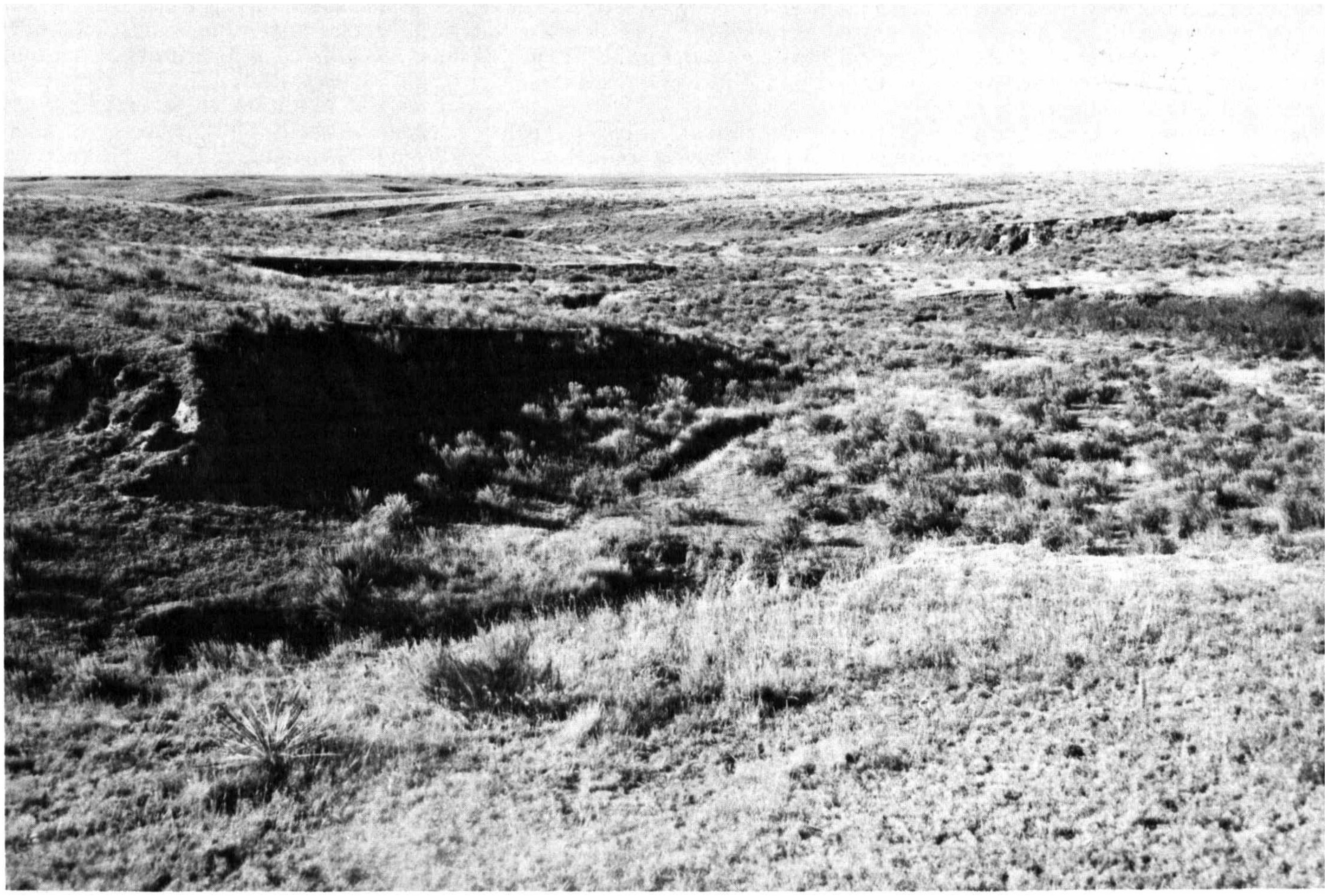

Figure 20.—Typical area of a Mansic clay loam on Limy Upland range site.

Increasers are blue grama, hairy grama, buffalograss, tall dropseed, western wheatgrass, broom snakeweed, and western ragweed. The common invaders are silver bluestem, tumblegrass, windmillgrass, and annuals.

If this site is in excellent condition, the average annual yield of air-dry herbage is about 2,500 pounds per acre. Production ranges from 4,000 pounds per acre in favorable years to 1,000 pounds in unfavorable years.

Generally, this site is in fair condition and blue grama and buffalograss provide most of the forage. Broom snakeweed increases during periods of drought and overuse.

SANDS RANGE SITE

This range site consists of soils in the Likes and Pratt series. The Likes soil has a surface layer of loamy sand and underlying material of loamy sand or fine sand. The Pratt soil has a surface layer of loamy fine sand or sand and subsoil of loamy fine sand or loamy sand. Maintaining an adequate cover to protect these soils from soil blowing is the main concern of management (fig. 21).

If this site is in excellent condition, such decreasers as sand bluestem and indiangrass make up as much as 85 percent of the total production, and increasers account for the rest. The common decreaser plants growing on this site are sand bluestem, little bluestem, switchgrass, indiangrass, sand lovegrass, giant sandreed, and lemon scurf-pea. Increasers are side-oats grama, blue grama, hairy grama, western ragweed, sand sagebrush, purple lovegrass, sand dropseed, and Scribners panicum. The common invaders are showy gaillardia, six-weeks three-awn, false buffalograss, and annual eriogonum.

If this site is in excellent condition, the average annual yield of air-dry herbage is about 3,000 pounds per acre. Production ranges from 3,500 pounds in favorable years to 2,000 pounds in unfavorable years. In many areas of this site, sand sagebrush is a concern and requires special management (fig. 22).

SANDY LOWLAND RANGE SITE

Only Lincoln soils are in this range site. These are deep soils that have a surface layer of loamy fine sand or sand and are underlain by sand (fig. 23). They sometimes receive additional water in the form of flooding.

If this site is in excellent condition, such decreasers as sand bluestem and indiangrass make up as much as 90 percent of the total production, and increasers account for the rest. The common decreaser plants growing on this site are sand bluestem, big bluestem, little bluestem, sand lovegrass, switchgrass, and indiangrass. Increasers are blue grama, side-oats grama, western wheatgrass, sand sagebrush, pricklypear, and vine-mesquite. The common invaders are windmillgrass, tumblegrass, annual brome, cocklebur, and other annuals.

If this site is in excellent condition, the average annual yield of air-dry herbage is about 4,000 pounds per acre. Production ranges from 4,500 pounds in favorable years to 3,500 pounds in unfavorable years.

SANDY TERRACE RANGE SITE

Only Yahola sandy loam is in this range site. This is a deep soil that has a surface layer and underlying material of sandy loam.

If this site is in excellent condition, such decreasers as sand bluestem make up as much as 70 percent of the total production, particularly in low-lying areas, and increasers account for the rest. If the site is overgrazed, invader species reduce the carrying potential. The common decreaser plants growing on this site are sand bluestem, little bluestem, switchgrass, side-oats grama, sand lovegrass, and Canada wildrye. Increasers are blue grama, buffalograss, western wheatgrass, sand dropseed, sand paspalum, Scribners panicum, western ragweed, and vine-mesquite. The common invaders are windmillgrass, tumblegrass, annual three-awn, sandbur, common sunflower, annual eriogonum, and other annuals.

If this site is in excellent condition, the average annual yield of air-dry herbage is about 2,400 pounds per acre. Production ranges from 3,000 pounds in favorable years to 1,600 pounds in unfavorable years.

SANDY RANGE SITE

This range site consists of soils in the Manter, Satanta, and Otero series. The Manter and Satanta soils have a surface layer of fine sandy loam and a subsoil of fine sandy loam or sandy clay loam. The Otero soil is fine sandy loam throughout.

If this site is in excellent condition, such decreasers as sand bluestem make up as much as 80 percent of the total production, and increasers account for the rest. The common decreaser plants growing on this site are sand bluestem, big bluestem, little bluestem, switchgrass, indiangrass, sand lovegrass, and prairie sandreed. Increasers are sand dropseed, blue grama, hairy grama, buffalograss, sand paspalum, and sand sagebrush. The common invaders are silver bluestem, annual three-awn, windmillgrass, annual brome, and annual eriogonum.

If this site is in excellent condition, the average annual yield of air-dry herbage is about 2,400 pounds per acre. Production ranges from 3,000 pounds in favorable years to 1,800 pounds in unfavorable years.

CHOPPY SANDS RANGE SITE

This range site consists of Tivoli soils and Blown-out land. Generally, they have a surface layer of loamy fine sand or fine sand and underlying material of fine sand. If this site is overused, leaving the soil unprotected, it is highly susceptible to soil blowing.

If this site is in excellent condition, such decreasers as sand bluestem and prairie sandreed make up as much as

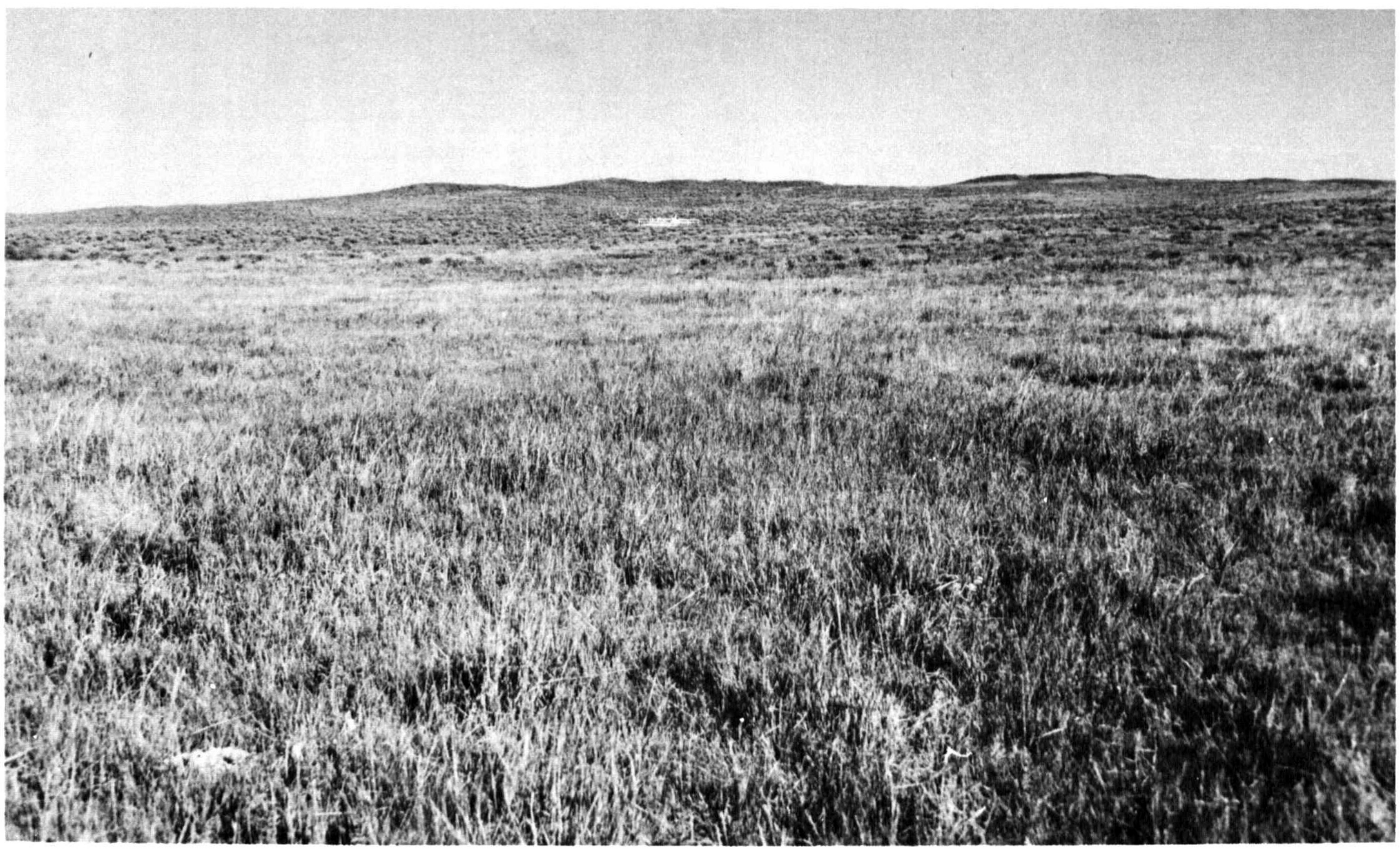

Figure 21.—Area of Sands range site in good condition on a Likes soil along the Cimarron River. An area of the Otero-Mansic complex, 5 to 25 percent slopes, is in the background.

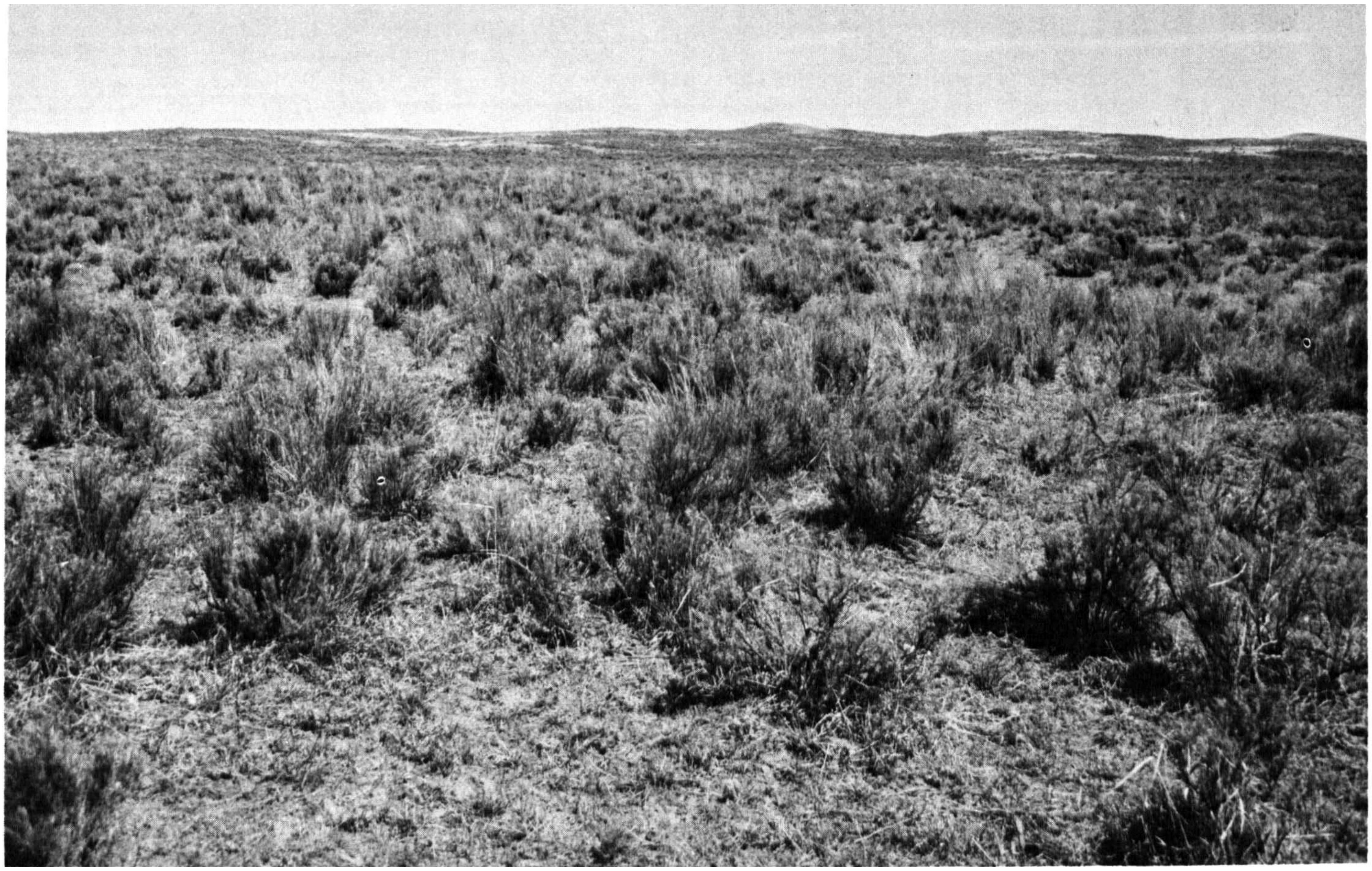

Figure 22.—Sand sagebrush on Likes loamy sand.

75 percent of the total production, and increasers account for the rest. The common decreaser plants growing on this site are sand bluestem, little bluestem, indiangrass, prairie sandreed, blowoutgrass, and sand lovegrass. Increasers are sand dropseed, and paspalum, blue grama, hairy grama, sand sagebrush, and perennial three-awn. The common invaders are false buffalograss, annual three-awn, red lovegrass, sandbur, common sunflower, and other annuals.

If this site is in excellent condition, the average annual yield of air-dry herbage is about 1,800 pounds per acre. Production ranges from 2,300 pounds in favorable years to 1,300 pounds in unfavorable years.

SHALLOW LIMY RANGE SITE

This range site consists of Canlon soils and Rough broken land. These soils are shallow over caliche. In many places the rough, broken topography makes the site difficult for livestock to utilize (fig. 24).

If this site is in excellent condition, such decreasers as little bluestem and side-oats grama make up as much as 70 percent of the total production, and increasers account for the rest. The common decreaser plants growing on this site are little bluestem, indiangrass, big bluestem, Canada wildrye, switchgrass, western wheatgrass, prairie-clover, and Jerseytea. Increasers are blue grama, hairy grama, buffalograss, side-oats grama, broom snakeweed, purple three-awn, and babywhite aster. Annuals are the common invaders.

If this site is in excellent condition, the average annual yield of air-dry herbage is about 1,400 pounds per acre. Production ranges from 1,600 pounds in favorable years to 800 pounds in unfavorable years.

SUBIRRIGATED RANGE SITE

This range site consists of soils in the Kanza, Leshara, Lesho, and Wann series. These are deep to moderately deep soils that have a surface layer of clay loam or loam and underlying material of clay loam, fine sandy loam, or sand. They receive extra moisture from floods and from a high water table.

If this site is in excellent condition, such decreasers as big bluestem, indiangrass, switchgrass, and prairie cordgrass make up 90 percent of the total production (fig. 25), and increasers account for the rest. The common decreaser plants growing on this site are big bluestem, indiangrass, switchgrass, eastern gamagrass, little bluestem, prairie cordgrass, and Illinois bundleflower. Increasers are side-oats grama, western wheatgrass, blue grama, western ragweed, buffalograss, and foxtail barley. The common invaders are silver bluestem, windmillgrass, annual brome, common sunflower, and other annuals.

If this site is in excellent condition, the average annual yield of air-dry herbage is about 7,500 pounds per acre. The subirrigated condition of this site reduces the effect of climate on production.

Windbreak Management

There are no large areas of woodland in Meade County. The flood plains of Crooked Creek and the Cimarron River support a sparse, mixed stand of eastern cottonwood, tamarisk, and other trees and shrubs. These trees and shrubs grow well in areas where additional moisture is received. They provide some protection for livestock as well as food and cover for wildlife. They also help to stabilize the streambank. Trees and shrubs are planted for windbreaks, shade, or ornamental purposes in the county.

Windbreak plantings protect farmsteads and feedlots. They also improve the appearance of the farmstead and provide food and cover for wildlife.

Windbreaks should be carefully planned to fit conditions of the soil and the site. Cultivation is necessary to control weeds and to give the trees maximum use of available moisture. Any extra water that can be provided by irrigation water or runoff diverted from surrounding areas is beneficial.

Several of the soils in Meade County are not suitable for windbreak plantings. Those that are suitable have been placed in four groups. To find the windbreak suitability group number for a specific soil, refer to the Guide to Mapping Units at the back of this survey.

Table 4 lists the height, in feet, that specific kinds of trees and shrubs will reach in 10 years, in irrigated and dryland windbreak suitability groups. The data in table 4 were obtained from the Soil Survey Reports of Finney, Grant, Haskell, Kearney, and Logan Counties.

More information about the planting and care of trees and shrubs in farmstead windbreaks can be obtained from the local representative of the Soil Conservation Service or from the county agent.

Wildlife Management [5]

Soil suitability is a valuable tool in planning, developing, and managing areas for wildlife. Land use, existing wildlife populations, and other factors require onsite evaluations. Knowing the properties of named kinds of soil makes it possible to manipulate soil, water, and plants to produce a suitable habitat and to maintain and improve wildlife populations.

The history of our land and wildlife, interpreted in the context of modern ecological knowledge, is a study of "management experiments." There is no doubt, however, concerning the key role played by vegetation in determining the nature of animal communities and the density of populations. A desired wildlife species can be "managed" only by first understanding its place in the succession of communities and then finding the means of renewing, through effective and practicable kinds of "disturbance," the conditions in which it lives. Every environmental change must be viewed as a balance of values, because the

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

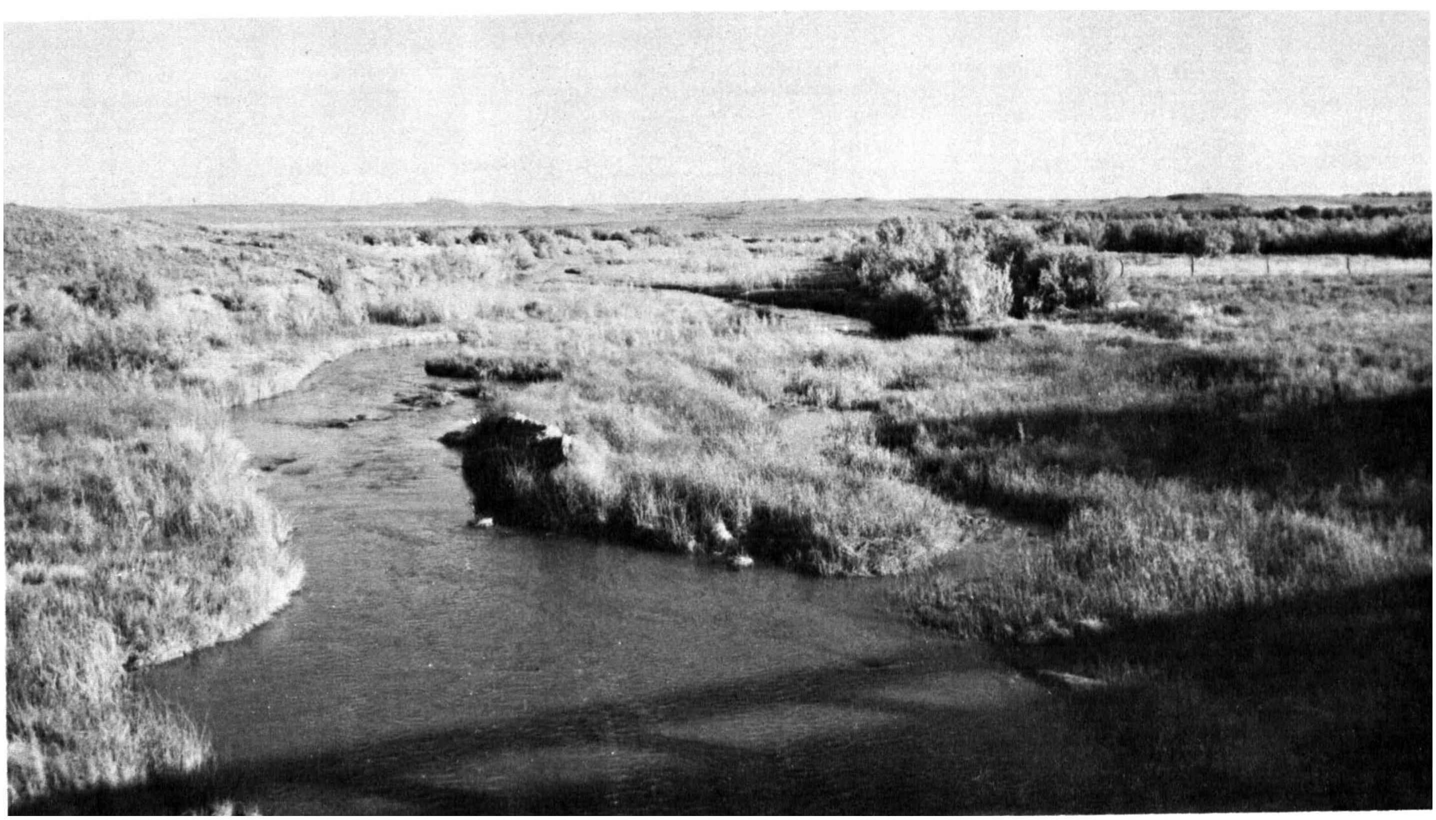

Figure 23.—Area of a Sandy Lowland range site in good condition along Crooked Creek. The soils are in the Lincoln series.

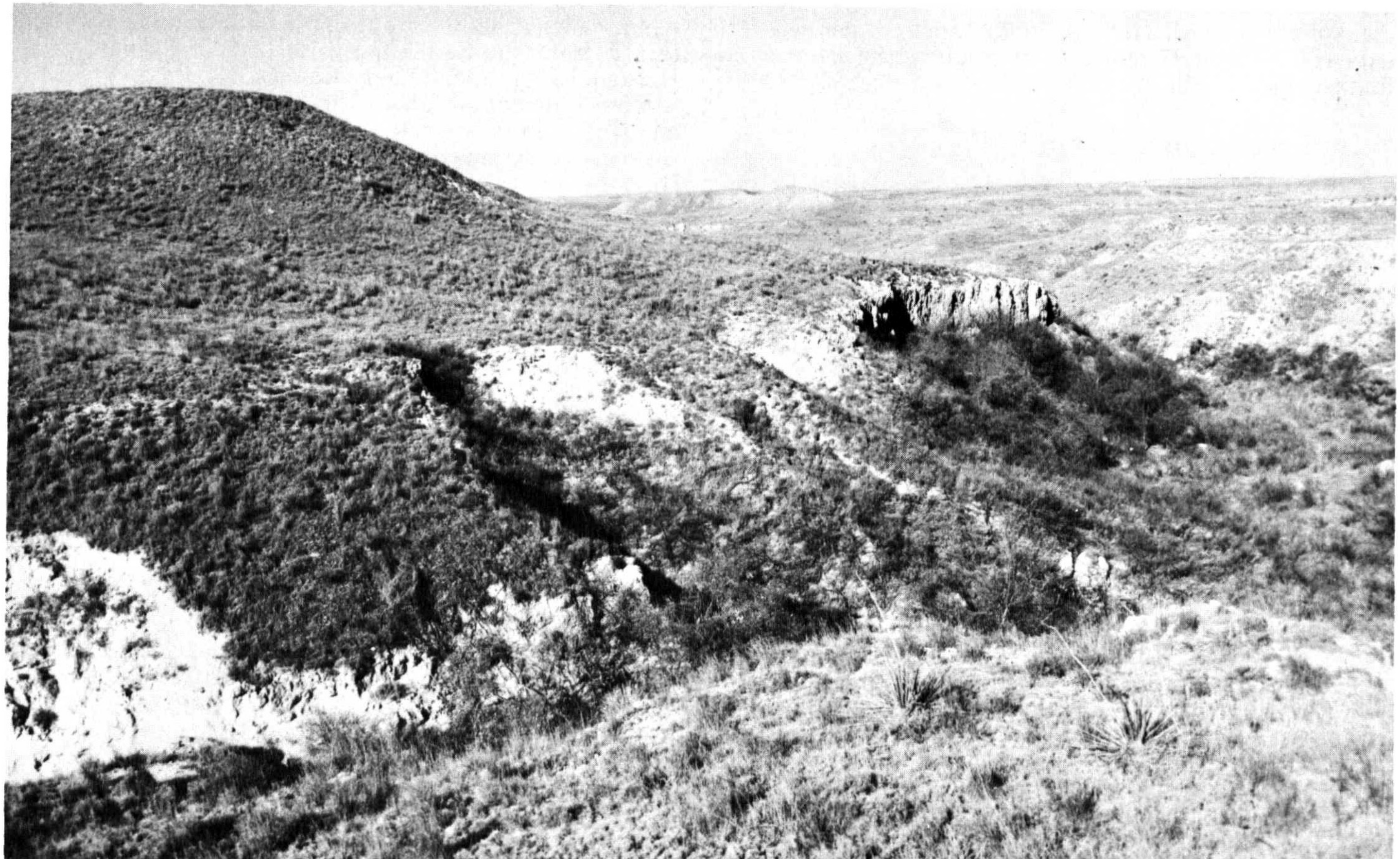

Figure 24.—Steep areas and caliche outcrops characterize the Canlon soils on the Shallow Limy range site. These steep areas are especially difficult to manage.

processes that wipe out one organism may very well benefit another.

Wildlife management, if it is to serve the vast numbers and diverse interests of people, must be intensive and purposeful. A balance of values must be established as we fashion our way of life for the future.

Wildlife responds to the differences in soils. This response is favorable on suitable soils and poor on soils that are not suitable to meet the needs of the animal concerned. Therefore, each soil is rated on the basis of its capacity to furnish grain and seed crops, grasses and legumes, wild herbaceous upland plants, hardwood woody plants, conif-

TABLE 4.—*Trees and shrubs suitable for planting, by windbreak suitability groups*

[Height figures are estimated for each species at an age of 10 years]

Suitable trees and shrubs	Windbreak suitability groups							
	Silty Upland		Sandy Upland		Subirrigated Lowland		Lowland	
	Dryland	Irrigated	Dryland	Irrigated	Dryland	Irrigated	Dryland	Irrigated
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
Eastern redcedar	5	9	12	20	7	9	13	18
Honeylocust	12	22	14	24	17	30	16	23
Mulberry	15	20	17	24	16	22	17	24
Osageorange	12	22	13	22	10	16	15	22
Ponderosa pine	6	9	8	11	11	17	8	10
Rocky Mountain juniper	5	9	8	11	11	17	7	9
Russian-olive	12	22	13	22	14	22	14	22
Siberian elm [1]	22	32	25	35	24	30	27	32
Tamarisk	10	20	10	15	10	16	10	18

[1] Commonly called Chinese elm.

erous woody plants, wetland food and cover plants, shallow water developments, and ponds. Specific habitat elements are rated for each kind of soil in the county. These are used to approximate a general soil suitability rating for each kind of soil for openland, wetland, and rangeland wildlife, as indicated in table 5.

Openland wildlife are birds and mammals of croplands, pastures, meadows, lawns, and areas overgrown with grasses, herbs, shrubs, and vines. They include bobwhite quail, pheasant, meadowlark, field sparrow, killdeer, cottontail rabbit, red fox, and woodchuck.

Wetland wildlife are birds and mammals of swampy, marshy, or open-water areas. They include ducks, geese, herons, shore birds, rails, kingfishers, muskrat, and beaver (fig. 26).

Rangeland wildlife are birds and mammals of natural range. They include antelope, white-tailed deer, muledeer, bison, lesser prairie chicken, coyote, badger, jackrabbit, and prairie dog.

Engineering Uses of the Soils [6]

This section is useful to those who need information about soils used as structural material or as foundations upon which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among properties of soils highly important in engineering are permeability, strength, compaction characteristics, soil drainage condition, shrink-swell potential, grain size, plasticity, and soil reaction. Also important are depth to the water table, depth to bedrock, and soil slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan for drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built, for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 6, 7, and 8, which show, respectively, several estimated soil properties significant to engineering, interpretations for various engineering uses, and results of engineering laboratory tests on soil samples.

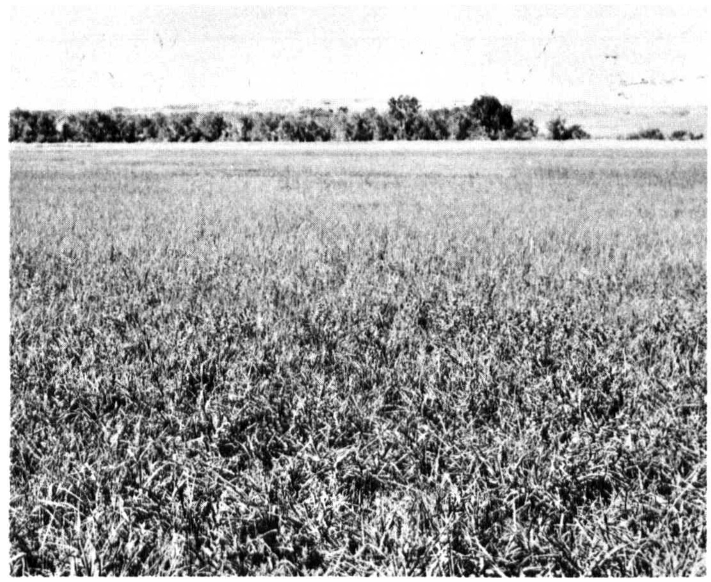

Figure 25.—An area of Kanza soils in the Subirrigated range site. This hayland meadow produces dominantly tall grasses, including eastern gamagrass in excellent condition.

This information, along with the soil map and other parts of this publication, can be used to make interpretations in addition to those given in table 7, and it also can be used to make other useful maps.

This information is not intended for use in design and does not eliminate the need for further investigation at sites selected for engineering works. The information in the tables is limited because estimates and interpretations were made for only the upper 6 feet of the soil material and because many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have special meaning to soil scientists but are not known to all engineers. The Glossary defines many of these terms as they are commonly used in soil science.

Engineering classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system, used by the Soil Conservation Service, Department of Defense, and other agencies, and the AASHTO system, adopted by the American Association of State Highway and Transportation Officials.

The Unified system (*2*) is used to classify soils according to engineering uses for building material or for the support of structures other than highways. Soils are classified according to particle-size distribution, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes. There are eight classes of coarse-grained soils that are subdivided on the basis of gravel and sand content. These are identified as GW, GP, GM, GC, SW, SP, SM, and SC. Six classes of fine-grained soils are subdivided on the basis of the plasticity and organic-matter content. Nonplastic classes are ML and MH; plastic classes are CL

[6] FRANCIS S. HOOPES, civil engineer, Soil Conservation Service, helped prepare this section.

TABLE 5.—*Suitability*

Soil series and map symbols	Elements of wildlife habitat				
	Grain and seed crops	Domestic grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants
Alluvial land, loamy: An.	Poor	Poor	Fair	Good	Good
Blown-out land: Bo	Very poor	Very poor	Very poor	Very poor	Very poor
Campus: Cc For Canlon part, see Canlon series.	Poor	Fair	Good	Poor	Poor
Canlon Mapped only in complex with Campus soils.	Poor	Poor	Poor	Poor	Poor
Harney: Ha, Hb, Hc	Good	Good	Good	Fair	Fair
Kanza: Kz	Poor	Fair	Fair	Fair	Fair
Leshara: Le	Fair	Good	Fair	Fair	Fair
Lesho: Lh	Poor	Fair	Fair	Fair	Fair
Likes: Lk	Poor	Fair	Fair	Poor	Poor
Lincoln: Ln	Poor	Fair	Fair	Fair	Poor
Mansic: Ma, Mb, Mc, Mf, Mm For Manter part of Mm, see Manter series.	Good	Good	Fair	Fair	Fair
Mg	Fair	Good	Fair	Poor	Poor
Manter: Mr, Ms, Mt, Mu For Satanta part of Mu, see Satanta series.	Good	Good	Good	Poor	Poor
Missler: Mx, Mz	Good	Good	Fair	Poor	Poor
Ness: Ns	Poor	Poor	Fair	Very poor	Very poor
Otero: Ot, Ov, Oz For Mansic part of Ov and Manter part of Oz, see their respective series.	Fair if slopes are 3 to 6 percent. Poor if slopes are 6 to 15 percent.	Good if slopes are 3 to 6 percent. Poor if slopes are 6 to 15 percent.	Good	Poor	Poor
Pratt: Pr, Pt	Poor	Fair	Good	Fair	Fair
Rough broken land: Rb	Very poor	Very poor	Poor	Poor	Fair
Roxbury: Rx	Good	Good	Good	Fair	Fair
Satanta: Sa, Sb, Sc	Fair	Good	Fair	Poor	Poor
Spearville: Sp	Good	Good	Fair	Poor	Poor
Tivoli: Tv	Poor	Poor	Fair	Poor	Poor
Uly: Ua, Ub, Uc, Us, Ut	Fair	Good	Good	Poor	Poor
Wann: Wn	Fair	Good	Good	Good	Good
Yahola: Yo	Fair	Good	Good	Good	Good

and CH; slightly organic classes are OL and OH. There is one class of highly organic soils, Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, CL-ML.

The AASHTO system (*1*) is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed in one of seven basic groups that range from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A-1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A-7, are clay soils that have low strength when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A-1, A-2, and A-7 groups are divided as follows: A-1-a, A-1-b; A-2-4, A-2-5, A-2-6, A-2-7; and A-7-5 and A-7-6. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest. The AASHTO classification for tested soils, with group index numbers in parentheses, is shown in table 8; the estimated classification, without group index numbers, is shown in table 6 for all soils mapped in the county.

USDA texture (*11*) is determined by the relative proportions of sand, silt, and clay in soil material that is less than *of the soils for wildlife*

Shrubs	Wetland plants	Shallow-water areas	Openland	Wetland	Rangeland
Elements of wildlife habitat—Continued			*Kinds of wildlife*		
Good	Poor	Good	Fair	Fair	Fair.
Very poor	Very poor	Very poor	Very poor	Very poor	Very poor.
Poor	Very poor	Very poor	Fair	Very poor	Fair.
Fair	Very poor	Very poor	Poor	Very poor	Poor.
Poor	Poor	Fair	Fair	Poor	Fair.
Good	Good	Fair	Fair	Fair	Fair.
Good	Fair	Fair	Fair	Fair	Fair.
Fair	Fair	Fair	Fair	Fair	Fair.
Fair	Very poor	Very poor	Fair	Very poor	Fair.
Fair	Very poor	Very poor	Fair	Very poor	Fair.
Good	Poor	Fair to poor	Good	Poor	Fair.
Good	Very poor	Very poor	Fair	Very poor	Fair.
Fair	Very poor	Very poor	Good	Very poor	Fair.
Fair	Poor	Very poor	Fair	Very poor	Fair.
Poor	Good	Good	Poor	Good	Poor.
Fair	Very poor	Very poor	Good if slopes are 3 to 6 percent. Poor if slopes are 6 to 15 percent.	Very poor	Fair.
Fair	Very poor	Very poor	Fair	Very poor	Fair.
Fair	Very poor	Very poor	Very poor	Very poor	Poor.
Fair	Poor	Poor	Good	Poor	Fair.
Poor	Very poor	Very poor	Fair	Very poor	Fair.
Poor	Poor	Good	Fair	Fair	Fair.
Poor	Very poor	Very poor	Poor	Very poor	Poor.
Fair	Very poor	Very poor	Fair	Very poor	Fair.
Good	Fair	Fair	Good	Fair	Good.
Fair	Poor	Very poor	Good	Poor	Fair.

2.0 millimeters in diameter. "Sand," "silt," "clay," and some of the other terms used in the USDA textural classification are defined in the Glossary. Stones, cobbles, and gravel are used as textural modifiers where present in the soil.

Estimated soil properties significant to engineering

Several estimated soil properties significant to engineering are shown in table 6. These estimates are made by layers of representative soil profiles that have significantly different soil properties. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties. Following are explanations of some of the columns in table 6.

Depth to bedrock is the distance from the surface of the soil to a layer of rock within the depth of observation.

Depth to seasonal high water table is the distance from the surface of the soil to the highest level that ground water reaches in the soil in most years.

Soil texture is described in table 6 in the standard terms used by the Department of Agriculture. These terms are based on the percentages of sand, silt, and clay less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other

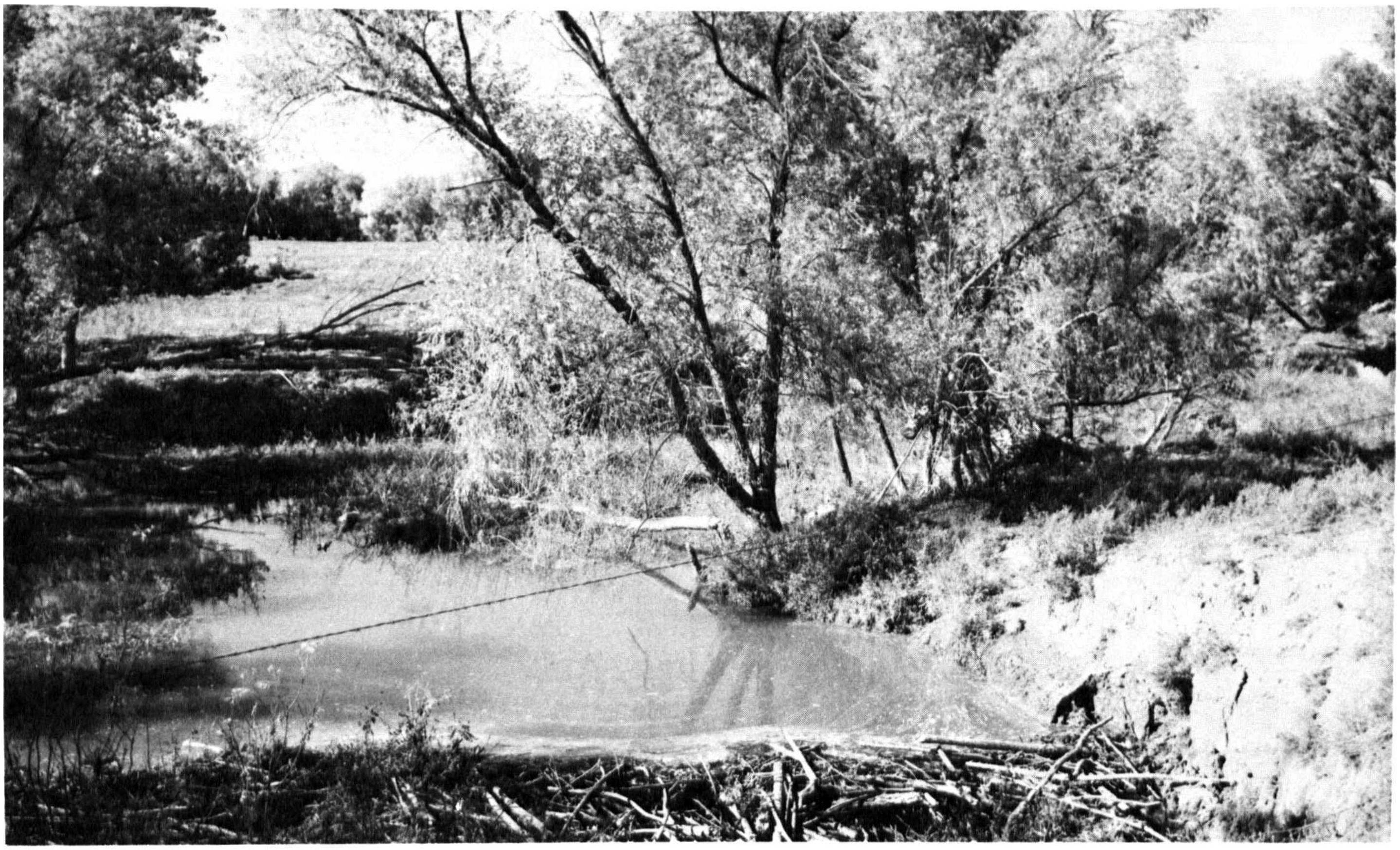

Figure 26.—**Beaver dam on Spring Creek.**

TABLE 6.—*Estimated soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in such mapping appear in the first column of this table. The symbol >

Soil series and map symbols	Depth to—		Depth from surface of typical profile	USDA texture	Classification		Percentage less than 3 inches passing sieve—	
	Bedrock	Seasonal high water table			Unified	AASHTO	No. 4 (4.7 mm)	No. 10 (2.0 mm)
	Feet	*Feet*	*Inches*					
Alluvial land, loamy: An. Too variable for valid estimates.								
Blown-out land: Bo. Too variable for valid estimates.								
*Campus: Cc	>6	>6	0-7	Clay loam	ML, CL	A-4, A-6	95-100	95-100
For Canlon part, see Canlon series.			7-60	Clay loam	CL, ML	A-4, A-6	98-100	90-100
Canlon	1-2	>6	0-12	Loam	ML, CL	A-6, A-4	80-95	70-90
Mapped only in complex with Campus soils.			12-60	Caliche.				
Harney: Ha, Hb, Hc	>6	>6	0-6	Silt loam	ML, CL	A-4, A-6	100	100
			6-15	Silty clay loam	CL	A-6, A-7-6	100	100
			15-20	Silty clay loam	CH, CL	A-7-6	100	100
			20-29	Silty clay loam	CL	A-7-6, A-6	100	100
			29-60	Silt loam	ML, CL	A-4, A-6	100	100

particles coarser than sand, an appropriate modifier is added, as for example, "gravelly loamy sand."

Liquid limit and plasticity index are water contents obtained by specified operations. As the water content of a clayey soil, from which the particles coarser than 0.42 millimeter have been removed, is increased from a dry state, the material changes from a semisolid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material changes from a semisolid to a plastic state; and the liquid limit, from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of water content within which a soil material is plastic. Liquid limit and plasticity index are estimated in table 6, but in table 8 the data on liquid limit and plasticity index are based on tests of soil samples.

Permeability, as used here, is an estimate of the rate at which saturated soil would transmit water in a vertical direction under a unit head of pressure. It is estimated on basis of those soil characteristics observed in the field, particularly structure, porosity, and texture. Lateral seepage or such transient soil features as plowpans and surface crusts are not considered.

Available water capacity is an estimate of the capacity of soils to hold water for use by most plants. It is defined here as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most plants.

Reaction refers to the acidity or alkalinity of a soil, expressed in pH values for a stated soil-solution mixture. The pH value and terms used to describe soil reaction are explained in the Glossary.

Shrink-swell potential refers to the relative change in volume to be expected of soil material with changes in moisture content, that is, the amount to which the soil shrinks as it dries out or swells when it gets wet. The extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils may damage building foundations, roads, and other structures. Soils that have a *high* shrink-swell potential are the most hazardous.

Shrink-swell is not indicated for organic soils or certain soils that shrink markedly on drying but do not swell quickly when rewetted.

Corrosivity, as used in table 6, pertains to potential soil-induced chemical action that dissolves or weakens steel or concrete. Rate of corrosion of steel is related to such soil properties as drainage, texture, total acidity, and electrical conductivity of the soil material. Installations of steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations made entirely in one kind of soil or in one soil horizon. Corrosivity for concrete is influenced mainly by the content of sodium or magnesium sulfate, but also by soil texture and acidity. A corrosivity rating of *low* means that there is a low probability of soil-induced corrosion damage. A rating of *high* means that there is a high probability of damage, so that protective measures for steel and more resistant concrete should be used to reduce damage.

Engineering interpretations

The estimated interpretations in table 7 are based on the engineering properties of soils shown in table 6, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of Meade County. In table 7 ratings are

significant to engineering

units have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring to other series that means more than; the symbol < means less than]

Percentage less than 3 inches passing sieve—*Continued*		Liquid limit	Plasticity index	Permea-bility	Available water capacity	Reaction	Shrink-swell potential	Corrosivity to—	
No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
				Inches per hour	*Inches per inch of soil*	*pH*			
85-95	60-70	30-40	8-20	0.6-2.0	0.17-0.19	7.4-8.4	Low	Low	Low.
75-95	50-80	33-45	11-20	0.6-2.0	0.14-0.17	7.9-8.4	Low	Low	Low.
60-85	50-70	30-40	8-15	0.6-2.0	0.16-0.19	7.9-8.4	Low	Low	Low.
100	95-100	28-35	6-15	0.6-2.0	0.21-0.23	5.6-7.3	Low	Moderate	Low.
100	95-100	40-50	20-30	0.2-0.6	0.19-0.21	5.6-7.8	Moderate	Moderate	Low.
100	95-100	45-55	20-30	0.2-0.6	0.18-0.20	7.9-8.4	High	High	Low.
100	95-100	35-45	15-25	0.2-0.6	0.18-0.20	7.9-8.4	Moderate to high.	High	Low.
100	95-100	28-35	10-15	0.6-2.0	0.19-0.21	7.9-8.4	Low	Moderate	Low.

TABLE 6.—*Estimated soil properties*

Soil series and map symbols	Depth to— Bedrock	Depth to— Seasonal high water table	Depth from surface of typical profile	USDA texture	Classification: Unified	Classification: AASHTO	Percentage less than 3 inches passing sieve— No. 4 (4.7 mm)	No. 10 (2.0 mm)
	Feet	*Feet*	*Inches*					
Kanza: Kz	>6	0-6	0-6	Clay loam	CL	A-6	100	100
			6-40	Loamy fine sand	SM	A-2-4	100	100
Leshara: Le	>6	4-6	0-60	Clay loam	ML, CL	A-4, A-6	100	100
Lesho: Lh	>6	3-6	0-30 30-40	Clay loam Sand	CL SP, SM	A-6, A-7-6 A-2-4	95-100 100	95-100 100
Likes: Lk	>6	>6	0-60	Loamy sand	SP, SM, SC	A-3, A-2-4	98-100	100
Lincoln: Ln	>6	4-8	0-60	Loamy fine sand	SP, SM	A-2-4, A-3	100	100
*Mansic: Ma, Mb, Mc, Mf, Mg, Mm. For Manter part of Mm, see Manter series.	>6	>6	0-60	Clay loam	CL, ML	A-6, A-7	98-100	90-100
*Manter: Mr, Ms, Mt, Mu. For Satanta part of Mu, see Satanta series.	>6	>6	0-60	Fine sandy loam	SM, SC, ML, CL	A-2-4, A-4	100	100
Missler: Mx, Mz	>6	>6	0-13	Silty clay loam	CH, CL	A-7	100	100
			13-60	Silty clay loam	CH, CL	A-7	100	100
Ness: Ns	>6	>6	0-32 32-50	Silty clay, clay Silty clay loam	CH CL, CH	A-7 A-6, A-7	100 100	100 100
*Otero: Ot, Ov, Oz. For Manter part of Oz and Mansic part of Ov, see their respective series.	>6	>6	0-60	Fine sandy loam	SM, SC	A-2-4, A-4	90-100	90-100
Pratt: Pr, Pt	>6	>6	0-60	Loamy fine sand	SM	A-2-4	100	100
Rough broken land: Rb. Too variable for valid estimates.								
Roxbury: Rx	>6	>6	0-20 20-60	Silt loam Silty clay loam	CL, ML CL, ML	A-4, A-6 A-4, A-6	100 100	100 100
Satanta:								
Sa	>6	>6	0-12 12-24 24-60	Fine sandy loam Sandy clay loam Clay loam	CL, ML, SM SC, CL CL	A-4 A-4, A-6 A-4, A-6	100 100 100	100 100 100
Sb, Sc	>6	>6	0-6 6-60	Loam Clay loam	ML, CL CL	A-4, A-6 A-4, A-7	100 100	100 100
Spearville: Sp	>6	>6	0-6 6-18 18-30	Silty clay loam Silty clay Silty clay loam	CL CH CL, CH	A-4, A-6 A-7 A-6, A-7	100 100 100	100 100 100
			30-60	Silt loam	CL	A-4, A-6	100	100
Tivoli: Tv	>6	>6	0-60	Fine sand	SM, SP	A-2-4, A-3	100	100
Uly: Ua, Ub, Uc, Us, Ut.	>6	>6	0-60	Silt loam	ML, CL	A-4, A-6, A-7	100	100
Wann: Wn	>6	3-6	0-13 13-60	Loam Fine sandy loam	ML, CL SM, ML	A-4 A-2-4, A-4	100 100	100 100
Yahola: Yo	>6	>6	0-60	Sandy loam	SM, ML	A-2-4, A-4	100	100

[1] Nonplastic.

significant to engineering—Continued

Percentage less than 3 inches passing sieve—*Continued*		Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity to—	
No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
				Inches per hour	*Inches per inch of soil*	*pH*			
100	80-90	30-45	15-25	0.2-2.0	0.17-0.19	5.6-8.4	Low to moderate.	High	Low to moderate.
75-100	15-30	<30	[1] NP	6.0-20.0	0.09-0.11	5.6-8.4	Low	High	Low to moderate.
100	80-90	30-40	5-15	0.6-2.0	0.14-0.18	7.4-8.4	Moderate	High	Low.
90-100	80-95	30-45	15-25	0.2-0.6	0.15-0.18	7.4-9.0	Moderate	High	Low.
55-70	5-20	<30	NP	6.0-20.0	0.05-0.07	7.4-9.0	Very low	High	Low.
75-95	10-30	<25	NP-6	2.0-6.0	0.07-0.11	7.4-8.4	Very low	Low	Low.
75-95	10-35	----------	NP	6.0-20.0	0.08-0.11	7.4-8.4	Very low	Low	Low.
90-100	75-90	31-40	10-18	0.6-2.0	0.14-0.19	7.4-8.4	Moderate	Moderate	Low.
99-100	35-70	<30	NP-6	6.0-20.0	0.14-0.18	6.6-7.3	Low	Low	Low.
95-100	70-90	41-55	15-30	0.2-0.6	0.20-0.22	7.4-7.8	Moderate to high.	Moderate	Low.
95-100	75-95	41-65	22-40	0.2-0.6	0.17-0.20	7.9-8.2	Moderate to high.	Moderate	Low.
95-100	90-95	55-70	30-45	<0.06	0.11-0.14	6.6-7.8	High	High	Low.
95-100	85-95	35-50	20-30	0.6-2.0	0.18-0.20	7.4-8.4	Moderate to high.	High	Low.
75-100	30-50	<30	NP-6	6.0-20.0	0.14-0.18	7.4-8.4	Low	Low	Low.
85-100	15-25	<30	NP	6.0-20.0	0.09-0.12	5.6-7.3	Low	Low	Low to moderate.
96-100	75-95	30-40	8-20	0.6-2.0	0.21-0.23	7.4-8.4	Low	Low	Low.
96-100	80-95	30-45	8-25	0.6-2.0	0.18-0.20	7.4-8.4	Moderate	Low	Low.
95-100	50-80	22-36	3-12	0.6-2.0	0.16-0.18	6.6-7.8	Low	Low	Low.
90-100	45-60	30-45	11-25	0.6-2.0	0.16-0.18	7.4-8.4	Moderate	Low	Low.
95-100	65-85	22-36	2-15	0.6-2.0	0.14-0.16	7.9-8.4	Low	Low	Low.
95-100	60-85	22-36	2-15	0.6-2.0	0.20-0.22	6.6-7.8	Low	Low	Low.
90-100	50-75	30-45	11-25	0.6-2.0	0.15-0.18	7.4-8.4	Moderate	Low	Low.
95-100	90-95	25-40	11-20	0.2-0.6	0.20-0.22	6.6-7.8	Moderate	Moderate	Low.
95-100	90-100	55-70	25-45	0.06-0.2	0.12-0.14	6.6-7.8	High	High	Low.
95-100	90-95	35-55	15-30	0.06-0.2	0.17-0.19	7.9-8.4	Moderate to high.	High	Low.
95-100	90-100	30-40	11-20	0.2-0.6	0.19-0.21	7.9-8.4	Moderate	Moderate	Low.
80-95	9-20	<30	NP	6.0-20.0	0.06-0.09	6.1-8.4	Very low	Low	Low.
100	90-100	30-45	7-18	0.6-2.0	0.20-0.24	6.6-8.4	Low to moderate.	Low	Low.
90-100	55-85	20-30	4-10	2.0-6.0	0.20-0.22	7.4-8.4	Low	Moderate	Low.
85-95	25-60	<30	NP-6	2.0-6.0	0.14-0.17	7.4-8.4	Low	Moderate	Low.
85-98	30-60	<30	NP-6	2.0-6.0	0.11-0.15	7.4-8.4	Low	Low	Low.

TABLE 7.—*Interpretations of*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in referring to other series that appear

Soil series and map symbols	Degree and kind of limitation for—							Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings	Local roads and streets	Sanitary landfill: Trench type [1]	Sanitary landfill: Area type	Cover material for sanitary landfill
Alluvial land, loamy: An. Too variable for valid interpretations.								
Blown-out land: Bo. Too variable for valid interpretations.								
*Campus: Cc. For Canlon part, see Canlon series.	Slight if slope is less than 8 percent; moderate if 8 to 15.	Moderate: moderate permeability.	Slight if slope is less than 8 percent; moderate if 8 to 15.	Moderate with or without basements: low strength.	Moderate: low strength.	Moderate: clay loam texture.	Slight if slope is less than 8 percent; moderate if 8 to 15.	Poor: thickness of material.
Canlon. Mapped only in complex with Campus soils.	Severe: depth to bedrock.	Severe: depth to bedrock.	Severe: depth to bedrock.	Severe with or without basements: depth to bedrock.	Severe: depth to bedrock.	Severe: depth to bedrock.	Moderate slope.	Poor: thickness of material.
Harney: Ha, Hb, Hc.	Severe: moderately slow permeability.	Slight if slope is less than 2 percent; moderate if 2 to 3 percent.	Slight	Moderate to severe with or without basements: moderate to high shrink-swell potential.	Moderate to severe: moderate to high shrink-swell potential.	Moderate: silty clay loam.	Slight	Fair: silty clay loam.
Kanza: Kz	Severe: seasonal high water table; occasional flooding.	Severe: seasonal high water table; occasional flooding.	Severe: poorly drained and somewhat poorly drained; seasonal high water table; occasional flooding.	Severe with or without basements: seasonal high water table; occasional flooding.	Severe: drainage; flooding.	Severe: drainage; seasonal high water table; flooding.	Severe: drainage; seasonal high water table; flooding.	Fair to poor: drainage.
Leshara: Le	Severe: occasional flooding.	Severe: occasional flooding.	Severe: occasional flooding.	Severe with or without basements: somewhat poorly drained; occasional flooding.	Severe: somewhat poorly drained; occasional flooding.	Severe: flooding.	Severe: flooding.	Fair: clay loam; thickness of material.
Lesho: Lh	Severe: occasional flooding.	Severe: occasional flooding.	Severe: occasional flooding.	Severe with or without basements: somewhat poorly drained; fluctuating water table; occasional flooding.	Severe: somewhat poorly drained; occasional flooding.	Severe: flooding.	Severe: flooding.	Fair: clay loam; thickness of material.

engineering properties of the soils

such mapping units have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for in the first column of this table]

Suitability as source of—*Continued*				Soil features affecting—				
Topsoil	Sand and gravel	Road subgrade [2]	Road fill [2]	Highway location [2]	Pond reservoir areas	Embankments, dikes, and levees	Terraces, diversions, and waterways	Irrigation
Fair to poor: thickness of material; clay loam texture.	Unsuitable	Poor: low soil support.	Fair: fair shear strength.	Sloping to strongly sloping; high lime content.	Moderate permeability.	High compressibility; moderate stability.	Highly calcareous subsoil.	High available water capacity.
Poor: thickness of material.	Unsuitable	Poor: low soil support.	Fair: fair shear strength.	Sloping to strongly sloping; caliche at a depth of 10 to 20 inches.	Shallow over caliche.	Fair to good compaction characteristics; moderate shear strength.	Not applicable: shallow soils; sloping to strongly sloping.	Not applicable: very low available water capacity; shallow soils; sloping to strongly sloping.
Fair: surface layer 6 inches thick over silty clay loam.	None	Fair: medium soil support and plasticity.	Fair: fair shear strength.	Nearly level to gently sloping; poor workability.	Moderately slow permeability.	Fair to poor compaction characteristics; moderate to high shrink-swell potential.	Thick soil material; low erodibility; moderately slow permeability.	Thick soil material; good drainage; moderately slow permeability; high available water capacity.
Poor: poorly drained.	Poor for sand: poorly graded. Poor for gravel: local pockets.	Good if confined.	Good	Seasonal high water table; frequently flooded; erodible.	Seasonal high water table; rapid permeability.	Good stability; fair to good compaction characteristics; poor resistance to piping.	Rapid permeability; seasonal high water table.	Rapid permeability; seasonal high water table.
Fair: clay loam.	Unsuitable	Fair: medium soil support.	Good	Nearly level; occasional flooding.	Moderate to low seepage.	Seasonal high water table.	Occasional flooding; somewhat poorly drained.	Moderate permeability.
Fair: clay loam.	Fair for sand below a depth of 18 to 40 inches. Poor for gravel: local pockets.	Poor: low support in upper 32 inches; good below if confined.	Good	Nearly level; occasional flooding; erodible.	Surface layer 18 to 40 inches thick over sand; occasional flooding.	Fair to good compaction characteristics.	Occasional flooding.	Moderately slow permeability; moderate available water capacity.

TABLE 7.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—							Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings	Local roads and streets	Sanitary landfill: Trench type [1]	Sanitary landfill: Area type	Cover material for sanitary landfill
Likes: Lk	Slight	Severe: moderately rapid permeability.	Severe: loamy sand.	Slight with or without basements.	Slight	Severe: moderately rapid permeability.	Severe: moderately rapid permeability.	Fair: loamy sand.
Lincoln: Ln	Severe: frequent flooding.	Severe: frequent flooding.	Severe: frequent flooding; loamy fine sand to sand.	Severe with or without basements: frequent flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Poor: loamy sand; thickness of material.
*Mansic: Ma, Mb, Mc, Mf, Mg, Mm. For Manter part of Mm, see Manter series.	Slight if slope is 0 to 8 percent; moderate if 8 to 15.	Moderate if slope is 0 to 7 percent; severe if 7 to 15.	Moderate: clay loam.	Moderate with or without basements: shrink-swell potential.	Severe: low strength.	Moderate: moderate permeability.	Slight if slope is 0 to 8 percent; moderate if 8 to 15.	Fair: clay loam.
*Manter: Mr, Ms, Mt, Mu. For Satanta part of Mu, see Satanta series.	Slight	Severe: rapid permeability.	Slight	Slight with or without basements.	Slight	Severe: rapid permeability.	Severe: rapid permeability.	Good
Missler: Mx, Mz.	Moderate: moderately slow permeability.	Slight if slope is less than 2 percent; moderate if more than 2.	Slight	Moderate to severe with or without basements: shrink-swell potential.	Moderate to severe: moderate to high shrink-swell potential.	Moderate: silty clay loam.	Slight	Fair: silty clay loam.
Ness: Ns	Severe: very slow permeability; frequent flooding.	Severe: frequent flooding. Slight if protected from flooding.	Severe: frequent flooding; clay.	Severe with or without basements: flooding.	Severe: high shrink-swell potential; flooding.	Severe: silty clay texture; flooding.	Severe: flooding; poorly drained.	Poor: silty clay.
*Otero: Ot, Ov, Oz. For Mansic part of Ov and Manter part of Oz, see their respective series.	Slight if slope is less than 8 percent; moderate if more than 8.	Severe: rapid permeability.	Slight if slope is less than 8 percent; moderate if 8 to 15.	Slight with or without basements where slope is less than 8 percent. Moderate with or without basements where slope is 8 to 15 percent.	Slight if slope is less than 8 percent; moderate if 8 to 15.	Severe: rapid permeability.	Severe: rapid permeability.	Good
Pratt: Pr, Pt	Slight if slope is 0 to 8 percent; moderate if 8 to 15.	Severe: rapid permeability.	Moderate: stability.	Slight with or without basements where slope is less than 8 percent. Moderate with or without basements where slope is 8 to 15 percent.	Slight if slope is less than 8 percent; moderate if 8 to 15.	Severe: rapid permeability.	Severe: rapid permeability.	Fair: loamy sand.
Rough broken land: Rb. Too variable to be rated.								

properties of the soils—Continued

Suitability as source of—*Continued*				Soil features affecting—				
Topsoil	Sand and gravel	Road subgrade [2]	Road fill [2]	Highway location [2]	Pond reservoir areas	Embankments, dikes, and levees	Terraces, diversions, and waterways	Irrigation
Poor: loamy sand.	Fair for sand. Poor for gravel.	Good if confined.	Good	Nearly level to gently sloping; erodible.	Moderately rapid permeability.	Good to fair compaction characteristics; high piping hazard.	Not applicable.	Moderately rapid permeability; low available water capacity.
Poor: loamy sand.	Fair for sand: poorly graded. Poor for gravel: local pockets.	Good	Fair to good	Frequent flooding.	Rapid permeability.	High piping hazard; erodible.	Not applicable.	Rapid permeability; low available water capacity.
Fair: clay loam.	Unsuitable	Fair: medium soil support.	Good	Nearly level to strongly sloping.	Moderate permeability.	Fair to good compaction characteristics; stable slopes.	Thickness of material; moderate erodibility; highly calcareous	Thickness of material; moderate permeability; high available water capacity.
Good	Poor	Good	Good	Nearly level to gently sloping; erodible.	Rapid permeability.	Good compaction characteristics; high erodibility.	Thickness of material; moderate stability and erodibility.	Thickness of material; high erodibility; rapid permeability.
Fair: silty clay loam.	Unsuitable	Poor: low soil support; high plasticity.	Fair: fair shear strength.	Nearly level to sloping; poor workability.	Moderately slow permeability.	Fair to poor compaction characteristics; medium compressibility.	Thickness of material; moderate erodibility.	Thickness of material; moderately slow permeability.
Poor: silty clay.	Unsuitable	Poor: low soil support; high plasticity.	Poor: poor shear strength.	Poor workability; subject to ponding; poor internal drainage.	Very slow permeability.	Fair to poor compaction characteristics; high shrink-swell potential.	Not applicable.	Very slow permeability; need for drainage.
Good if slope is less than 8 percent; fair if more more than 8.	Poor	Good	Good	Moderately steep; erodible.	Rapid permeability; a few strata of sand.	Good compaction characteristics; high erodibility.	Slopes; moderate stability and erodibility.	Rapid permeability; moderate available water capacity.
Poor: loamy sand.	Fair for sand. Unsuitable for gravel.	Good if confined.	Good	Erodible	Rapid permeability.	Good compaction characteristics; unstable slopes; highly erodible.	Not applicable; subject to soil blowing.	Rapid permeability; low available water capacity.

TABLE 7.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—							Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings	Local roads and streets	Sanitary landfill		Cover material for sanitary landfill
						Trench type [1]	Area type	
Roxbury: Rx	Slight if protected from flooding. Severe: occasional flooding.	Moderate if protected from flooding. Severe: occasional flooding.	Slight if protected from flooding. Severe: occasional flooding.	Moderate with or without basements if protected from flooding: moderate shrink-swell potential. Severe with or without basements: occasional flooding.	Moderate if protected from flooding: low strength; moderate shrink-swell potential. Severe: occasional flooding.	Slight if protected from flooding. Severe: occasional flooding.	Slight if protected from flooding. Severe: occasional flooding.	Good
Satanta: Sa, Sb, Sc.	Slight	Moderate: moderate permeability.	Slight	Moderate with or without basements: moderate shrink-swell potential.	Moderate: moderate shrink-swell potential.	Slight	Slight	Fair to good: clay loam and sandy clay loam.
Spearville: Sp	Severe: slow permeability.	Slight	Slight	Severe with or without basements: high shrink-swell potential.	Severe: high shrink-swell potential.	Severe: silty clay loam.	Slight	Fair to poor: silty clay.
Tivoli: Tv	Moderate if slope is less than 15 percent. Severe if slope is more than 15 percent or if pollution is a hazard to ground-water.	Severe: rapid permeability.	Severe: fine sand.	Moderate with or without basements: slope.	Moderate if slope is less than 15 percent. Severe if slope is more than 15 percent.	Severe: rapid permeability.	Severe: rapid permeability.	Poor: fine sand.
Uly: Ua, Ub, Uc, Us, Ut.	Slight	Moderate: moderate permeability.	Slight	Moderate with or without basements; low strength.	Moderate: low strength.	Slight	Slight	Good
Wann: Wn	Severe: occasional flooding; seasonal high water table.	Severe: occasional flooding; moderately rapid permeability.	Severe: occasional flooding; seasonal high water table.	Severe with or without basements: occasional flooding; poorly drained.	Moderate to severe: somewhat poorly drained; occasional flooding.	Severe: flooding.	Severe: flooding.	Good
Yahola: Yo	Slight	Severe: moderately rapid permeability.	Slight	Slight with or without basements.	Slight	Severe: moderately rapid permeability.	Severe: moderately rapid permeability.	Good

[1] Onsite studies of the underlying strata, water table, and hazards of aquifer pollution and drainage into ground water need to be made for landfills more than 5 or 6 feet deep.

properties of the soils—Continued

Suitability as source of—*Continued*				Soil features affecting—				
Topsoil	Sand and gravel	Road subgrade [2]	Road fill [2]	Highway location [2]	Pond reservoir areas	Embankments, dikes, and levees	Terraces, diversions, and waterways	Irrigation
Good	Unsuitable	Poor: low soil support.	Fair: fair shear strength.	Nearly level; occasional flooding.	Moderate permeability; occasional flooding.	Fair compaction characteristics; medium to low shrink-swell potential.	Moderate permeability; occasional flooding.	Moderate permeability; high available water capacity.
Good	Unsuitable	Fair: medium soil support.	Good	Nearly level to gently sloping.	Moderate permeability.	Fair to good compaction characteristics; medium compressibility.	Slope; moderate permeability.	Moderate permeability; high available water capacity.
Poor: silty clay and silty clay loam.	Unsuitable	Poor: low soil support.	Fair: fair shear strength.	Nearly level; poor workability.	Slow permeability.	Fair to poor compaction characteristics; high shrink-swell potential.	Thickness of material; moderate erodibility; silty clay subsoil.	Thickness of material; slow permeability; high available water capacity.
Poor: fine sand.	Fair for sand. Poor for gravel.	Good if confined.	Good	Sloping to steep; high erodibility; difficult to vegetate.	Rapid permeability.	Good compaction characteristics; unstable slopes; high erodibility.	Not applicable; subject to silting.	Rapid permeability; low available water capacity.
Good	Unsuitable	Fair: medium soil support.	Good	Nearly level to sloping; erodible.	Moderate permeability.	Fair to poor compaction characteristics; moderate shear strength; moderate stability and plasticity.	Thickness of material; moderate erodibility.	Thickness of material; moderate permeability; high available water capacity.
Good	Available below a depth of 5 feet in places.	Good	Good	Occasional flooding; fluctuating water table; erodible.	Moderate to high seepage; seasonal high water table at a depth of 3 to 6 feet.	Piping hazard; fair to good compaction characteristics.	Not applicable.	Moderately rapid permeability; high available water capacity.
Good	Fair for sand. Poor for gravel.	Good	Good	Erodible	Moderately rapid permeability.	Slight to medium compressibility; poor resistance to piping.	Moderate stability and erodibility.	Moderately rapid permeability; moderate available water capacity; pockets of sand.

[2] C. N. CLARK, soils engineer, and HERBERT WORLEY, soils research engineer, Kansas State Highway Commission, assisted in interpreting soil properties for road subgrade, road fill, and highway location.

TABLE 8—*Engineering*

[Tests were performed by the State Highway Commission of Kansas under a cooperative agreement with the U.S. Department of Commerce, Officials (AASHTO), except as

Soil name and location	Parent material	SCS sample No. S-71-Kans—	Depth from surface	Moisture-density data [1]	
				Maximum dry density	Optimum moisture
			In	*Lb per cu ft*	*Pct*
Likes loamy sand: 990 feet east and 330 feet north of the center of section 7, T. 35 S., R. 29 W. (Modal)	Colluvial-alluvial material from nearby slopes.	60-1-1	0-9	119	8
		60-1-2	9-60	111	13
Mansic clay loam: 1,590 feet east and 510 feet north of the southwest corner of section 7, T. 34 S., R. 28 W. (Modal)	Calcareous loamy High Plains sediment.	60-3-1	0-17	112	15
		60-3-2	17-27	113	15
		60-3-3	27-72	110	17
Otero fine sandy loam: 1,320 feet north and 330 feet west of the southeast corner of section 7, T. 34 S., R. 28 W. (Nonmodal; surface layer thicker than modal.)	Moderately sandy eolian deposit.	60-2-1	0-12	116	12
		60-2-2	12-25	120	12
		60-2-3	40-60	121	10
Roxbury silt loam: 350 feet west and 10 feet south of the center of section 11, T. 31 S., R. 27 W. (Modal)	Alluvium	60-5-1	0-19	99	20
		60-5-2	19-28	103	19
		60-5-3	28-42	108	16
Spearville silty clay loam: 300 feet south and 100 feet east of the northwest corner of section 21, T. 30 S., R. 28 W. (Modal)	Calcareous loess	60-4-1	0-9	107	18
		60-4-2	9-20	93	27
		60-4-3	40-60	105	19

[1] Based on AASHTO Designation T 99-56, Method A (*1*), with the following variations: (1) all material is ovendried at 230° F; (2) all material is crushed in a laboratory crusher after drying; and (3) no time is allowed for dispersion of moisture after mixing with the soil material.

[2] Mechanical analysis according to AASHTO Designation T 88-57, with the following variations: (1) all material is ovendried at 230° F and crushed in a laboratory crusher; (2) the sample is not soaked prior to dispersion; (3) sodium silicate is used as the dispersing agent; and (4) dispersing time, in minutes, is established by dividing the plasticity index value by 2; the maximum time is 15 minutes, and the minimum is 1 minute. Results by this procedure may differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure,

used to summarize limitation or suitability of the soils for all listed purposes other than for drainage of crops and pasture, irrigation, ponds and reservoirs, embankments, and terraces and diversions. For these particular uses, table 7 lists those soil features not to be overlooked in planning, installation, and maintenance.

Soil limitations are indicated by the ratings *slight, moderate*, and *severe. Slight* means that soil properties are generally favorable for the rated use, or in other words, limitations are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means that soil properties are so unfavorable and so difficult to correct or overcome as to require major soil reclamation, special design, or intensive maintenance.

Soil suitability is rated by the terms *good, fair*, and *poor*, which have, respectively, meanings approximately parallel to the terms slight, moderate, and severe.

Following are explanations of some of the columns in table 7.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distributes effluent from a septic tank into natural soil. The soil material from a depth of 18 inches to 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope is a soil property that affects difficulty of layout and construction and also the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor and sides, or embankments, of compacted soil material. The assumption is made that the embankment is compacted to medium density and the pond is protected from flooding. Properties are considered that affect the pond floor and the embankment. Those that affect the pond floor are permeability, organic matter, and slope. If the floor needs to be leveled, depth to bedrock is important. The soil properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified soil classification and the amounts of stones, if any, that influence the ease of excavation and compaction of the embankment material.

Shallow excavations are those that require digging or trenching to a depth of less than 6 feet; for example, excavations for pipelines, sewerlines, phone and power transmission lines, basements, open ditches, and cemeteries. Desirable soil properties are good workability, moderate resistance to sloughing, gentle slopes, absence of rock outcrops or big stones, and freedom from flooding or a high water table.

test data

Bureau of Public Roads (BPR), in accordance with standard procedures of the American Association of State Highway and Transportation explained in footnotes 1 and 2]

Mechanical analysis [2]							Liquid limit	Plasticity index	Classification	
Percentage less than 3 inches in diameter passing sieve—			Percentage smaller than—						AASHTO	Unified [3]
No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)	0.05 mm	0.02 mm	0.005 mm	0.002 mm				
							Pct			
100	88	24	15	6	4	3	20	4	A-2-4(0)	SM, SC
100	90	10	6	4	4	4	18	[4] NP	A-3(0)	SP, SM
100	97	59	48	26	17	14	27	9	A-4(5)	CL
100	97	64	53	36	27	23	30	14	A-6(7)	CL
100	99	87	79	62	47	39	43	26	A-7-6(15)	CL
100	96	44	35	19	12	8	23	5	A-4(2)	SM, SC
100	95	42	33	23	17	15	22	6	A-4(1)	SM, SC
100	92	24	19	16	14	12	19	3	A-2-4(0)	SM
100	100	90	82	57	35	25	39	15	A-6(10)	ML, CL
100	100	92	76	54	34	28	42	23	A-7-6(14)	CL
100	100	95	84	56	33	27	41	22	A-7-6(13)	CL
100	100	94	84	54	28	19	31	11	A-6(8)	CL
100	100	98	93	75	58	51	66	42	A-7-6(20)	CH
100	100	96	91	63	36	25	38	19	A-6(12)	CL

the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses in this table are not suitable for use in naming textural classes of soils.

[3] Unified soil classification system (*2*).

[4] Nonplastic.

Dwellings, as rated in table 7, are no more than three stories high and are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to capacity to support load and resist settlement under load and those that relate to ease of excavation. Soil properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

Sanitary landfill is a method of disposing of refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated, the ratings in table 7 apply only to a depth of about 6 feet; therefore, limitation ratings of *slight* or *moderate* may not be valid if trenches are to be much deeper than that. For some soils, reliable predictions can be made to a depth of 10 or 15 feet, but regardless of that, every site should be investigated before it is selected.

Local roads and streets, as rated in table 7, have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base consisting of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep.

Soil properties that most affect design and construction of roads and streets are load-supporting capacity and stability of the subgrade and the workability and quantity of cut and fill material available. The AASHTO and Unified classifications of the soil material and, also, the shrink-swell potential indicate the traffic-supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect ease of excavation and amount of cut and fill needed to reach an even grade.

Road fill is soil material used in embankments for roads. The suitability ratings reflect (1) the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage and (2) the relative ease of excavating the material at borrow areas.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 7 provide guidance about where to look for probable sources. A soil rated as a *good* or *fair* source of sand or gravel generally has a layer at least 3 feet thick, the top of which is within a depth of 6 feet. The ratings do not take into account thickness of overburden, location of the water table, or other factors that affect mining of the materials, and neither do they indicate quality of the deposit.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as for preparing a seedbed; natural fertility of the material, or the response of plants when fertilizer is applied; and absence of substances toxic to plants. Texture of the soil material and its content of stone fragments are characteristics that affect suitability, but also considered in the ratings is damage that will result at the area from which topsoil is taken.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to their permeability and depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage and piping and of favorable stability, shrink-swell potential, shear strength, and compactibility. Presence of stones or organic material in a soil are among the unfavorable factors.

Drainage of crops and pasture is affected by such soil properties as permeability, texture, and structure; depth to claypan, rock, or other layers that influence rate of water movement; depth to the water table; slope stability in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage.

Irrigation of a soil is affected by such features as slope; susceptibility to stream overflow, water erosion, or soil blowing; soil texture; content of stones; accumulations of salts and alkali; depth of root zone; rate of water intake at the surface; permeability of soil layers below the surface layer and in fragipans or other layers that restrict movement of water; amount of water held available for plants; and need for drainage, or depth to water table or bedrock.

Terraces and diversions are embankments, or ridges, constructed across the slope to intercept runoff so that it soaks into the soil or flows slowly to a prepared outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope, depth to bedrock or other unfavorable material, presence of stones, permeability, and resistance to water erosion, soil slipping, and soil blowing. A soil suitable for these structures provides outlets for runoff and is not difficult to vegetate.

Engineering test data

Engineering test data for five soil series are shown in table 8. Samples were taken, by horizons, from five soil profiles in Meade County and were tested by the State Highway Commission of Kansas in accordance with standard procedures of the American Association of State Highway and Transportation Officials.

The engineering classifications in table 8 are based on data obtained by mechanical analyses and by tests to determine the liquid limit and the plastic limit.

Recreation [7]

Knowledge of soils is necessary in planning, developing, and maintaining areas used for recreation. In table 9 the soils of Meade County are rated according to limitations that affect their suitability for camp areas, playgrounds, picnic areas, and paths and trails.

In table 9 the soils are rated as having *slight, moderate,* or *severe* limitations for the specified uses. For all of these ratings, it is assumed that a good cover of vegetation can be established and maintained. A limitation of *slight* means that soil properties are generally favorable and limitations are so minor that they can be easily overcome. A *moderate* limitation can be overcome or modified by planning, design, or special maintenance. A *severe* limitation means that costly soil reclamation, special design, intense maintenance, or a combination of these is required.

Camp areas are used intensively for tents and small camp trailers and the accompanying activities of outdoor living. Little preparation of the site is required, other than shaping and leveling for tent and parking areas. Camp areas are subject to heavy foot traffic and limited vehicular traffic. The best soils have mild slopes, good drainage, a surface free of rocks and coarse fragments, freedom from flooding during periods of heavy use, and a surface that is firm after rain but not dusty when dry.

Picnic areas are attractive natural or landscaped tracts used mainly for preparing meals and eating outdoors. These areas are subject to heavy foot traffic. Most of the vehicular traffic, however, is confined to access roads. The best soils are firm when wet but not dusty when dry, are free of flooding during the season of use, and do not have slopes or stoniness that greatly increases the cost of leveling sites or of building access roads.

Playgrounds are areas used intensively for baseball, football, badminton, and similar organized games. Soils suitable for this use need to withstand intensive foot traffic. The best soils have a nearly level surface free of coarse fragments and rock outcrops, good drainage, freedom from flooding during periods of heavy use, and a surface that is firm after rain but not dusty when dry. If grading and leveling are required, depth to rock is important.

Paths and trails are used for local and cross-country travel by foot or on horseback. Design and layout should require little or no cutting and filling. The best soils are at least moderately well drained, are firm when wet but not dusty when dry, are flooded no more than once during the season of use, have slopes of less than 15 percent, and have few or no rocks or stones on the surface.

Formation and Classification of the Soils

This section consists of two main parts. The first part tells how the factors of soil formation have affected the formation of soils in Meade County. The second explains the system of soil classification currently used and places each soil series in the classes of that system.

Factors of Soil Formation

Soil is produced by soil-forming processes acting on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or

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[7] By JACK W. WALSTROM, biologist, Soil Conservation Service.

TABLE 9.—*Limitations of the soils for recreational development*

Soil series and map symbols	Camp areas	Picnic areas	Playgrounds	Paths and trails
Alluvial land, loamy: An	Severe: flooding	Moderate: flooding	Moderate: flooding	Slight.
Blown-out land: Bo	Severe: blowing soils	Severe: blowing soils	Severe: blowing soils	Severe: blowing soils.
Campus: Cc For Canlon part, see Canlon series.	Slight	Slight	Moderate: slope is more than 5 percent.	Slight.
Canlon Mapped only in complex with Campus soils.	Moderate if slope is less than 15 percent; severe if more than 15 percent: stoniness.	Moderate if slope is less than 15 percent; severe if more than 15 percent: stoniness.	Severe: slope is more than 6 percent in places; depth to rock.	Moderate: stoniness.
Harney:				
Ha, Hb	Moderate: moderately slow permeability.	Slight	Slight	Slight.
Hc	Moderate: silty clay loam	Moderate: silty clay loam	Moderate: silty clay loam; slope is more than 2 percent in places.	Moderate: silty clay loam.
Kanza: Kz	Severe: wetness and flooding.	Severe: wetness	Severe: wetness and flooding.	Severe: wetness.
Leshara: Le	Severe: wetness	Severe: wetness and flooding.	Severe: wetness and flooding.	Moderate: wetness and flooding.
Lesho: Lh	Severe: wetness; clay loam.	Moderate; wetness; clay loam.	Moderate: wetness; clay loam.	Moderate: wetness; clay loam.
Likes: Lk	Moderate: loamy sand	Moderate: loamy sand	Moderate: loamy sand	Moderate: loamy sand.
Lincoln: Ln	Severe: flooding	Severe: flooding	Severe: flooding	Slight.
Mansic:				
Ma, Mb, Mc, Mf, Mm For Manter part of Mm, see Manter series.	Moderate: clay loam	Moderate: clay loam	Moderate: clay loam; slope is mostly 2 to 6 percent.	Moderate: clay loam.
Mg	Moderate: slope is more than 8 percent in places.	Moderate: clay loam	Severe: slope is more than 6 percent.	Moderate: clay loam.
Manter: Mr, Ms, Mt, Mu For Satanta part of Mu, see Satanta series.	Slight	Slight	Slight if slope is less than 2 percent; moderate if more than 2 percent.	Slight.
Missler: Mx, Mz	Moderate: silty clay loam	Moderate: silty clay loam	Moderate: silty clay loam; slope is more than 2 percent.	Moderate: silty clay loam.
Ness: Ns	Severe: silty clay	Severe: silty clay	Severe: silty clay	Severe: silty clay.
Otero: Ot, Ov, Oz For Mansic part of Ov and the Manter part of Oz, see their respective series.	Slight if slope is less than 8 percent; moderate if more than 8 percent.	Slight if slope is less than 8 percent; moderate if more than 8 percent.	Moderate if slope is less than 6 percent; severe if more than 6 percent.	Slight.
Pratt: Pr, Pt	Moderate: loamy fine sand.	Moderate: loamy fine sand.	Moderate: slope is more than 2 percent; loamy fine sand.	Moderate: loamy fine sand.
Rough broken land: Rb	Severe: slope is more than 15 percent.	Severe: slope is more than 15 percent.	Severe: slope is more than 6 percent.	Severe: slope is more than 25 percent.
Roxbury: Rx	Slight if protected from flooding; severe if flooded.	Slight if protected from flooding; moderate if flooded.	Slight if protected from flooding; moderate if flooded.	Slight.
Satanta: Sa, Sb, Sc	Slight	Slight	Slight if slope is less than 2 percent; moderate if more than 2 percent.	Slight.
Spearville: Sp	Moderate: slow permeability; silty clay loam.	Moderate: silty clay loam	Moderate: slow permeability; silty clay loam.	Moderate: silty clay loam.
Tivoli: Tv	Severe: fine sand	Severe: fine sand	Severe if slope is more than 6 percent: fine sand.	Severe: fine sand.
Uly: Ua, Ub, Uc, Us, Ut	Slight	Slight	Slight if slope is less than 2 percent; moderate if more than 2 percent.	Slight.
Wann: Wn	Severe: wetness and flooding.	Moderate: wetness	Severe: wetness	Moderate: wetness and flooding.
Yahola: Yo	Severe: flooding	Moderate: flooding	Severe: flooding	Slight.

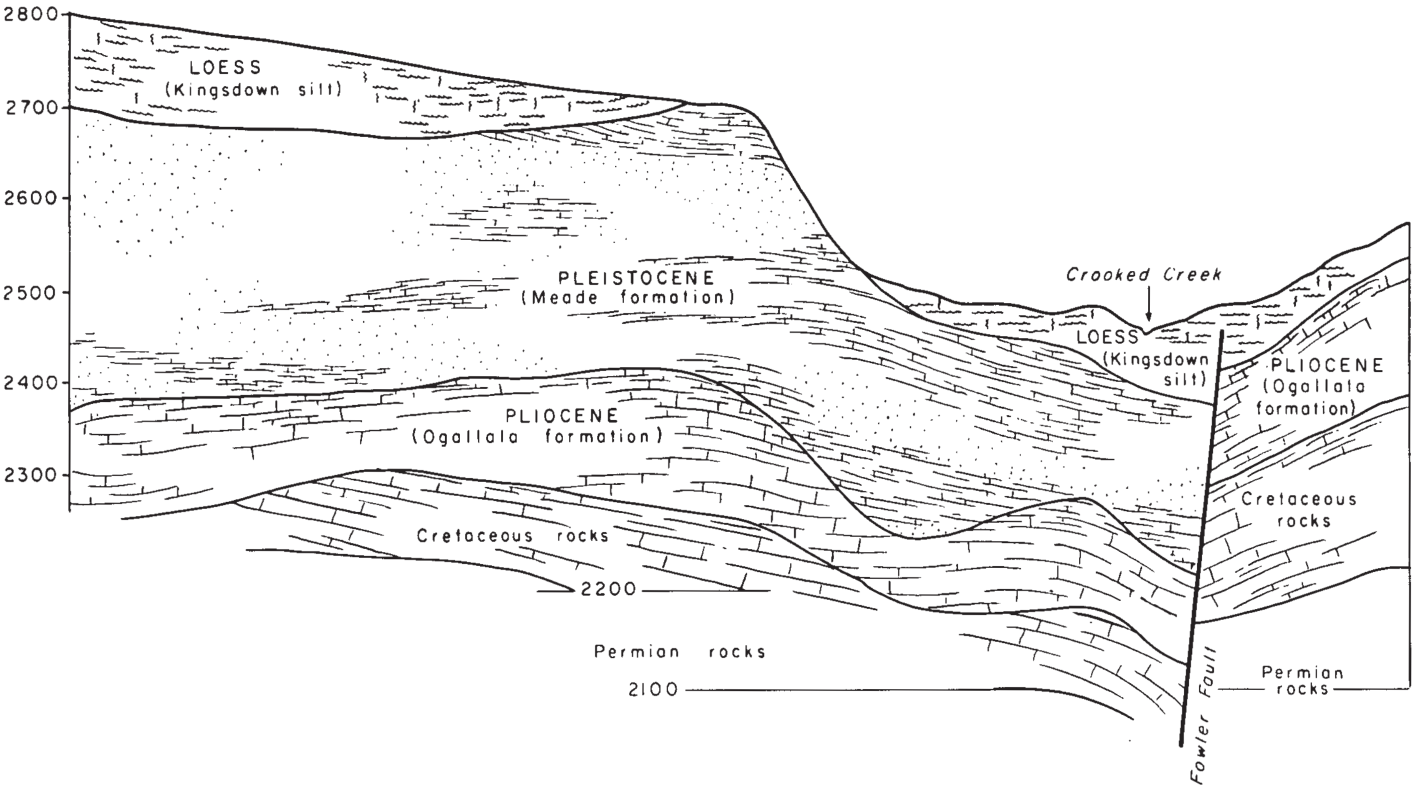

***Figure 27.*—An approximate geologic cross-section through the northern part of the county from east to west along the northern edge of Fowler (7).**

lay of the land; and (5) the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that is formed and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil profile. It may be much or little, but some time is always required for differentiation of soil horizons. Usually, a long time is required for the development of distinct horizons.

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

Parent material

The soils of Meade County formed in sediment deposited during the Pleistocene and Recent epochs. The parent material is mainly outwash sediment laid down in the Pleistocene or Late Pliocene epoch (fig. 27).

Outwash sediments.—Outwash sediments are the predominant parent material of the sloping to moderately steep soils. These sediments consist of unconsolidated loamy and clayey sediments that are probably of Upper Pliocene age. The deposit contains beds of caliche, and in places these beds are exposed. The material was deposited by widely shifting streams that originated in the Rocky Mountains. Campus, Canlon, and Mansic soils formed in outwash sediments.

Faulting in the Meade Basin followed after the close of the Middle Pliocene sedimentation (*7*). The close of the Pliocene epoch was marked by renewed downwarping. During Early Pleistocene time, the basin and adjacent areas east of the fault were filled by sand, gravel, silt, clay, and volcanic ash. All of these Early Pleistocene deposits make up the Meade Formation. The Mansic-Otero complex is in an area of this geologic material.

Loess deposits.—Loess is the predominant parent material of the soils on the High Plains tableland. A loessal deposit of almost grit-free material was deposited as a mantle over the area in the Wisconsin stage of the Pleistocene epoch. The loess on the High Plains is approximately 10 to 45 feet thick. In Meade County, Harney, Spearville, and Uly soils are the dominant soils that formed in loess.

Alluvial deposits.—Alluvium of the Recent epoch on the flood plains of the Cimarron River and Sand Creek consists mainly of sand, silt, and gravel. The alluvium along Crooked Creek consists of clay, silt, and sand. Kanza, Lesho, and Lincoln soils formed in recent alluvium on the flood plain of the Cimarron River and Sand Creek. Leshara clay loam is on the flood plain of Crooked Creek, and Roxbury silt loam is on the low stream terrace along Crooked Creek.

Sandy eolian material.—Dune sand of Recent age occurs on uplands in the northeastern and southern parts of the county. The sandhills are undulating to hummocky. Tivoli and Pratt soils are the dominant soils that formed in this sandy material.

Climate

Climate affects the physical, chemical, and biological relationships in the soil. The amount of water that percolates through the soil depends partly on rainfall, humidity, and the frost-free period. Water dissolves small amounts of the minerals present and carries them out of the soil. Temperature influences the growth of organisms and affects chemical reaction in the soil.

The climate of Meade County is continental and typical of that in the High Plains. It is characterized by extreme temperatures in summer and winter, by low relative humidity, and by slight to moderate, irregular rainfall.

Because of the limited amount of precipitation in Meade County, soil minerals have not been weathered and leached to any great extent. Few soils have been leached of lime to a depth of more than 30 inches. Except for soils that formed in noncalcareous fine sand, most of the soils have an accumulation of calcium carbonate within 30 inches of the surface.

Plant and animal life

Plant and animal life, both on and in the soil, are active in soil-forming processes. The kinds of plants, animals, and micro-organisms that live on and in the soil are determined by the environment, climate, parent material, relief, and age of the soils. Climate strongly influences soil flora and fauna and, thereby, exerts a strong, indirect influence upon the morphology of the soils.

Organic material is added to the soil as plants die and decay. Most of it is added to the A horizon, where it is acted upon by micro-organisms, earthworms, and other forms of life and by chemicals in the soil and in plant remains.

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

Relief

Relief, or lay of the land, affects runoff and drainage. If other factors, such as vegetative cover and rainfall, are about equal, runoff is rapid on steep soils and slower or lacking on level ones. As a result, soil development is less rapid on steeper soils.

The relationship of the Ness, Harney, and Uly soils is an example of the effect of relief on the formation of soils. The parent material of the soils in these three series is similar, and most of the differences in profile characteristics are the result of difference in relief.

Ness soils are in undrained depressions that receive runoff from adjacent areas. The clayey texture and gray color of the Ness soils show the effects of additional moisture and poor drainage. Harney soils are on smooth, gentle slopes and have neither restricted nor excessive surface drainage. Of all the soils they most nearly reflect the full influence of the climate on the parent material. Uly soils are sloping and occur on convex areas. Runoff and erosion have been greater on these soils than on the less sloping soils, and their less distinct profile reflects the influence of relief.

Time

Time is required for soil formation. The length of time needed depends largely on the other factors of soil formation. Soils develop more slowly in Meade County, where the clim ıte is dry and the vegetation is sparse, than they do in area where the climate is moist and the vegetation dense. As water moves downward through the soil profile, lime and fine particles are gradually leached from the surface layer and deposited in the subsoil. The amount of leaching depends on how much time has elapsed and on the amount of water that penetrates the soil. For example, the Tivoli soils in the sandhills are young soils because they have been stabilized for only a short time and show very little horizon development other than a slight darkening of the surface layer. At the other extreme are such soils as Harney and Spearville soils, which are older, mature soils whose parent material has been in place long enough so that they have a well-developed profile.

Classification of Soils

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

The narrow categories of classification, such as those used in detailed soil surveys, allow us to organize and apply knowledge about soils in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Because this system is under continual study, readers interested in developments of the current system should search the latest literature available (*8*, *12*).

The current system of classification has six categories. Beginning with the broadest, these categories are the order, the suborder, the great group, the subgroup, the family, and the series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that soils of similar genesis, or mode of origin, are grouped. The same property or subdivisions of this property may be used in several different categories. In table 10 the soil series of Meade County are placed in higher categories of the current system. Classes of the current system are briefly defined in the following paragraphs.

ORDER.—Ten soil orders are recognized. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. Three exceptions to this are Entisols, Histosols, and Vertisols, which occur in many different climates. Table 10 shows that the four soil orders in Meade County are Entisols, Vertisols, Mollisols, and Alfisols.

Entisols are recently formed mineral soils. They have

TABLE 10.—*Soil series classified according to the current system*

Series	Family	Subgroup	Order
Campus	Fine-loamy, mixed, mesic	Typic Calciustolls	Mollisols.
Canlon	Loamy, mixed (calcareous), mesic	Lithic Ustorthents	Entisols.
Harney [1]	Fine, montmorillonitic, mesic	Typic Argiustolls	Mollisols.
Kanza	Mixed, thermic	Mollic Psammaquents	Entisols.
Leshara [2]	Fine-silty, mixed, mesic	Typic Haplaquolls	Mollisols.
Lesho	Fine-loamy over sandy or sandy-skeletal, mixed, thermic.	Fluvaquentic Haplustolls	Mollisols.
Likes	Mixed, thermic	Typic Ustipsamments	Entisols.
Lincoln	Sandy, mixed, thermic	Typic Ustifluvents	Entisols.
Mansic	Fine-loamy, mixed, thermic	Aridic Calciustolls	Mollisols.
Manter	Coarse-loamy, mixed, mesic	Aridic Argiustolls	Mollisols.
Missler	Fine, mixed, thermic	Typic Haplustolls	Mollisols.
Ness	Fine, montmorillonitic, mesic	Udic Pellusterts	Vertisols.
Otero	Coarse-loamy, mixed (calcareous), mesic	Ustic Torriorthents	Entisols.
Pratt	Sandy, mixed, thermic	Psammentic Haplustalfs	Alfisols.
Roxbury	Fine-silty, mixed, mesic	Cumulic Haplustolls	Mollisols.
Satanta	Fine-loamy, mixed, mesic	Aridic Argiustolls	Mollisols.
Spearville	Fine, montmorillonitic, mesic	Typic Argiustolls	Mollisols.
Tivoli	Mixed, thermic	Typic Ustipsamments	Entisols.
Uly	Fine-silty, mixed, mesic	Typic Haplustolls	Mollisols.
Wann	Coarse-loamy, mixed, mesic	Fluvaquentic Haplustolls	Mollisols.
Yahola [3]	Coarse-loamy, mixed (calcareous), thermic	Typic Ustifluvents	Entisols.

[1] The Harney soils in units Hb and Hc are taxadjuncts to the Harney series because depth to carbonate and thickness of solum are less than in the defined range for the series. They resemble the series in other characteristics.

[2] The Leshara soils are taxadjuncts to the Leshara series because they are calcareous throughout. They resemble the series in other characteristics.

[3] The Yahola soils are taxadjuncts to the Yahola series because they are less red than in the defined range for the series. They resemble the series in other characteristics.

little or no evidence of genetic horizons and do not have features that reflect soil mixing caused by shrinking and and swelling. *Vertisols* are mineral soils that are high in content of clay throughout and have evidence of soil mixing caused by shrinking and swelling. *Mollisols* are mineral soils that have a thick, dark-colored surface layer that contains colloids dominated by bivalent cations. They do not have features that reflect soil mixing caused by shrinking and swelling. *Alfisols* are mineral soils that contain horizons of clay accumulation. Unlike Mollisols, they do not have a dark-colored surface horizon dominated by bivalent cations; however, the base saturation of the lower horizon is moderate to high.

SUBORDER.—Each order is divided into suborders using those soil characteristics that seem to produce classes that have the greatest genetic similarity. The suborders are more narrowly defined than the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of a water table at a shallow depth; soil climate; the accumulation of clay, iron, or organic carbon in the upper part of the solum; cracking of soils caused by a decrease in soil moisture; and fine stratification.

GREAT GROUP.—Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequence of soil horizons and features. The horizons used to make separations are those in which clay, carbonates, and other constituents have accumulated or have been removed and those that have pans that interfere with growth of roots, movement of water, or both. Some features used are soil acidity, soil climate, soil composition, and soil color.

SUBGROUP.—Great groups are divided into subgroups, one that represents the central (typic) segment of the group and others, called intergrades, that have properties of the group and also one or more properties of another great group, suborder, or order. Other subgroups may have soil properties unlike those of any great group, suborder, or order.

FAMILY.—Soil families are established within a subgroup mainly on the basis of properties important to the growth of plants or to the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, soil depth, and consistence.

Environmental Factors Affecting Soil Use

In this section the physiography, drainage, and water supply; the climate; the farming of Meade County; and natural resources, transportation, and markets are discussed. The statistics on farming and population are from the Federal census report and Kansas State Board of Agriculture Biennial Reports.

Physiography, Drainage, and Water Supply

Meade County lies partly within the High Plains section and partly within the Plains Border section of the Great Plains physiographic province (*7*). The western and northwestern parts of the county are dominated by broad, nearly level uplands that are typical of the High Plains. The eastern and southeastern parts of the county are in the Plains Border sections and have relatively rough, steep slopes (fig. 28).

The Cimarron River crosses the southwestern corner of the county. Crooked Creek, an intermittent stream that enters the north-central part of the county, flows eastward, leaves the county, and then re-enters it in the northeastern corner. It flows south across the central part of the county

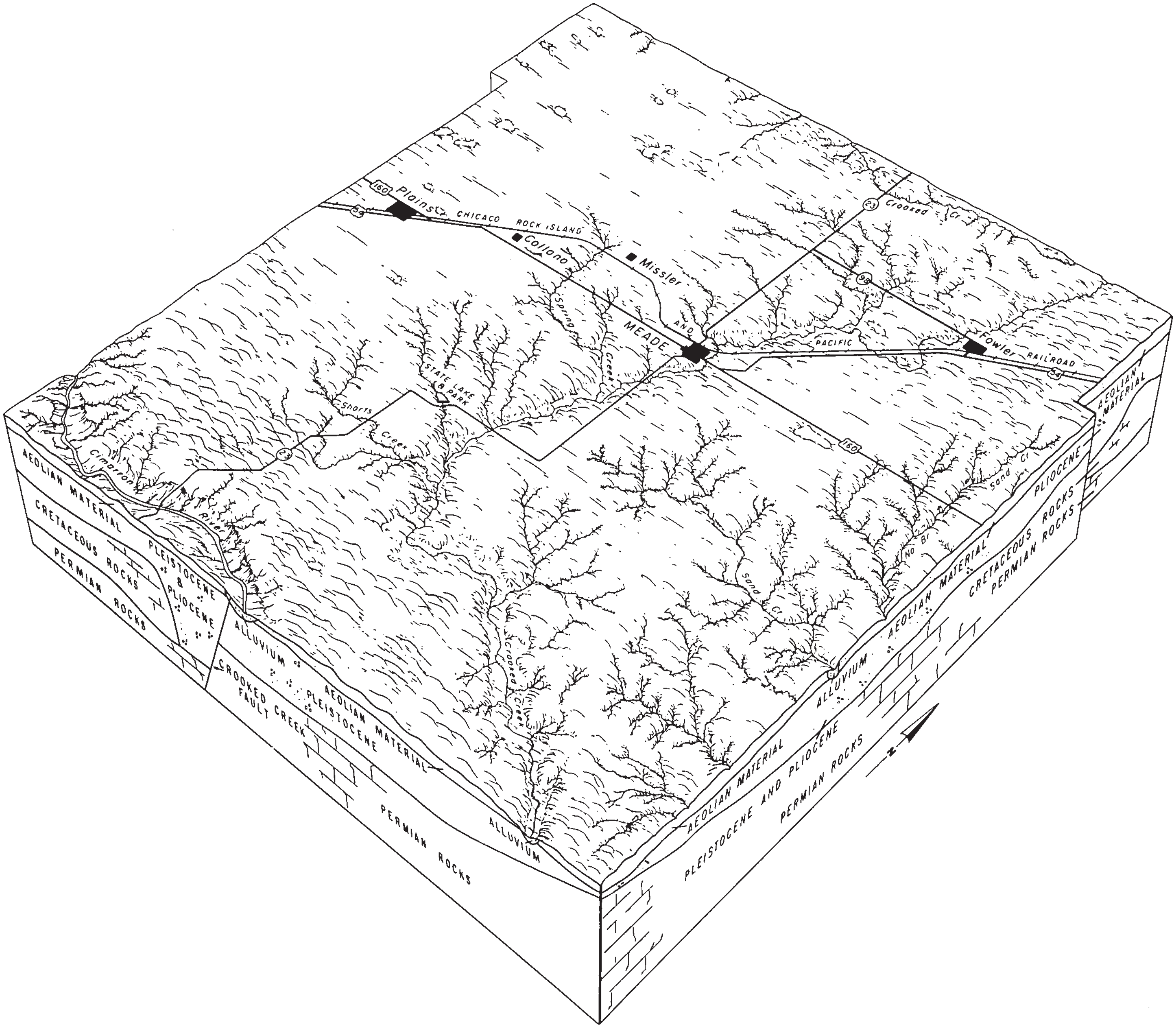

Figure 28.—**Diagram of the landscape of Meade County.**

and, about 6 miles from the State line, swings southeast and leaves the county. North of Meade, the valley of Crooked Creek is a broad, shallow basin. South of Meade, the valleysides along Crooked Creek are steeper, and the valley becomes narrower. The winding channel is inconspicuous in places north of Meade, but in times of heavy rainfall, the sluggish stream quickly overflows its banks and floods wide areas of the valley floor (*9*).

The upland plains in the northwestern and east-central parts of the county are flat and featureless. A common feature of these undissected plains is the occurrence of many undrained depressions, commonly referred to as "potholes," which hold water after rain. They become temporary lakes. An area of hummocky to undulating sandhills and dunes is in the southern part of the county and, also, in a small area in the extreme northeast corner.

Broken, dissected areas are adjacent to the Cimarron River, Crooked Creek, Sand Creek, and their tributaries.

The county is drained by the Cimarron River and two tributaries—Crooked Creek and Sand Creek. The highest point in the county, about 2,800 feet above sea level, is in the northwestern part of the county. The lowest point in the county, about 2,100 feet, is where the valley of Crooked Creek crosses the Kansas-Oklahoma State line.

Nearly all of the domestic and livestock water in rural areas of Meade County is obtained from wells and springs. On a few farms and ranches in the county, small streams furnish adequate water for livestock. Some small dams have been constructed across intermittent drainageways in the uplands, but most ranchers must rely upon wells for stockwater during at least part of the year. Irrigation water is pumped from deep wells drilled into the Ogallala Formation. Water is relatively abundant in some areas, but it is limited or absent in others.

The sands and gravels of the Ogallala Formation are the most productive source of ground water in the county. The sands and gravels of the Meade Formation rank next to the Ogallala Formation as a water-bearing formation in Meade County.

Climate [8]

Meade County has a typical continental climate, as would be expected from its location in the interior of a large landmass in the middle latitudes. Such climates are characterized by large diurnal and annual variations in temperature. This feature of the climate is similar to all of Kansas, as well as for much of the area between the Rockies to the west and the Appalachian Mountains to the east.

The climate of Meade County can also be described as semiarid (*10*), because the average evapotranspiration is considerably higher than the average precipitation reached each year. Even in the years of highest rainfall, the climate is subhumid. Low precipitation is typical of the western part of Kansas and of much of the Great Plains Region. The Rocky Mountains, less than 300 miles to the west of Meade County, serve as a barrier to the moisture-laden winds from the Pacific Ocean. By the time these air currents reach the Great Plains, their moisture content is extremely low and not sufficient to produce substantial precipitation. Most of the moisture that reaches this area must come from the Gulf of Mexico (*4*); however, the general circulation pattern of the atmosphere allows movement in this direction only occasionally.

Climatological records have not been made continuously at one location in Meade County for a long period of time. Early records were made at Plains, but they ceased in the late 1940's. Since then records have been kept at Meade and at Fowler. Because it is necessary to have at least 30 years of record to determine the reliable climatic data, the records from Ashland in nearby Clark County are shown in table 11; these should be representative of Meade County. The values for precipitation might be slightly lower than those presented; but it would amount to no more than 1 inch difference in the annual total.

Even in the most favorable years, precipitation is marginal for farm production without some conservation measures. The year 1949 was the wettest year on record, with the following totals: Fowler, 36.15 inches; Meade, 38.50 inches; and Plains, 35.66 inches. The year 1954 was the driest year, with 9.06 inches at Folwer and 10.61 inches at Meade. The year 1966 was also dry; total precipitation was about 10 inches in some parts of the county (*6*).

Normally, precipitation in Meade County is about 21 inches annually. It is largely a result of summertime convective shower activity. About 75 percent of the annual total falls during the growing season of April to September (*5*). Measurable amounts of precipitation occur about 62 days each year. Precipitation days are infrequent (2 to 4 per month) in winter and reach a peak of 8 days in May and June. Unfortunately, 60 percent of the precipitation days produces less than 0.25 inch. There are only about 5 days in a year when precipitation totals 1 inch or more.

[8] By L. DEAN BARK, climatologist, Kansas Agricultural Experiment Station, Manhattan, Kansas.

TABLE 11.—*Temperature and precipitation*

[Data from Ashland, Kansas]

Month	Temperature				Precipitation		
	Average daily— [1]		Two years in 10 will have about 4 days with— [2]		Average total [1]	One year in 10 will have— [3]	
	Maximum	Minimum	Maximum temperature equal to or higher than—	Minimum temperature equal to or lower than—		Less than—	More than—
	°F	*°F*	*°F*	*°F*	*Inches*	*Inches*	*Inches*
January	48.0	20.4	67.3	4.8	0.48	0.04	1.03
February	52.8	23.8	72.6	8.6	0.77	0.08	2.27
March	60.6	30.8	81.0	14.0	1.23	0.01	2.60
April	71.8	42.2	87.7	28.4	1.74	0.40	3.57
May	79.6	52.8	94.1	39.7	3.37	0.94	6.98
June	90.4	62.8	102.4	52.4	3.48	0.90	5.90
July	96.0	67.4	105.8	59.9	2.85	0.57	5.59
August	95.6	66.2	106.6	56.4	2.98	0.87	5.30
September	87.4	57.2	99.8	42.7	2.34	0.42	5.42
October	76.0	45.0	90.5	31.9	1.67	0.90	4.04
November	60.2	30.0	77.0	15.8	0.77	0.01	3.09
December	50.8	23.0	69.2	8.8	0.66	0.04	1.61
Year	72.6	43.6	107 [4]	-5 [5]	22.34	15.02	31.20

[1] Period of record 1941-70.
[2] Period of record 1931-60.
[3] Period of record 1901-70.
[4] Average annual highest temperature.
[5] Average annual lowest temperature.

Snowfall is light in most years. The average for the county is about 15 inches. Winter cyclones moving from their origin in the northeastern part of New Mexico pass nearby. Such storms can bring blizzard conditions, but they are infrequent. Snow seldom remains on the ground for much more than 2 or 3 days.

The large daily variations in temperature are the result of high altitude and low humidity, both of which allow marked heating by solar radiation during the day and large losses of heat from the ground at night. The daytime temperature averages 25 to 30 degrees higher than the nighttime temperature. It is not unusual for diurnal ranges of temperature to reach 40 degrees.

The annual range in temperature is also large. Annual extremes generally range from near zero to more than 100 degrees. These extreme spells are generally of short duration and are not of great importance to the overall climate. Table 11 shows the monthly average temperatures at Ashland, from which it can be seen that the transitional seasons of spring and fall are rather short. Winter lasts from December to February, and summer from May into October. The average frost-free, or growing, season is 185 days (*3*). The probabilities of freezes in spring and fall are shown in table 12.

The prevailing wind is southerly. Winds are moderate in all seasons, but strong winds occur occasionally. Strongest winds are usually associated with intense low-pressure storms in spring or with thunderstorms in summer. A combination of moderate to strong winds, light precipitation, low humidity, and warm temperatures can produce severe moisture stress on growing crops. Such conditions are frequent in this area of the State, and such measures as irrigation, fallowing, and control of soil blowing must be used as a regular part of the farm operation. These drought conditions, which exist almost every year for at least a short period of time, are the most detrimental of all weather hazards in the county.

Hail and tornadoes occur in Meade County, but not so frequently as in other parts of the State. Such storms are local in extent, of short duration, and extremely variable in amount of damage.

The climate of Meade County is marginal for the continuous production of cultivated crops. It is similar to much of the climate of the High Plains Region. If supplemental water and careful cultural practices are used, farming can be done as it was in the past. The moisture climate is extremely variable, and all farm practices should include a good reserve, some degree of mobility, and a method of conserving or supplementing the natural moisture supply.

Farming

Before the 1880's, all of Meade County was used for raising cattle. During the latter part of the nineteenth century, there was rapid settlement of the area by farmers. The population of the county has fluctuated over the years. It has decreased rapidly during prolonged droughts, but surged upward again as new settlers arrived during times of adequate rainfall to produce crops.

After the droughts and dust storms of the 1930's as a result of low rainfall, the first large irrigation well was constructed on the upland in 1939. Some acreages in the Artesian Valley were also irrigated with existing flowing wells. The U.S. Census of Agriculture reported that in 1969 about 50,000 acres in the county was irrigated.

Dryland farming and irrigated farming are both practiced in Meade County. The raising of livestock has increased in the last 20 years. Ranchers are mainly confined to the sloping and strongly sloping land along the Cimarron River, Crooked Creek, and Sand Creek. In 1969 cropland amounted to 377,484 acres. Most of the crops grown in the county are shipped out of the county. Farming operations are on a large scale and are highly mechanized.

According to the 1969 U.S. Census of Agriculture, there were an estimated 562 farms, compared to 883 in 1935. The average farm was 1,107 acres, compared to 676 acres in 1935. These figures show that, although the number of farms has decreased, the average size of the farms has increased greatly.

Crops.—Wheat and grain sorghum are the main dryfarmed crops. Alfalfa and barley are also grown, but to a lesser extent. On the silty and loamy soils, wheat and grain sorghum are commonly grown in a crop-fallow system. During the fallow period weeds are controlled so that moisture is conserved for use by the following crops. Sorghum is generally grown continuously on the sandy soils because of the difficulty in controlling soil blowing during periods of fallow.

Pasture.—In 1964 there was about 244,000 acres of pasture or range in Meade County. Most of the pasture or range is nonarable or lies adjacent to or within nonarable areas, and therefore it cannot be cultivated conveniently.

Livestock.—Cattle is the principal livestock in the county. The number of cattle is generally high in fall and winter, particularly when the preceding growing season was favorable. These animals are brought in from the range, and others are brought into the county to graze on the dryfarmed and irrigated wheat. A commercial feedyard just north of Meade has facilities for as many as 10,000

TABLE 12.—*Probabilities of last freezing temperatures in spring and first in fall (3)*

Proabability	Dates for given probability and temperature				
	16° F or lower	20° F or lower	24° F or lower	28° F or lower	32° F or lower
Spring:					
1 year in 10 later than	April 2	April 7	April 12	April 26	May 7
2 years in 10 later than	March 27	April 1	April 7	April 21	May 2
5 years in 10 later than	March 15	March 22	March 29	April 11	April 22
Fall:					
1 year in 10 earlier than	November 8	October 31	October 24	October 18	October 8
2 years in 10 earlier than	November 14	November 5	October 28	October 23	October 12
5 years in 10 earlier than	November 26	November 16	November 7	November 1	October 22

head of cattle. Hundreds of other cattle are finished out at smaller feedyards. There are only a few herds of dairy cattle in the county. According to the 1969 U.S. Census of Agriculture, there were about 305 milk cows, 53,478 other cattle, 5,330 hogs and pigs, 4,175 sheep and lambs, and 10,527 chickens in the county.

Natural Resources, Transportation, and Markets

Soil and ground water are important natural resources in Meade County. Gas, oil, sand, gravel, and volcanic ash are other natural resources in the county. The sand and gravel are used locally for road construction and in the making of concrete. They are from the Ogallala Formation along Crooked Creek south of the city of Meade and from the Meade Formation at several localities west of the city of Meade. Volcanic ash occurs in several parts of the county.

A railroad passes through Fowler, Meade, and Plains. Fowler, Meade, Missler, Collano, and Plains have facilities to handle and store grain. The railroad provides adequate transportation to terminal elevators and markets to the east.

There are modern highways and improved secondary roads throughout the county. U.S. Highway 160 extends from east to west through Meade and Plains, and U.S. Highway 54 passes through Fowler and Meade. Kansas Route 23 crosses the county from north to south through Meade. Approximately 79 percent of the county is accessible by county, State, or Federal roads.

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Glossary

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

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

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

Caliche. A more or less cemented deposit of calcium carbonate in many soils of warm-temperate areas, as in the Southwestern States. The material may consist of soft, thin layers in the soil or of hard, thick beds just beneath the solum, or it may be exposed at the surface by erosion.

Chlorosis. Yellowing or blanching of green portions of a plant, particularly the leaves. May be caused by disease organisms, unavailability of nutrients, or other factors.

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.

Complex, soil. A mapping unit consisting of different kinds of soils that occur in such small individual areas or in such an intricate pattern that they cannot be shown separately on a publishable soil map.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

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

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

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

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

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

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

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

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Gravel. Individual rock or mineral fragments having diameters ranging from 2.0 millimeters to 3 inches. As a textural class modifier, gravelly is used when the soil mass contains above 15 to 20 percent, by volume, of the fragments, depending on the other soil characteristics.

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

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

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

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

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

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

Leached soil. A soil from which most of the soluble materials have been removed from the entire profile or have been removed from one part of the profile and have accumulated in another part.

Loam. As a soil textural class, a soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand.

Loess. Fine-grained material, dominantly of silt-sized particles, that has been deposited by wind.

Parent material. Disintegrated and partly weathered rock from which soil has formed.

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

pH value. A numerical means for designating acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

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

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

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

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

Saline soil. A soil that contains soluble salts in amounts that impair growth of plants but that does not contain excess exchangeable sodium.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 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.

Series, soil. A group of soils developed from a particular type of parent material and having genetic horizons that, except for texture,of the surface layer, are similar in differentiating characteristics and in arrangement in the profile.

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.

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

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each gran by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

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

Substratum. Technically, the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

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GUIDE TO MAPPING UNITS

For a complete description of a mapping unit, read both the description of the mapping unit and the description of the soil series to which the mapping unit belongs. Dashed lines indicate soil is not irrigated or is not placed in a range site or windbreak suitability group.

Map symbol	Mapping unit	Page	Capability unit Dryland Symbol	Capability unit Irrigated Symbol	Range site Name	Range site Page	Windbreak suitability group Name
An	Alluvial land, loamy	7	VIw-1	------	Loamy Lowland	33	Lowland
Bo	Blown-out land	7	VIIe-1	------	Choppy Sands	35	------------
Cc	Campus-Canlon complex, 5 to 15 percent slopes	8	VIe-4	------	-------------	--	------------
	Campus soils	--	------	------	Limy Upland	33	------------
	Canlon soils	--	------	------	Shallow Limy	36	------------
Ha	Harney silt loam, 0 to 1 percent slopes	10	IIc-1	I-1	Loamy Upland	33	Silty Upland
Hb	Harney silt loam, 1 to 3 percent slopes	10	IIe-1	IIe-1	Loamy Upland	33	Silty Upland
Hc	Harney silty clay loam, 1 to 3 percent slopes, eroded	11	IIIe-1	IIe-1	Loamy Upland	33	Silty Upland
Kz	Kanza soils	11	Vw-1	------	Subirrigated	36	------------
Le	Leshara clay loam	11	IIw-1	IIw-1	Subirrigated	36	Subirrigated Lowland
Lh	Lesho clay loam	12	IIIw-3	IIIw-3	Subirrigated	36	Subirrigated Lowland
Lk	Likes loamy sand	12	VIe-2	------	Sands	34	Sandy Upland
Ln	Lincoln soils	13	Vw-1	------	Sandy Lowland	34	------------
Ma	Mansic clay loam, 0 to 1 percent slopes	14	IIc-1	I-1	Limy Upland	33	Silty Upland
Mb	Mansic clay loam, 1 to 3 percent slopes	14	IIIe-1	IIe-3	Limy Upland	33	Silty Upland
Mc	Mansic clay loam, 3 to 6 percent slopes	15	IIIe-1	IIIe-1	Limy Upland	33	Silty Upland
Mf	Mansic clay loam, 3 to 6 percent slopes, eroded	15	IVe-2	IIIe-1	Limy Upland	33	Silty Upland
Mg	Mansic clay loam, 6 to 15 percent slopes	15	VIe-1	------	Limy Upland	33	Silty Upland
Mm	Mansic-Manter complex, 1 to 4 percent slopes	15	IIe-2	IIe-2	------------	--	------------
	Mansic soils	--	------	------	Limy Upland	33	Silty Upland
	Manter soils	--	------	------	Sandy	35	Sandy Upland
Mr	Manter fine sandy loam, 0 to 1 percent slopes	16	IIIe-4	IIs-1	Sandy	35	Sandy Upland
Ms	Manter fine sandy loam, 1 to 3 percent slopes	17	IIIe-4	IIe-2	Sandy	35	Sandy Upland
Mt	Manter fine sandy loam, 1 to 3 percent slopes, eroded	17	IIIe-4	IIe-2	Sandy	35	Sandy Upland
Mu	Manter-Satanta fine sandy loams, 1 to 4 percent slopes	17	IIe-2	IIe-2	Sandy	35	Sandy Upland
Mx	Missler silty clay loam, 0 to 1 percent slopes	18	IIc-1	I-1	Clay Upland	33	Silty Upland
Mz	Missler silty clay loam, 1 to 6 percent slopes	18	IIIe-1	IIIe-1	Clay Upland	33	Silty Upland
Ns	Ness silty clay	18	VIw-2	IVs-1	------------	--	------------
Ot	Otero fine sandy loam, 6 to 15 percent slopes	19	VIe-3	------	Sandy	35	Sandy Upland
Ov	Otero-Mansic complex, 5 to 25 percent slopes	19	VIe-5	------	------------	--	------------
	Otero soils	--	------	------	Sandy	35	------------
	Mansic soils	--	------	------	Limy Upland	33	------------
Oz	Otero-Manter fine sandy loams, 3 to 6 percent slopes	19	IVe-3	IIIe-3	Sandy	35	Sandy Upland
Pr	Pratt soils, 0 to 5 percent slopes	20	IVe-1	IIIe-2	Sands	34	Sandy Upland
Pt	Pratt soils, 5 to 15 percent slopes	20	VIe-2	IVe-4	Sands	34	Sandy Upland
Rb	Rough broken land	20	VIIs-1	------	Shallow Limy	36	------------
Rx	Roxbury silt loam	20	IIc-2	I-1	Loamy Terrace	33	Lowland
Sa	Satanta fine sandy loam, 0 to 2 percent slopes	21	IIe-2	IIe-2	Sandy	35	Sandy Upland

Map symbol	Mapping unit	Page	Capability unit Dryland Symbol	Capability unit Irrigated Symbol	Range site Name	Range site Page	Windbreak suitability group Name
Sb	Satanta loam, 0 to 1 percent slopes----------	21	IIc-1	I-1	Loamy Upland	33	Silty Upland
Sc	Satanta loam, 1 to 3 percent slopes----------	21	IIe-1	IIe-1	Loamy Upland	33	Silty Upland
Sp	Spearville silty clay loam, 0 to 1 percent slopes------------------------------------	22	IIs-2	IIs-2	Clay Upland	33	Silty Upland
Tv	Tivoli fine sand, 10 to 25 percent slopes---	23	VIIe-1	------	Choppy Sands	35	------------
Ua	Uly silt loam, 0 to 1 percent slopes--------	24	IIc-1	I-1	Loamy Upland	33	Silty Upland
Ub	Uly silt loam, 1 to 3 percent slopes--------	25	IIe-3	IIe-3	Loamy Upland	33	Silty Upland
Uc	Uly silt loam, 1 to 3 percent slopes, eroded------------------------------------	25	IIIe-1	IIe-3	Limy Upland	33	Silty Upland
Us	Uly silt loam, 3 to 6 percent slopes--------	25	IIIe-1	IIIe-1	Loamy Upland	33	Silty Upland
Ut	Uly silt loam, 3 to 6 percent slopes, eroded------------------------------------	26	IVe-2	IIIe-1	Limy Upland	33	Silty Upland
Wn	Wann loam------------------------------------	27	IIw-2	IIw-2	Subirrigated	36	Subirrigated Lowland
Yo	Yahola sandy loam----------------------------	28	IIIe-4	IIs-1	Sandy Terrace	35	Sandy Upland

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