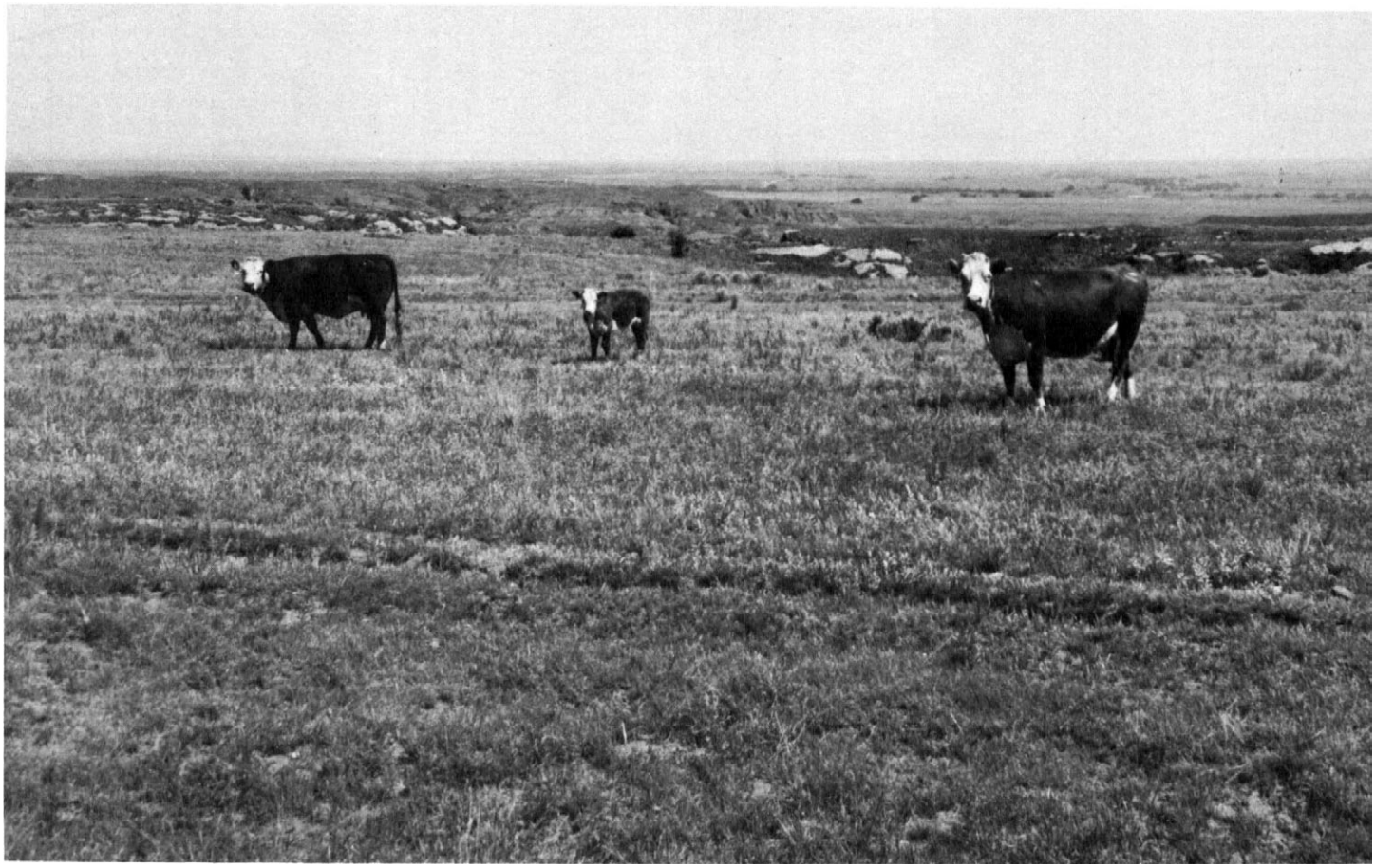
SOIL SURVEY OF

Barber 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 1961–71. Soil names and descriptions were approved in 1972. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1971. 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 Barber County Conservation District.

HOW TO USE THIS SOIL SURVEY

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

Locating Soils

All the soils of Barber 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 gives the capability classification of each. It also shows the page where each soil is described and the page for the range site and number of the windbreak suitability group in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the 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 with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers, ranchers, and others can learn about use and management of the soils from the soil descriptions and from the discussions of the range sites and windbreak suitability groups.

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

Ranchers and others can find, under "Range," groupings of the soils according to their suitability for range, the names of many of the plants that grow on each range site, and the expected annual yield of each 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 Barber 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 given in the section "General Facts about the County."

Cover: Area of Sandy range site in excellent condition. Quality cattle are grazing well-managed range.

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Issued February 1977

SOIL SURVEY OF BARBER COUNTY, KANSAS

BY DAROLD A. DODGE, SOIL SCIENTIST, SOIL CONSERVATION SERVICE [1]

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

BARBER COUNTY, in the south-central part of Kansas, has a total area of 1,146 square miles, or 733,248 acres (fig. 1). Medicine Lodge, which is in the east-central part of the county at the confluence of Medicine River and Elm Creek, is the county seat.

Ranching and farming are important enterprises in the county. Beef cattle are the major livestock, but some dairy cows are kept. Winter wheat, grain and forage sorghums, and alfalfa are the major crops.

Irrigation is practiced on a few farms in the Sharon Valley, the Medicine River Valley, and in an area near Isabel.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Barber County, where they are located, and how they can be used. The soil scientists went into the county knowing they were likely to 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 speed 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* and the *soil phase* are the categories of soil classification most used in a local survey.

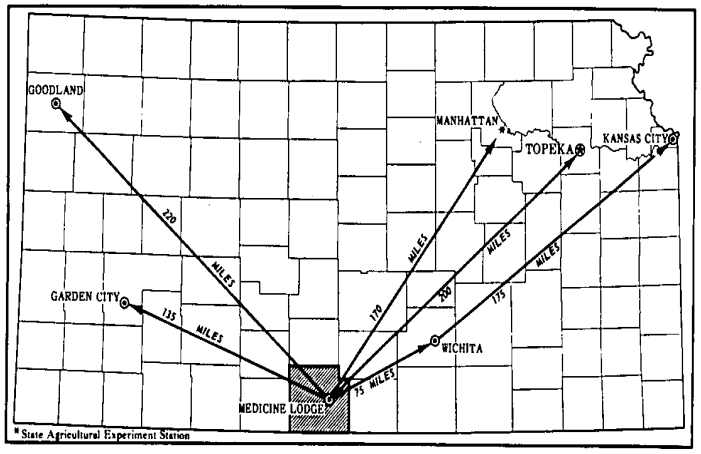

Figure 1.—Location of Barber County in Kansas.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Grant and Pond Creek, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

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, Grant silt loam, 0 to 1 percent slopes, is one of several phases within the Grant series.

After a guide for classifying and naming the soils had been worked out, the soil scientist 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 other kind that have been seen within an area that is dominantly a recognized soil phase.

Some mapping units are made up of soils of different series, or no series name is assigned. Two such kinds of mapping units are shown on the soil map of Barber County: soil complexes and miscellaneous land types.

A soil complex consists of areas of two or more soils,

[1] WILLIAM E. ROTH, soil scientist, Soil Conservation Service, helped survey the Davis Ranch along the Salt Fork of the Arkansas River.

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. Quinlan-Woodward complex, 5 to 15 percent slopes, is an example.

Miscellaneous land types are areas of land that have little or no natural soil. They are land areas that are nearly inaccessible, or for other reasons, it is not feasible to classify the soil. They are named in terms of the land form and in terms of the soil material present. For example, Rough broken land, shaly, is a land type in Barber County.

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

Soil scientists set up trial groups of soils on the basis of yield and practice tables and other data. They test these groups by further study and by consultation with farmers, ranchers, agronomists, engineers, and others. Then, they adjust the groups according to the results of their studies and consultations. Thus, the groups that are finally evolved reflect up-to-date knowledge of soils and their behavior under present 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 Barber County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of 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, recreation 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 structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The soil associations in this survey have been grouped into three general kinds of landscapes for broad interpretative purposes. Each of the broad groups and each of the soil associations in those groups are described in the following pages. The terms for texture used in the title for several of the associations apply to the texture of the surface layer. For example, in the title of Pratt-Attica-Farnum association, the words "sandy" and "loamy" refer to the texture of the surface layer.

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.

Well-Drained, Nearly Level to Moderately Steep Soils That Formed in Loess and Old Alluvium; on Uplands

About 55 percent of the acreage of these soils is used for range and 45 percent for crops. The range is mostly on sloping and moderately steep, loamy soils and on rolling, sandy soils. The crops are mostly on nearly level, gently sloping, and sloping, loamy and clayey soils.

The main concerns of management are controlling water erosion and soil blowing, conserving moisture, maintaining soil fertility, and protecting native grassland with good range management.

1. *Albion-Shellabarger association*

Deep, gently sloping to moderately steep, loamy soils

The soils of this association are gently sloping, rolling, and hilly (fig. 2).

This association makes up 20 percent of the county. It is 45 percent Albion soils, 27 percent Shellabarger soils, and 28 percent minor soils.

The gently sloping to moderately steep Albion soils are on narrow, convex ridgetops and side slopes. These soils are moderately deep to sand and gravel and somewhat excessively drained. They have a surface layer of sandy loam about 8 inches thick and a subsoil of heavy sandy loam about 8 inches thick.

Shellabarger soils are gently sloping to moderately steep and are on medium-length, convex ridges and side slopes. These soils are deep and well drained. They have a surface layer of sandy loam about 14 inches thick and a subsoil of sandy clay loam about 34 inches thick. Underlying material is sandy loam and loamy sand.

The minor soils are mainly Naron, Clark, and Farnum soils, but there are also small areas of Pratt soils and gravel beds. Gently sloping Naron, Clark, and Farnum soils are on convex ridges. Sloping and moderately steep gravel beds are on convex side slopes and ridges.

Nearly all of this association is used for range. A small acreage of Albion, Shellabarger, Naron, Clark, and Farnum soils is used for crops.

The chief concerns of management are using proper management of range and controlling erosion and runoff in areas used for crops.

2. *Blanket-Farnum association*

Deep, nearly level and gently sloping, loamy soils

The soils of this association are on medium and long, convex ridges and side slopes.

This association makes up 3 percent of the county. It

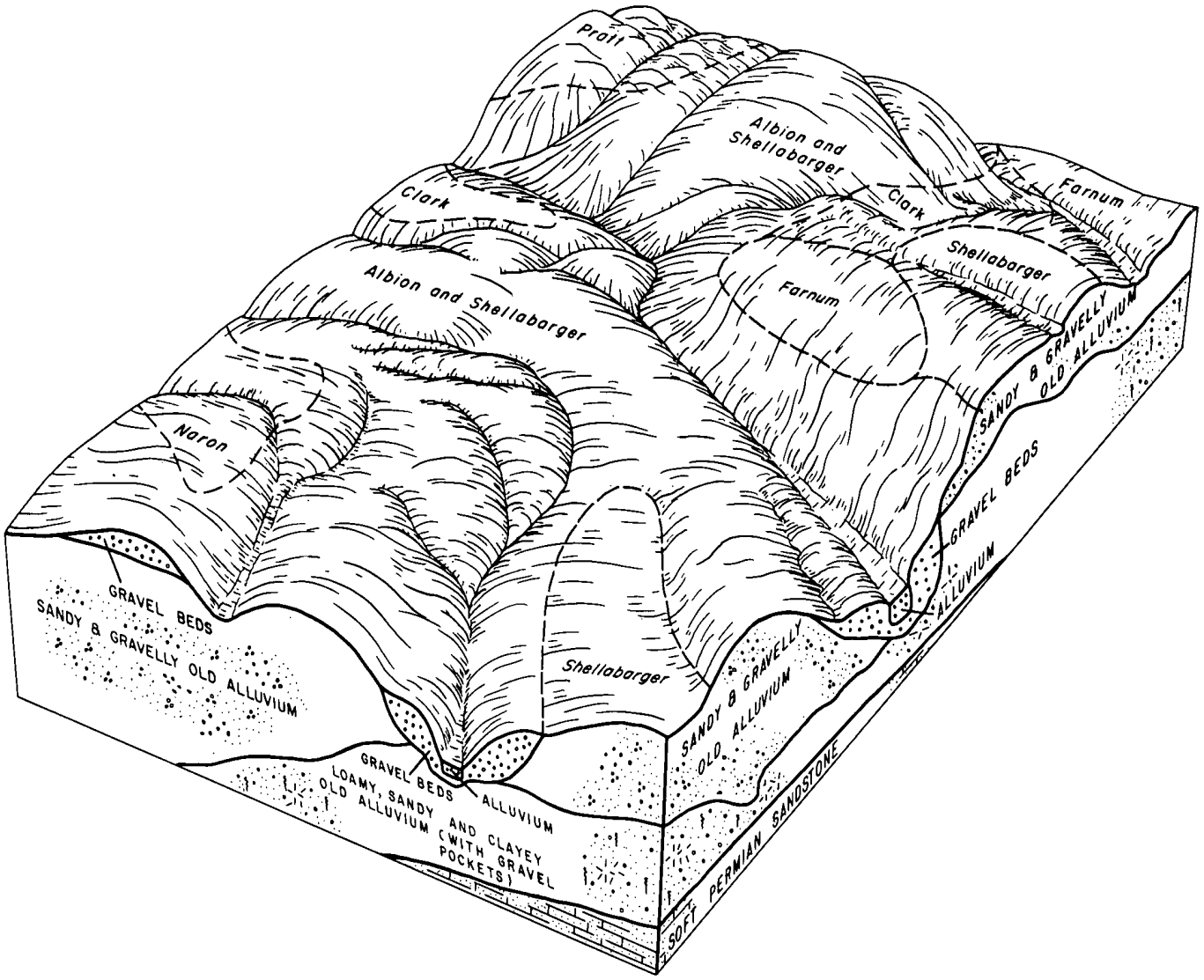

Figure 2.—**Parent material and position of soils in association 1.**

is 63 percent Blanket soils, 21 percent Farnum soils, and 16 percent minor soils.

The deep, nearly level and gently sloping Blanket soils have medium and long, convex slopes and are on ridges, divides, and along drainageways. They have a surface layer of silt loam about 9 inches thick and a subsoil of silty clay loam and silty clay about 37 inches thick. Underlying material is clay loam. Blanket soils formed in loess and old alluvium. They are well drained and have moderately slow permeability.

The deep, nearly level and gently sloping Farnum soils are on medium and long, convex ridges and side slopes. They have a surface layer of loam about 9 inches thick and a subsoil of clay loam about 39 inches thick. Underlying materials are clay loam or sandy clay loam. Farnum soils formed in stratified, loamy, old alluvium. They are well drained and have moderately slow permeability.

The minor soils are mainly Ost and Clark soils, but there are small areas of Case soils. Nearly level and gently sloping Ost soils are in the narrow, convex areas that are associated with Blanket soils. Gently sloping and sloping Clark soils are on convex ridges and side slopes. Case and Clark soils are close together on convex side slopes along drainageways.

Most of this association is used for crops. It is well suited to all the crops and grasses commonly grown in the county. Sloping areas along drainageways have been somewhat damaged by erosion. Other sloping areas in native grass are not eroded.

The chief management needs are controlling erosion, conserving moisture, and maintaining tilth and good fertility. Small areas that need to be reseeded to native grasses and others where native grasses are already established need proper range management.

3. *Pratt-Attica-Farnum association*

Deep, gently rolling and rolling, sandy soils and nearly level and gently sloping, loamy soils

The soils in this association have complex, short and medium-length slopes and are on ridges and side slopes. They have been reworked by wind in the upper layers and have stratified, old, alluvial sediment in the lower layers (fig. 3).

This association makes up 2 percent of the county. It

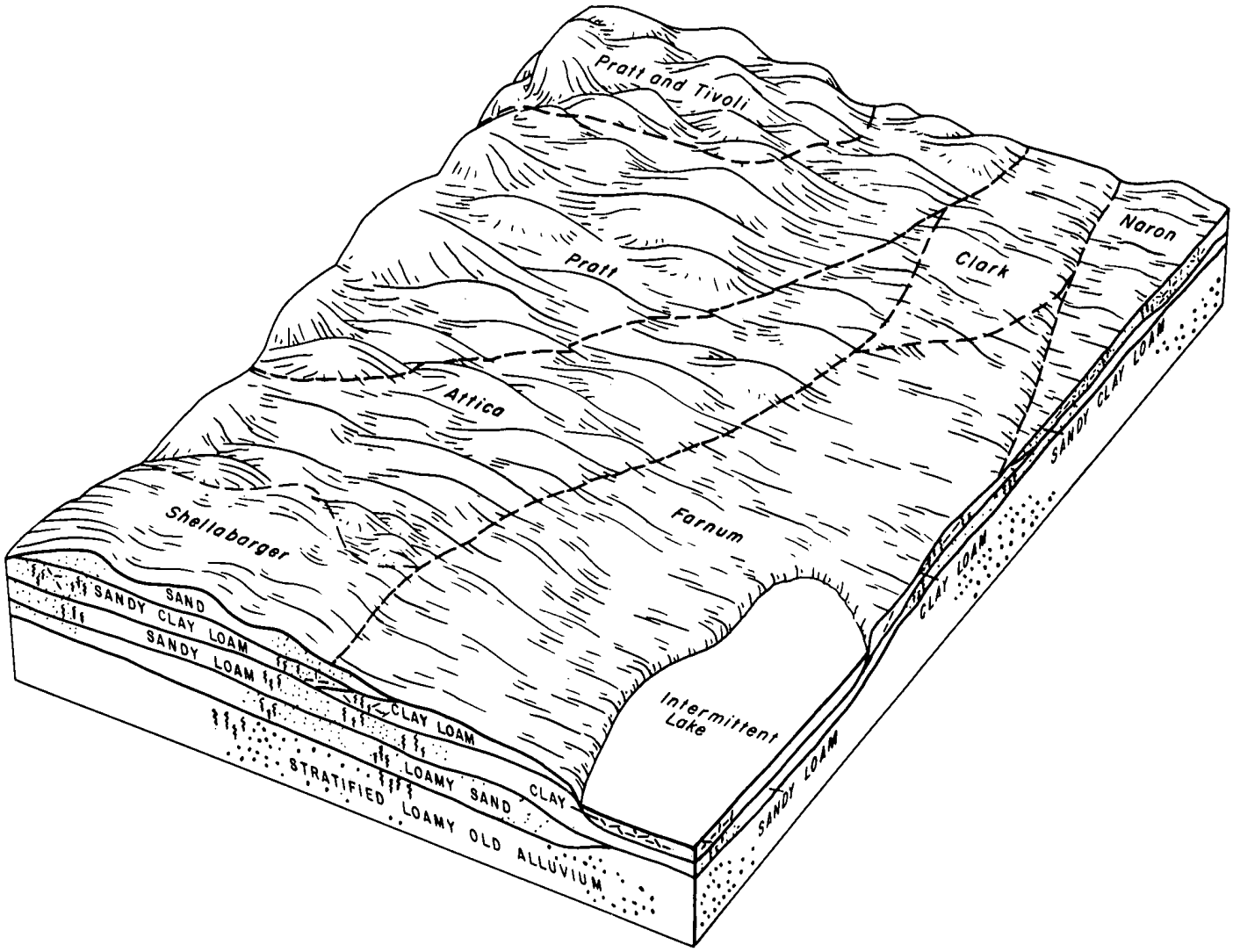

Figure 3.—**Parent material and position of soils in association 3.**

is 20 percent Pratt soils, 20 percent Attica soils, 20 percent Farnum soils, and 40 percent minor soils.

The deep, rolling Pratt soils have short and medium, complex slopes and are in wind-modified areas. They have a surface layer of loamy fine sand about 7 inches thick and a subsoil of heavy loamy fine sand about 23 inches thick. Underlying material is loamy fine sand. Pratt soils formed in sandy eolian sediments. They are well drained and have rapid permeability.

The deep, gently rolling Attica soils have complex slopes and are in wind-modified areas that are slightly lower than Pratt soils. They have a surface layer of loamy fine sand about 12 inches thick and a subsoil of fine sandy loam about 18 inches thick. Underlying material is loamy fine sand. Attica soils formed in loamy and sandy eolian sediments. They are well drained and have moderately rapid permeability.

The deep, nearly level and gently sloping Farnum soils are on medium and long, convex ridges and side slopes. They have a surface layer of loam or fine sandy loam about 9 inches thick and a subsoil of clay loam about 39 inches thick. Underlying materials are clay loam and sandy clay loam. Farnum soils formed in stratified, loamy, old alluvium. They are well drained and have moderately slow permeability.

The minor soils are mainly Shellabarger, Clark, and Naron soils, but there are small areas of Tivoli soils and intermittent lakes. Sloping Shellabarger soils are on medium-length, convex ridges and side slopes in lower areas than Pratt or Attica soils. Nearly level and gently sloping Clark soils are on short convex side slopes below the Pratt, Attica, and Shellabarger soils. Nearly level and gently sloping Naron soils are at about the same level in the landscape as Farnum soils. Tivoli soils occur only with Pratt soils in the higher, rolling and hilly areas. Intermittent lakes form in low areas of Farnum soils.

Most of this association is used for crops, but areas of Pratt-Tivoli loamy fine sand and other small areas are used as range. This association is well suited to dryland crops as well as the native and tame grasses commonly grown in the county.

The chief management needs are protecting the soil from blowing, conserving moisture, and maintaining soil fertility. Good management is needed in the areas used as range.

4. *Farnum-Naron-Ost association*

Deep, nearly level and gently sloping, loamy soils

The soils of this association have medium and long, convex slopes and are on ridges and divides.

This association makes up 7 percent of the county. It is 29 percent Farnum soils, 26 percent Naron soils, 16 percent Ost soils, and 29 percent minor soils.

The deep, nearly level and gently sloping Farnum soils are on medium and long, convex ridges, divides, and the upper part of drainageways. They have a surface layer of loam, clay loam, or fine sandy loam about 9 inches thick and a subsoil of clay loam about 39 inches thick. Underlying materials are clay loam or sandy clay loam. Farnum soils formed in stratified, old alluvium. They are well drained and have moderately slow permeability.

The deep, nearly level and gently sloping Naron soils have long and medium, convex slopes. They are closely intermingled with Farnum soils. They have a surface layer of fine sandy loam about 12 inches thick and a subsoil of heavy fine sandy loam and sandy clay loam about 25 inches thick. Underlying materials are light fine sandy loam, light sandy clay loam, or loamy sand in places. Naron soils formed in eolian deposits underlain by old alluvium. They are well drained and have moderate permeability.

The deep, nearly level and gently sloping Ost soils are on medium-length, convex ridges and on side slopes. Ost soils have a surface layer of clay loam about 8 inches thick and a subsoil of clay loam about 20 inches thick. Underlying material is calcareous clay loam. Ost soils formed in highly calcareous, loamy, old alluvium. They are well drained and have moderately slow permeability.

The minor soils are mainly Shellabarger, Blanket, and Attica soils, but there are small areas of Case, Clark, Pratt, and Tivoli soils. The sloping Shellabarger soils are on convex ridges above areas of Naron soils and on side slopes adjacent to broad areas of the Albion-Shellabarger association. The nearly level Blanket soils have medium-length, convex slopes, and they are intermingled with Farnum and Ost soils. The gently rolling Attica soils are on isolated knobs throughout the association. Case and Clark soils are in convex, sloping, somewhat eroded areas along the lower part of drainageways. Pratt and Tivoli soils are on the higher isolated knobs, mainly in the eastern and northeastern parts of the association.

Most of this association is cultivated and is suited to all the crops commonly grown in the county. Some small areas along drainageways and areas of hilly sandy soils are used for range.

The chief management needs are protecting the soil from blowing, controlling water erosion, conserving moisture, and maintaining tilth and fertility. Proper management is needed in areas used as range.

Well-Drained, Nearly Level to Moderately Steep Soils That Formed in Material Weathered from Soft Sandstone, Siltstone, and Shale; on Uplands

About 60 percent of the acreage is used for range and about 40 percent for crops. The range is mostly on sloping and moderately steep, clayey and loamy soils. The crops are mostly on nearly level to sloping, loamy soils.

The main management needs are controlling water erosion and soil blowing, protecting native grassland with good range management practices, controlling cutting of and deposition in channels, conserving moisture, and maintaining soil fertility.

5. *Vernon-Kingfisher association*

Moderately deep and deep, gently sloping to moderately steep, loamy soils

The higher areas of this association are steep, shaly and dissected by drainageways that occur in a complex dendritic pattern (fig. 4). The lower areas consist mainly of Vernon, Kingfisher, and Clairemont soils.

This association makes up 24 percent of the county. It is 55 percent Vernon soils; 20 percent Rough broken land, shaly; 15 percent Kingfisher soils, and 10 percent minor soils.

The moderately deep, gently sloping, sloping, and moderately steep Vernon soils are on short, convex ridges and side slopes. Vernon soils have a surface layer of clay loam about 5 inches thick, and a subsoil of clay about 17 inches thick. Underlying layers are clayey shale. Vernon soils formed in materials weathered from clayey shale red beds that contain much gypsum. They are well drained and very slowly permeable.

Steep Rough broken land, shaly, has short, complex, concave slopes.

The deep, gently sloping and sloping Kingfisher soils are on short and medium-length, convex ridges and divides. They have a surface layer of silt loam about 9 inches thick and a subsoil of silty clay loam and heavy silty clay loam about 19 inches thick. Underlying layers are partly weathered clayey shale. They are well drained and have moderately slow permeability. Except in some gently sloping areas, Kingfisher soils occur in a complex pattern with Vernon soils.

The minor soils consist mainly of Clairemont soils, but there are small areas of Mangum soils and colluvial materials. Nearly level Clairemont soils are on the flood plains in the middle and upper part of drainageways. Nearly level Mangum soils are on the flood plains, which consist of the broader lower part of drainageways and alluvial fans.

Nearly all of this association is used for range. Some small fields of Kingfisher and Vernon soils are used for crops. Kingfisher soils are well suited to all the crops commonly grown in the county but Vernon soils are less well suited.

The main management needs are protecting native grassland with good range management, controlling soil erosion, conserving moisture, and maintaining good fertility.

6. *Quinlan-Woodward-Grant association*

Shallow, moderately deep and deep, nearly level to moderately steep, loamy soils

This association consists of moderately steep soils that are dissected by deep ravines and gently sloping and sloping soils in adjoining areas (fig. 5). The soils formed in material that weathered from soft sand-

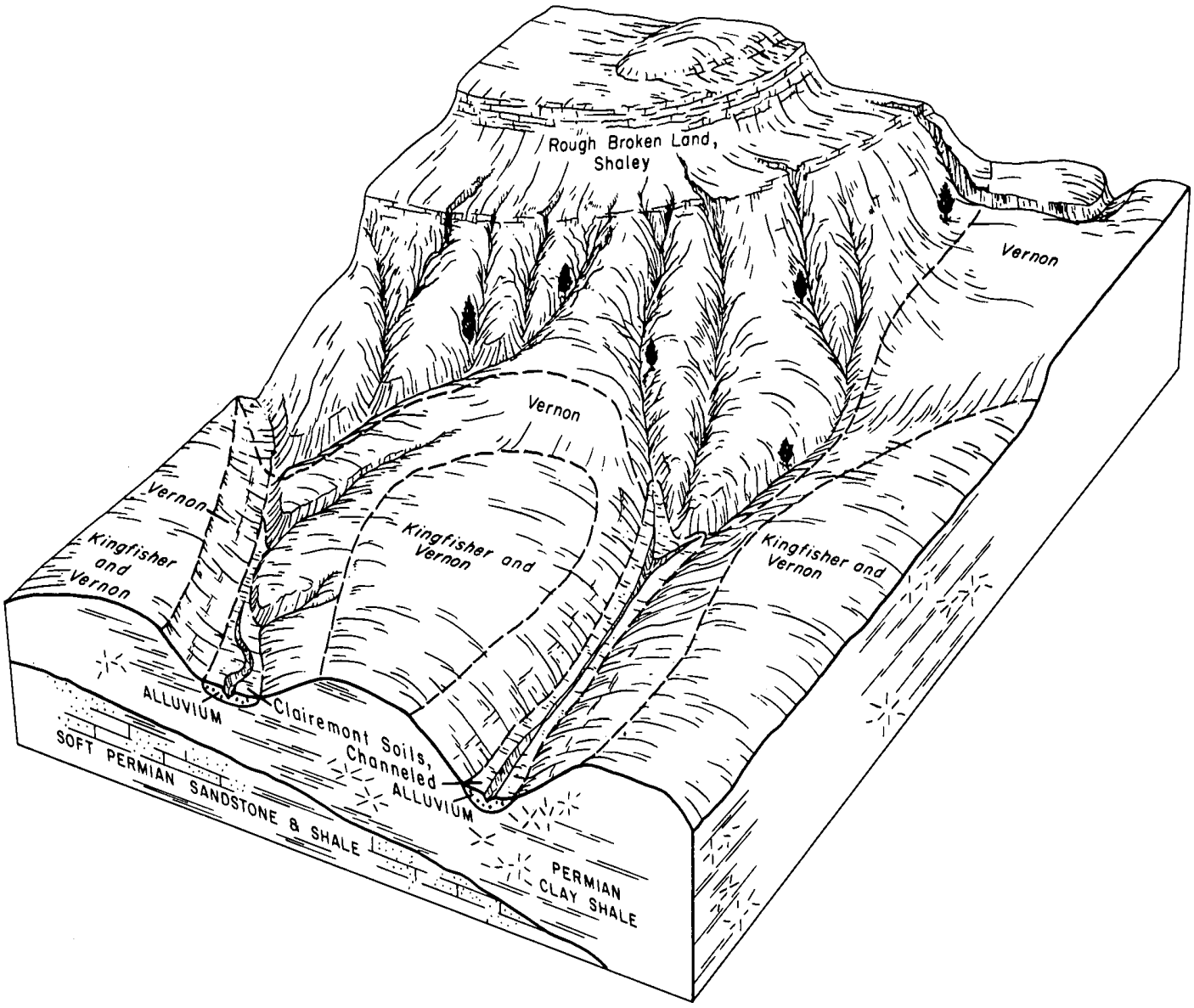

Figure 4.—**Parent material and position of soils in association 5.**

stone. The material is underlain by layers of soft sandstone. Water erosion has created many ravines. Small areas of sandstone outcrop are on the sides of the ravines or breaks and in the sloping and moderately steep areas of Quinlan and Woodward soils.

This association makes up 17 percent of the county. It is 36 percent Quinlan soils, 28 percent Woodward soils, 17 percent Grant soils, and 19 percent minor soils.

The shallow, nearly level to moderately steep Quinlan soils are on short and medium, convex ridges, divides, and side slopes. They have a surface layer of loam about 6 inches thick, and a subsoil of loam about 8 inches thick. Weakly cemented sandstone is in the underlying layers. Quinlan soils formed in material that weathered from soft, fine-grained sandstone. They are well drained and have moderately rapid permeability and a very low available water capacity.

The moderately deep, nearly level to moderately steep Woodward soils are on short and medium, convex ridges and side slopes. They have a surface layer of loam about 10 inches thick, and a subsoil of heavy loam or loam about 30 inches thick. The underlying material is weakly cemented sandstone. Woodward soils formed in material that weathered from soft, fine-grained sandstone and shale. They are well drained, have moderate permeability, and have a moderate available water capacity.

The deep, nearly level to sloping Grant soils are on medium-length, convex side slopes. They have a surface layer of silt loam about 13 inches thick and a subsoil of silt loam or silty clay loam about 37 inches

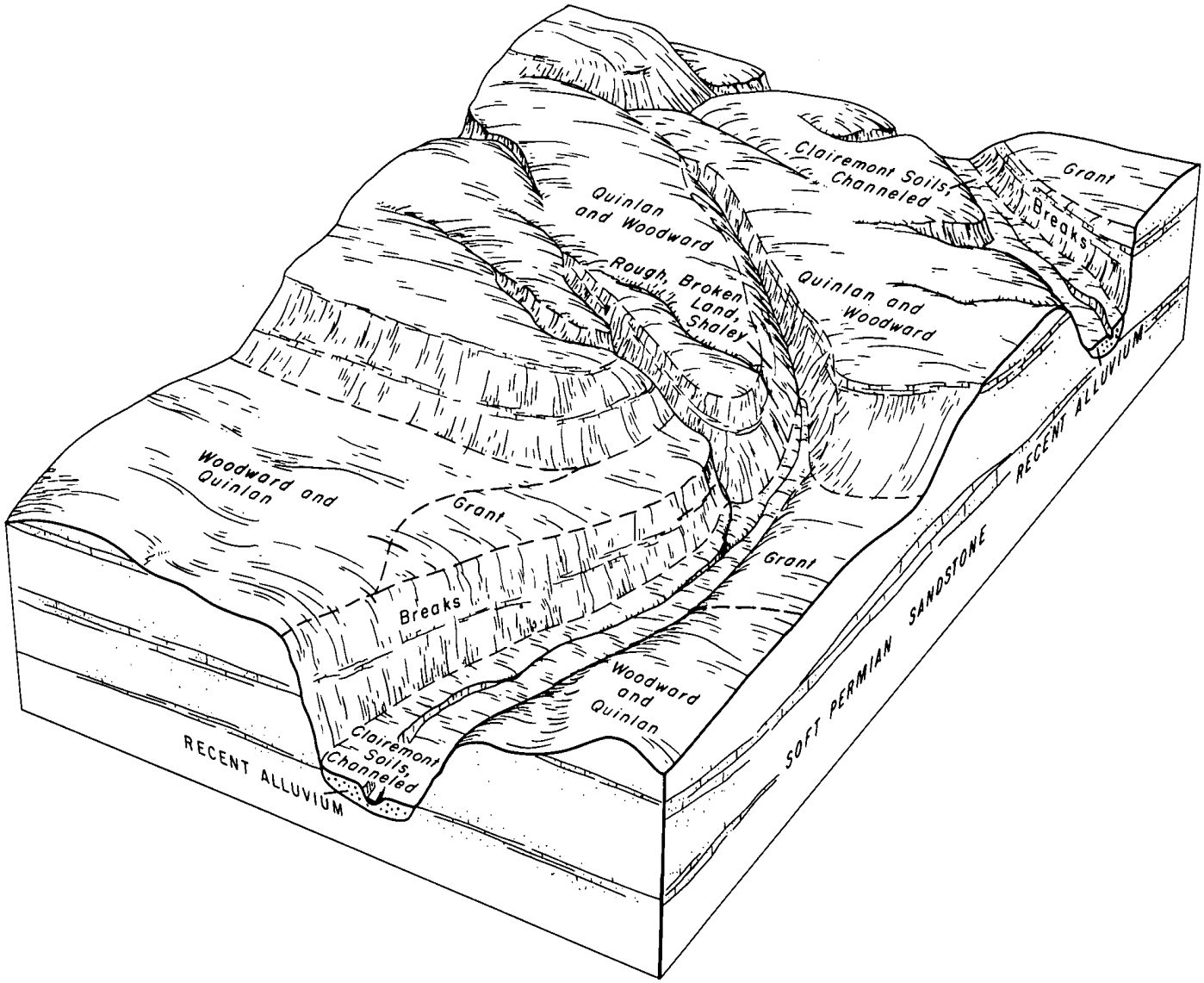

***Figure 5.*—Parent material and position of soils in association 6.**

thick. The underlying material is silt loam or loam. Grant soils formed from loamy materials that are residual or loessal. They are well drained and have moderate permeability.

The minor soils are mainly Clairemont soils, channeled, but there are some small areas of Breaks and Rough broken land, shaly. Clairemont soils are on flood plains that have meandering, deeply cut channels. Breaks and rough broken areas are on the nearly vertical sides of ravines.

About 60 percent of the acreage of this association is native grassland, and 40 percent is cultivated. The moderately steep soils, the ravines, and the narrow channels in areas of Clairemont soils are used for range. A large part of Quinlan, Woodward, and Grant soils are used for crops. They are suited to all the crops commonly grown in the county. Some small areas of Clairemont soils are used for cultivated crops.

The main management needs are controlling erosion, conserving moisture, controlling soil blowing, and maintaining fertility. Proper management of range is the main concern on native grassland.

7. *Grant-Pond Creek association*

Deep, nearly level to sloping, loamy soils

This association is on medium and long, convex ridges, divides, and side slopes (fig. 6).

This association makes up 16 percent of the county. It is 35 percent Grant soils, 30 percent Pond Creek soils, and 35 percent minor soils.

The deep, nearly level to sloping Grant soils are on medium and long, convex ridges and side slopes. They have a surface layer of silt loam about 13 inches thick and a subsoil of silt loam or silty clay loam about 37 inches thick. The underlying material is silt loam or

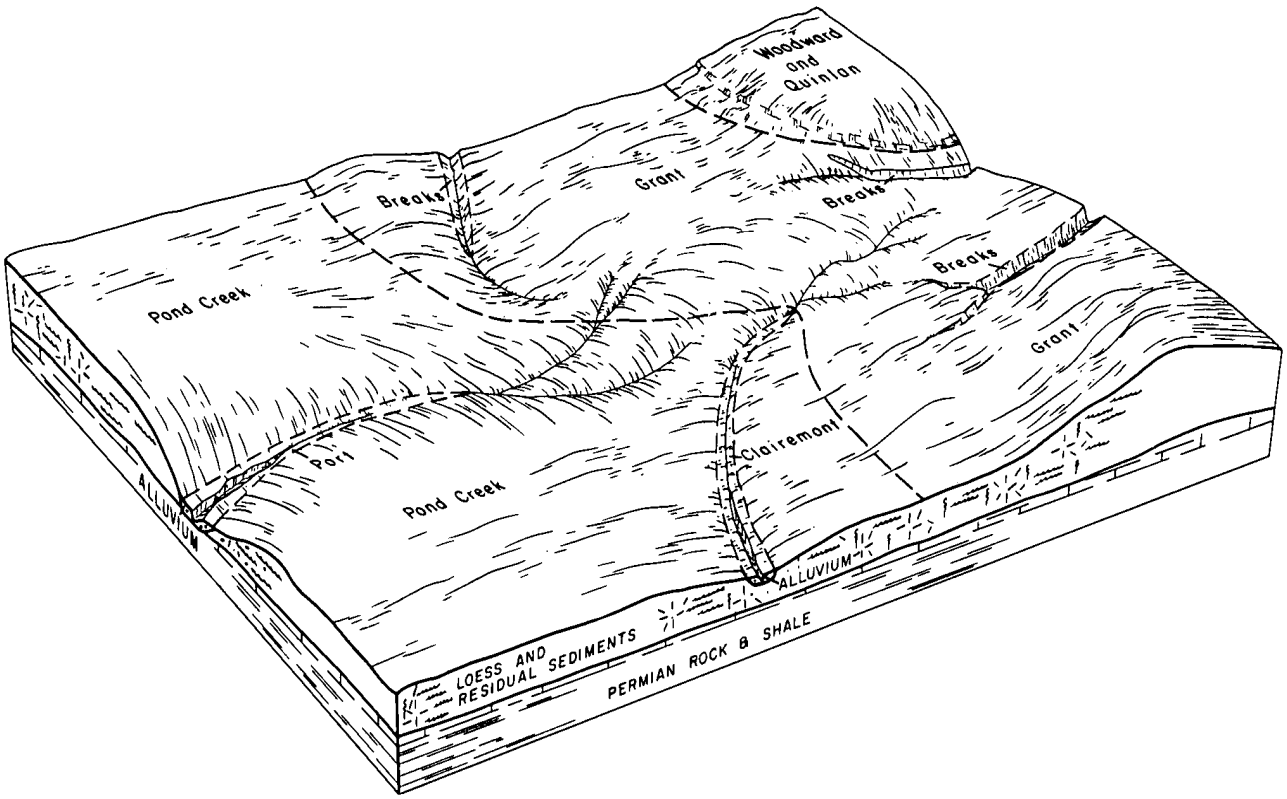

Figure 6.—**Parent material and position of soils in association 7.**

loam. Grant soils formed from residuum or loess. They are well drained and have moderate permeability.

The deep, nearly level and gently sloping Pond Creek soils have medium and long, convex slopes. They have a surface layer of silt loam about 11 inches thick and a subsoil of silty clay loam about 34 inches thick. The underlying material is heavy silt loam. Pond Creek soils formed from loess, residuum, and old alluvium. They are well drained and have moderately slow permeability.

The minor soils are mainly Clairemont, Woodward, Quinlan, and Port soils, but there are small areas of Breaks. Clairemont soils are on the flood plains of drainageways. The sloping Woodward and Quinlan soils are on short and medium, convex ridges and side slopes in higher areas than Grant or Pond Creek soils. Port soils are on stream terraces and are subject to occasional flooding. Breaks are on the nearly vertical sides of ravines.

The soils in this association are well suited to all the crops and grasses commonly grown in the county. Nearly all the acreage is used for winter wheat, sorghum, and alfalfa, but some small areas that consist of Breaks or Quinlan soils are in native grassland.

The chief management needs are controlling water erosion and soil blowing, conserving moisture, maintaining tilth and fertility, and properly managing range on native grassland.

Figure 7.—**Sand-filled channel of Elm Creek at the east edge of Medicine Lodge.**

Well-Drained and Excessively Drained, Nearly Level and Gently Sloping to Rolling and Hilly, Loamy and Sandy Soils That Formed in Alluvium and Eolian Sediments; on Flood Plains, Stream Terraces, and Uplands

About 50 percent of the acreage is used for crops and 50 percent for range. The crops are mostly on the nearly level and gently sloping, loamy soils of the flood plains, stream terraces, and uplands. The range is mostly on the nearly level, sandy soils of the flood plains and of the rolling and hilly uplands.

The main management needs are controlling soil blowing and water erosion, conserving moisture, maintaining soil tilth and fertility, and using good range management to protect native grassland.

8. *Lincoln-Yahola association*

Deep, nearly level, sandy and loamy soils; on flood plains

The soils in this association consist of layers of recent alluvium that are a few feet to several feet thick. The stream channels have a low gradient and are sand filled (fig. 7). They are good fishing streams and are excellent habitats for wetland wildlife.

This association makes up 8 percent of the county. It is 45 percent Lincoln soils, 15 percent Yahola soils, and 40 percent minor soils.

The deep, nearly level Lincoln soils are on long, broad flood plains. They have a surface layer of sandy loam or loamy sand about 6 inches thick. The underlying layers are fine sand, coarse sand, or fine gravel that has thin lenses of sandy loam or loamy sand. Lincoln soils formed in stratified, sandy, recent alluvium. They are somewhat excessively drained and have rapid permeability and a low available water capacity.

The deep, nearly level Yahola soils are on long, narrow, somewhat channeled flood plains. They have a surface layer of sandy loam about 14 inches thick. The underlying layers generally are sandy loam, but in some places they are clay loam and loamy fine sand. Yahola soils formed from loamy and sandy recent alluvium. They are well drained and have moderately rapid permeability and a moderate available water capacity.

The minor soils are mainly Port and Mangum soils, but there are small areas of Tivoli, Canadian, Clairemont, Kanza, Zenda, and Waldeck soils. Nearly level Port and Canadian soils are on stream terraces. Nearly level Mangum and Clairemont soils are on long narrow flood plains adjacent to stream channels. Nearly level Kanza, Waldeck, and Zenda soils are on flood plains or low stream terraces, mainly along Turkey and Elm Creeks, in the northern part of the county. The hilly Tivoli soils have complex slopes and are in wind-modified areas that border present and old stream channels.

About 60 percent of this association is native grassland, and 40 percent is cultivated land. Most of the cultivated land is in areas of Yahola soils, but small fields of Port, Mangum, and other minor soils are also cultivated.

The chief management needs are reducing soil blowing and maintaining tilth and fertility. Proper management of range is the main concern on native grassland.

9. *Pratt-Tivoli association*

Deep, rolling and hilly, sandy soils; on uplands

The soils of this association have short and medium, complex slopes and are in wind-modified areas.

This association makes up 1 percent of the county. It is 62 percent Pratt soils, 33 percent Tivoli soils, and 5 percent minor soils.

The deep, rolling Pratt soils have complex slopes and are in wind-modified areas. They commonly occur with Tivoli soils. They have a surface layer of loamy fine sand about 7 inches thick and a subsoil of heavy loamy fine sand about 23 inches thick. The underlying material is loamy fine sand. Pratt soils formed from sandy eolian sediment. They are well drained and have rapid permeability and a low available water capacity.

The deep, rolling and hilly Tivoli soils formed from sandy eolian sediment. They are in the higher areas of the landscape. They have a surface layer of fine sand or loamy fine sand about 5 inches thick. The underlying material is fine sand. Tivoli soils are excessively drained and have rapid permeability and a low available water capacity.

The minor soils are mainly Attica soils, but there are small areas of Farnum soils. The deep, gently rolling Attica soils occur with Pratt and Tivoli soils but are in slightly lower areas. The deep, nearly level and gently sloping Farnum soils and intermittent lakes are in the lower areas.

Most of this association is used for range, but small fields of Pratt, Attica, or Farnum soils are used for crops. The soils are well suited to the native grasses commonly grown in the county, but they are poorly suited to dryland crops.

The main management needs are using proper range management on native grassland, protecting the soil from blowing, conserving moisture, and maintaining fertility.

10. *Port-Canadian-Minco association*

Deep, nearly level and gently sloping, loamy soils; on stream terraces and uplands

This association is on broad convex stream terraces and long convex side slopes and ridges.

This association makes up 2 percent of the county. It is 40 percent Port soils, 35 percent Canadian soils, 15 percent Minco soils, and 10 percent minor soils.

The deep, nearly level Port soils are on broad flats 3 to 12 feet above the flood plain. They have a surface layer of silt loam about 20 inches thick and a subsoil of heavy silt loam or silty clay loam about 12 inches thick. The underlying material is silt loam or silty clay loam. Port soils formed from unconsolidated loamy alluvium. They are well drained and have moderate permeability.

The deep, nearly level Canadian soils are on slightly convex stream terraces 3 to 12 feet above the flood plain. They are nearer the stream channel than Port soils. They have a surface layer of fine sandy loam about 18 inches thick and a subsoil of fine sandy loam about 30 inches thick. The underlying material is fine sandy loam. Canadian soils formed from unconsolidated loamy alluvium. They are well drained and have moderately rapid permeability.

The deep, nearly level and gently sloping Minco soils are on broad convex uplands. They have a surface layer of silt loam about 14 inches thick and a subsoil of silt loam about 13 inches thick. The underlying material is silt loam. Minco soils formed from loamy eolian sediment. They are well drained and have moderate permeability.

The minor soils are mainly Lincoln soils, but there are small areas of Alluvial land, saline, and Port-Slickspots complex. The nearly level, sandy Lincoln soils are on flood plains. Nearly level Alluvial land, saline, is also on flood plains. Nearly level Port-Slickspots complex is on short and medium-length, convex stream terraces 3 to 12 feet above the flood plain.

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

Soil	Area	Extent	Soil	Area	Extent
	Acres	*Percent*		*Acres*	*Percent*
Albion-Shellabarger sandy loams, 2 to 4 percent slopes	1,450	0.2	Naron fine sandy loam, 0 to 1 percent slopes	3,690	.5
Albion and Shellabarger soils, 4 to 15 percent slopes	128,450	17.5	Naron fine sandy loam, 1 to 3 percent slopes	12,530	1.7
Alluvial land, saline	1,530	.2	Ost clay loam, 0 to 1 percent slopes	1,740	.2
Attica loamy fine sand, 1 to 5 percent slopes	7,050	1.0	Ost clay loam, 1 to 3 percent slopes	8,000	1.1
Blanket silt loam, 0 to 1 percent slopes	3,950	.5	Pond Creek silt loam, 0 to 1 percent slopes	11,600	1.6
Blanket silt loam, 1 to 3 percent slopes	11,220	1.5	Pond Creek silt loam, 1 to 3 percent slopes	20,200	2.8
Blanket silty clay loam, 1 to 3 percent slopes, eroded	1,790	.2	Port silt loam	22,180	3.0
Breaks-Clairemont complex	14,240	1.9	Port-Slickspots complex	890	.1
Canadian fine sandy loam	5,650	.8	Pratt loamy fine sand, 5 to 10 percent slopes	2,680	.4
Case-Clark clay loams, 2 to 6 percent slopes	2,670	.4	Pratt-Tivoli loamy fine sands, 5 to 15 percent slopes	11,180	1.5
Clairemont silt loam	11,000	1.5	Quinlan loam, 1 to 3 percent slopes	3,170	.4
Clairemont soils, channeled	30,500	4.2	Quinlan-Woodward complex, 5 to 15 percent slopes	62,730	8.6
Clark clay loam, 0 to 2 percent slopes	4,530	.6	Rough broken land, shaly	35,860	4.9
Farnum fine sandy loam, 0 to 1 percent slopes	2,950	.4	Shellabarger sandy loam, 3 to 6 percent slopes	12,160	1.7
Farnum loam, 0 to 1 percent slopes	3,960	.5	Shellabarger sandy loam, 3 to 6 percent slopes, eroded	3,600	.5
Farnum loam, 1 to 3 percent slopes	13,730	1.9	Tivoli fine sand, 5 to 20 percent slopes	2,600	.4
Farnum clay loam, 1 to 3 percent slopes, eroded	3,600	.5	Vernon clay loam, 3 to 5 percent slopes	2,500	.3
Grant silt loam, 0 to 1 percent slopes	1,600	.2	Vernon clay loam, 5 to 15 percent slopes	82,430	11.2
Grant silt loam, 1 to 3 percent slopes	38,640	5.3	Vernon-Shale outcrop complex	19,770	2.7
Grant silt loam, 3 to 6 percent slopes	15,200	2.1	Waldeck sandy loam	1,920	.3
Kanza soils	3,200	.4	Woodward-Quinlan loams, 0 to 3 percent slopes	5,430	.7
Kingfisher silt loam, 1 to 3 percent slopes	5,870	.8	Woodward-Quinlan loams, 3 to 6 percent slopes	32,280	4.4
Kingfisher-Vernon complex, 1 to 3 percent slopes	1,270	.2	Yahola sandy loam	7,610	1.0
Kingfisher-Vernon complex, 3 to 6 percent slopes	13,720	1.9	Zenda clay loam	1,100	.2
Lincoln soils	29,860	4.1	Gravel pits	448	.1
Mangum clay	2,560	.3	Water area of more than 40 acres	190	(1)
Mangum-Slickspots complex	2,420	.3	Total	733,248	100.0
Minco silt loam, 0 to 2 percent slopes	2,150	.3			

[1] Less than 0.1 percent.

Most of this association is cultivated and is suited to all the crops grown in the county. Some small areas along drainageways are used for range.

The main management needs are protecting the soil from blowing, controlling water erosion, conserving moisture, and maintaining soil tilth and fertility. Proper management of range is needed in areas used as range.

Descriptions of the Soils

In this section the soils of Barber County are described in detail and their use and management are discussed. Each soil series is described in detail, and then, briefly, the mapping units in that series. Unless it is 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 much more detailed and is for those who need to make thorough and precise studies of soils. The profile described in the soil series is representative for mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are stated in describing the mapping unit, or are differences that are apparent in the name of the mapping unit. Color terms are for moist soil, unless otherwise stated. The description of each mapping unit contains suggestions on 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, saline, for example, does not belong to a soil series, nevertheless it is listed in alphabetic order along with the soil series.

Preceding the name of each mapping unit is a symbol. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit, range site, and windbreak suitability group in which the mapping unit has been placed. The page for the description of each of these interpretative groups can be learned by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each map-

ping 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 (*10*).[2]

Albion Series

The Albion series consists of gently sloping to moderately steep, somewhat excessively drained soils that are moderately deep to sand. These soils are on uplands. They formed in loamy and sandy, old alluvium.

In a representative profile the surface layer is brown sandy loam about 8 inches thick. The upper part of the subsoil is brown, friable, heavy sandy loam about 8 inches thick. The lower part of the subsoil is brown, friable, loamy sand about 12 inches thick. The underlying material is yellow sand and fine gravel.

Albion soils have a low available water capacity, low natural fertility, and moderately rapid permeability.

The gently sloping Albion soils are suited to dryland cultivated crops. Among these crops are winter wheat, sorghum, and sweetclover. All of the Albion soils are well suited to native grasses.

Representative profile of Albion sandy loam, 2 to 4 percent slopes, 1,500 feet north and 25 feet east of the southwest corner of sec. 21, T. 30 S., R. 11 W. in a cultivated field:

Ap—0 to 8 inches, brown (7.5YR 4/2) sandy loam, dark brown (7.5YR 3/2) when moist; weak, medium, granular structure; slightly hard, friable; many fibrous roots; slightly acid; few pebbles; gradual, smooth boundary.

B2t—8 to 16 inches, brown (7.5YR 5/3) heavy sandy loam, dark brown (7.5YR 3/3) when moist; moderate, medium, granular structure; hard, friable; many fibrous roots; slightly acid; many pebbles; gradual, smooth boundary.

B3—16 to 28 inches, brown (7.5YR 5/4) loamy sand, dark brown (7.5YR 4/4) when moist; weak, fine, granular structure; slightly hard, friable; few roots; slightly acid; diffuse, smooth boundary.

IIC—28 to 60 inches, yellow (10YR 7/6) sand and fine gravel; yellowish brown (10YR 5/6) when moist; single grained; loose; very friable, slightly acid.

The A horizon is brown or dark grayish brown and is 6 to 12 inches thick. It is slightly acid in most places, but is medium acid in places. The B horizon is 14 to 24 inches thick. The B2t horizon is heavy sandy loam or sandy loam. The B3 horizon is slightly acid or medium acid, loamy sand or light sandy loam. Layers of medium sand, coarse sand, and fine gravel are at a depth of 20 to 36 inches.

Albion soils are similar to Pratt and Shellabarger soils and are associated with Farnum and Naron soils. Albion soils are shallower to coarse-textured underlying layers than Pratt or Shellabarger soils. They have less clay in the B horizon than Farnum or Naron soils.

Ad—Albion-Shellabarger sandy loams, 2 to 4 percent slopes. This mapping unit is gently sloping and is on narrow, convex ridgetops.

This complex consists of about 55 percent Albion soil, 30 percent Shellabarger soil, and 15 percent small areas of Farnum soil and small areas of sand and gravel beds. The Albion soil in this complex has the profile described as representative of the series.

Runoff is slow for Albion soil and medium for Shellabarger soils.

Unless these soils are protected by native grasses, crops, or crop residue, water erosion and soil blowing are management concerns. The main management needs are conserving moisture, controlling erosion, and improving soil fertility.

Nearly all of the acreage has been used to grow dryland crops. Small areas are used as range. Capability unit IIIe–2; Sandy range site; Albion soil in windbreak suitability group 2, Shellabarger soil in windbreak suitability group 1.

Ae—Albion and Shellabarger soils, 4 to 15 percent slopes. This mapping unit is sloping to moderately steep.

This complex consists of about 30 percent Albion sandy loam, 25 percent Shellabarger sandy loam, and 10 percent Naron fine sandy loam. About 20 percent consists of soils that are similar to Albion soils but that have a thinner surface layer and subsoil and are shallower to layers of sand and fine gravel. The remaining 15 percent is Case, Clark, Farnum, and Pratt soils, outcrops of caliche, and beds of sand and gravel. All of the soils occur throughout the complex, except for Pratt soils and some of the beds of sand and gravel that are high in content of lime. Pratt soils occur only in small areas in the western part of the county, and the beds of sand and gravel that are high in content of lime occur only near Lake City.

Runoff is medium.

If the native grass cover is not maintained, erosion is a management concern. Management of the native grasses helps to control erosion and reduce runoff.

Nearly all of the acreage is used for range. Some small cultivated areas have been damaged by erosion. Capability unit VIe–1; Sandy range site; Albion soil in windbreak suitability group 2; Shellabarger soil in windbreak suitability group 1.

Alluvial Land

As—Alluvial land, saline, (0 to 2 percent slopes) is deep, nearly level, somewhat poorly drained, and saline. It is on flood plains. This land type is less than 500 feet wide and has shallow meandering channels 1 to 10 feet deep and 10 to 50 feet wide. The soil material consists of brown, reddish-brown, light-brown, and light reddish brown, stratified, loamy sediments. These sediments are moderately alkaline or strongly alkaline, and they have many soft masses of lime and layers of other crystalline salts. A small area of these sediments is shallow to wet sand or loamy sand. Other areas are underlain by gray clay, fine-grained sandstone, or soft, reddish shale. Included in mapping are some small areas of soils that have a subsoil of firm clay. These areas are slightly higher than the flood plain.

This land type is frequently flooded. Slickspots and seeps are common in the areas underlain by clay, sandstone, or shale. The water table fluctuates between 2 and 6 feet from the surface. Runoff is slow.

Flooding, silt deposition, and cutting and filling of alluvial channels are management concerns. Management of native grass is needed to control erosion and deposition.

Nearly all of the acreage is used for grass, but some small areas are used for crops. If this soil is cultivated, the crops are severely damaged as a result of the slick-

[2] Italic numbers in parentheses refer to Literature Cited, p. 72.

spots, which have a white-crusted surface, and the salts, which affect the underlying material.

This land type is not well suited to crops. Capability unit VIs–1; Saline Lowland range site; windbreak suitability group 6.

Attica Series

The Attica series consists of deep, gently rolling, well-drained soils on uplands. These soils formed in loamy and sandy, eolian sediments.

In a representative profile the surface layer is grayish brown and brown loamy fine sand about 12 inches thick. The subsoil is brown, very friable, fine sandy loam about 18 inches thick. The underlying material is yellowish-brown loamy fine sand.

Attica soils have a moderate available water capacity, medium natural fertility, and moderately rapid permeability.

These soils are well suited to dryland crops and to the native grasses and tame grasses commonly grown in the county. The major crops are winter wheat, sorghum, and alfalfa.

Representative profile of Attica loamy fine sand, 1 to 5 percent slopes, 246 feet east and 155 feet south of the northwest corner of the southeast quarter, sec. 11, T. 30 S., R. 11 W., in a cultivated field:

Ap—0 to 6 inches, grayish-brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; soft, very friable; many roots; slightly acid; gradual, smooth boundary.

A12—6 to 12 inches, brown (10YR 5/3) heavy loamy fine sand, dark brown (10YR 4/3) when moist; weak, fine, granular structure; slightly hard, very friable; many roots; slightly acid; gradual, smooth boundary.

B2t—12 to 30 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) when moist; weak, very coarse, blocky structure breaking to weak, medium, granular structure; slightly hard, very friable; common roots; slightly acid; diffuse, smooth boundary.

C—30 to 60 inches, yellowish-brown (10YR 5/4) loamy fine sand, dark yellowish brown (10YR 4/4) when moist; massive; soft, very friable; few roots; neutral.

The A horizon is 12 to 20 inches thick. It is typically grayish-brown or brown loamy fine sand, but it is light fine sandy loam in places. The B2t horizon is 8 to 18 inches thick. The C horizon is yellowish-brown, pale-brown, brown, or reddish-brown loamy fine sand or fine sandy loam.

Attica soils are similar to Albion soils and are associated with Farnum, Naron, Pratt, Shellabarger, and Tivoli soils. Attica soils are deeper to a sandy or gravelly underlying layer than Albion or Tivoli soils. They have less clay in the B horizon than Farnum, Naron, or Shellabarger soils and have less sand in the B horizon than Pratt soils.

At—Attica loamy fine sand, 1 to 5 percent slopes. This soil is gently rolling, has short and medium, complex slopes, and is in wind-modified areas. Included in mapping were small areas of Farnum, Naron, and Pratt soils. Also included are some small areas where the underlying layer is mildly alkaline.

Runoff is slow. Unless protected by crops or crop residue, this soil blows.

Management is needed to control soil blowing, to conserve moisture, and to maintain soil tilth and fertility.

About half the acreage is used for dryland crops. The other half is in native grass and is used for grazing. Capability unit IIIe–4; Sands range site; windbreak suitability group 4.

Blanket Series

The Blanket series consists of deep, well-drained, nearly level to gently sloping soils on uplands. These soils formed in moderately alkaline, moderately fine textured loess and old alluvium.

In a representative profile the surface layer is dark grayish-brown silt loam about 9 inches thick. The upper 7 inches of the subsoil is dark grayish-brown, firm silty clay; and the lower 16 inches is brown, firm, silty clay loam. The underlying material is brown clay loam.

Blanket soils have a high available water capacity, high natural fertility, and moderately slow permeability. The surface tends to crust after rains.

These soils are well suited to dryland crops. Native or tame grasses are commonly grown in the county. The major dryland crops are winter wheat, sorghum, and alfalfa.

Representative profile of Blanket silt loam, 0 to 1 percent slopes, 150 feet north and 150 feet east of the southeast corner of the northwest quarter of sec. 32, T. 34 S, R. 13 W., in a cultivated field:

Ap—0 to 9 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; hard, friable; many roots; slightly acid; gradual, smooth boundary.

B21t—9 to 16 inches, dark grayish-brown (10YR 4/2) silty clay loam; very dark grayish brown (10YR 3/2) when moist; moderate, medium, subangular blocky structure; hard, firm; many roots; slightly acid; gradual, smooth boundary.

B22t—16 to 30 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) when moist; strong, medium, subangular blocky structure; very hard, very firm; many roots; thin clay films on faces of nearly all peds; neutral; gradual, smooth boundary.

B23tca—30 to 46 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) when moist; moderate, medium, subangular blocky structure; hard, firm; common roots; thin clay films on faces of peds; many fine and medium soft masses of lime and fine concretions; strongly effervescent; moderately alkaline; diffuse, smooth boundary.

Cca—46 to 60 inches, brown (10YR 5/3) clay loam, dark brown (10YR 4/3) when moist; weak, fine, subangular blocky structure in the upper part but massive in the lower part; slightly hard, friable; few roots; many soft masses of lime and fine concretions; strongly effervescent; moderately alkaline.

The A horizon is 6 to 10 inches thick. It is typically silt loam but is silty clay loam or loam in some places. It is grayish brown or dark grayish brown. The B2t horizon is 26 to 38 inches thick. The B21t horizon is silty clay loam in most places, but it is silty clay in some places. The B22t horizon is silty clay or heavy silty clay loam. The B23tca horizon is silty clay loam or clay loam. The Cca horizon is brown, strong-brown, or yellowish-brown clay loam or silty clay loam. Fine and medium soft masses of lime or lime concretions are at a depth of 28 to 38 inches.

Blanket soils are similar to Farnum and Pond Creek soils and are associated with Ost soils. Blanket soils have a higher content of clay and a lower content of sand in the B2t horizon than Farnum soils. They have less reddish colors in the lower part of the B horizon and in the C horizon than Pond Creek soils, and they have more clay in the B2t horizon. Blanket soils lack the high concentration of lime, which occurs in the lower part of the B horizon and in

Figure 8.—An area of Breaks-Clairemont complex where the Breaks are nearly vertical.

the C horizon of the Ost soils. The lime is in the form of soft masses and concretions.

Ba—Blanket silt loam, 0 to 1 percent slopes. This soil is nearly level and is on medium and long, convex ridges and divides. It has the profile described as representative of the series. Included in mapping are some small areas of Farnum, Kingfisher, Ost, and Pond Creek soils. Also included are some small areas that have slopes of 1 to 2 percent.

Runoff is slow. Unless protected by crops or crop residue, this soil is likely to blow. The main management needs are conserving moisture, controlling soil blowing, and maintaining soil tilth and fertility. Water erosion on long slopes is a concern of management.

Nearly all of the acreage is used for dryland crops; small areas are used for range. Capability unit IIc–2; Loamy Upland range site; windbreak suitability group 1.

Bb—Blanket silt loam, 1 to 3 percent slopes. This soil is gently sloping and is on medium and long, convex, ridges and divides. It has a profile similar to the one described for the series, but the surface layer is about 6 to 8 inches thick and the subsoil is a few inches thinner. Included in mapping were some small areas of Farnum, Kingfisher, Ost, and Pond Creek soils. Also included are a few small eroded areas.

Runoff is medium. Unless protected, the soil is likely to blow.

Water erosion is a concern of management. Management is needed to conserve moisture and to maintain soil tilth and fertility.

Nearly all of the acreage is used for dryland crops; small areas are used for range. Capability unit IIe–4; Loamy Upland range site; windbreak suitability group 1.

Bc—Blanket silty clay loam, 1 to 3 percent slopes, eroded. This soil is gently sloping, is on short and medium, convex, ridges and divides and along drainageways of the uplands. It has a profile similar to the one described for the series, but the surface layer is 4 to 8 inches thick. Some of the subsoil has been mixed into the surface layer. The surface layer is silty clay loam in most places, but is heavy clay loam or silty clay in some places. This soil has a profile similar to the one described as representative for the series, but the subsoil is thinner and there is lime in the form of soft masses or concretions at a depth of 10 to 30 inches. Included with this soil in mapping are small areas of Farnum, Ost, and Vernon soils and small areas that have slopes of 4 percent.

Runoff is medium. Unless protected, surface soil is likely to blow.

Water erosion is a concern of management. Management of crops, crop residue, and native-grass cover is needed to conserve moisture, to reduce erosion, and to improve fertility. When this soil is used for crops, the tilth of the surface soil is difficult to maintain. Native grasses provide the best cover for protecting this soil against erosion.

Nearly all of the acreage has been used for dryland crops. Some small areas have been seeded to native grasses and are used for range. Capability unit IIIe–6; Loamy Upland range site; windbreak suitability group 1.

Breaks

Breaks consists of nearly vertical, loamy, calcareous banks (fig. 8). In Barber County, they are mapped only in a complex with Clairemont soils.

Bf—Breaks-Clairemont complex. This complex has slopes of 3 to 80 percent. These soils are subject to flooding.

This complex consists of 45 percent Breaks, 40 percent Clairemont soils, and 15 percent small areas of Quinlan and Woodward soils and outcrops of soft sandstone. Included are some small nearly level areas of Alluvial land, saline.

Breaks and rock outcrops are excessively drained and have a low available water capacity. In these areas runoff is rapid. Clairemont soils are well drained and have very high available water capacity. On these soils, runoff is medium. Frequent flooding, silting, and water erosion are hazards. Soil material is removed rapidly from bare breaks.

The main management needs are maintaining native grasses and other vegetation in good condition and controlling erosion and silting.

Nearly all of the acreage is used for range; some small areas are used for livestock protection. Other small areas of Clairemont soils are cultivated but are not suited to this use because they are frequently flooded. Capability unit VIe–4. Breaks in Red Shales range site but not assigned to a windbreak suitability group. Clairemont soil in Loamy Lowland range site and windbreak suitability group 5.

Canadian Series

The Canadian series consists of deep, nearly level, well-drained soils on stream terraces that are 3 to 12 feet above the flood plain. These soils formed in loamy alluvium.

In a representative profile the surface layer is grayish brown and dark grayish-brown fine sandy loam about 18 inches thick. The subsoil is grayish-brown, very friable fine sandy loam, about 30 inches thick. The underlying material is pale-brown fine sandy loam.

Canadian soils have a moderate available water ca-

pacity, medium natural fertility, and moderately rapid permeability.

Canadian soils are well suited to the dryland crops and the native or tame grasses grown in the county. The major dryland crops are winter wheat, sorghum, and alfalfa. The soils are also well suited to trees and shrubs.

Representative profile of Canadian fine sandy loam (0 to 1 percent slopes) 1155 feet east and 660 feet south of the center of sec. 20, T. 30 S., R. 12 W., in a cultivated field:

Ap—0 to 8 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft, very friable; many roots; slightly acid; gradual, smooth boundary.

A12—8 to 18 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; slightly hard, friable; many roots; slightly acid; gradual, smooth boundary.

B2—18 to 48 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, medium and fine, granular; soft, very friable; few roots; neutral; gradual boundary.

C—48 to 60 inches, pale-brown (10YR 6/3) fine sandy loam, brown (10YR 6/3) when moist; weak, fine, granular structure; soft, very friable; violently effervescent with lime films; moderately alkaline.

The A horizon is 10 to 20 inches thick. It is typically fine sandy loam, but it is loam in some places. It is grayish brown or dark grayish brown. The B2 horizon is 12 to 32 inches thick. It is fine sandy loam or sandy loam. The C horizon is mainly pale-brown, brown, or yellowish-brown fine sandy loam or sandy loam that has thin layers of loamy fine sand or clay loam in some places. Buried layers ranging from sand to clay are at depths below 4 feet in some places.

Canadian soils are similar to Naron and Waldeck soils and are associated with Lincoln and Zenda soils. Canadian soils have a less clayey B horizon than Naron soils. They have better drainage in the B and C horizons than the somewhat poorly drained Waldeck and Zenda soils. They are less sandy than Lincoln soils.

Ca—Canadian fine sandy loam. This soil is nearly level and has slightly convex slopes. It is on stream terraces that are 3 to 12 feet above the flood plain. About 1 year in 3 during periods of heavy rain, this soil is subject to flooding that is of short duration. Slopes are 0 to 1 percent.

Included in mapping were some small areas of Naron fine sandy loam and some small areas of a soil that has calcareous, sandy or loamy underlying material. In some places the underlying material has reddish-brown colors.

Runoff is slow. In most places the water table is below a depth of 6 feet, but in some places it is at a depth of 3 or 4 feet in layers of sand. Unless protected by crops or crop residue, this soil blows.

The main management needs are controlling soil blowing, conserving moisture, and maintaining fertility.

Nearly all the acreage is used for dryland crops, but some small areas are used for range. Capability unit IIe–6; Sandy Terraces range site; windbreak suitability group 8.

Case Series

The Case series consists of deep, sloping, well-drained, calcareous soils on uplands. These soils formed in unconsolidated, calcareous loamy old alluvium.

In a representative profile the surface layer is light brownish-gray calcareous clay loam about 6 inches thick. The underlying material is very pale brown, friable, calcareous clay loam, in which about 40 percent of the soil volume is soft and hard masses of lime.

Case soils have a high available water capacity, medium natural fertility, and moderate permeability. The concentration of lime in underlying material slows and restricts the downward movement of moisture and roots.

These soils have limited suitability for cultivated crops. The most common crop is winter wheat. Sorghum is grown, but the yellowing of plants is severe and growth is stunted. The soils are well suited to the native grasses grown in the county.

Representative profile of Case clay loam, 900 feet north and 100 feet east of the southwest corner of sec. 5, T. 30, R. 14 W., in cultivated field:

Ap—0 to 6 inches, light brownish-gray (10YR 6/2) clay loam, grayish brown (10YR 5/2) when moist; moderate, medium, granular structure; slightly hard, friable; common roots; violently effervescent; moderately alkaline; soft masses of lime and medium and fine concretions on the surface; gradual, wavy boundary.

Cca—6 to 60 inches, very pale brown (10YR 7/3) clay loam, pale brown (10YR 6/3) when moist; massive, but breaks to fine, subangular blocky structure; slightly hard, friable; few roots; violently effervescent; strongly calcareous; about 40 percent of the volume is nearly white, soft and hard masses of lime; moderately alkaline.

Many medium and fine lime concretions are on the surface. The Ap horizon is clay loam 3 to 8 inches thick. It is light gray, light brownish gray, pinkish gray, light brown, pale brown, brown, or yellowish brown. The Cca horizon is clay loam. It has about the same colors as the Ap horizon, but the soft masses of lime and concretions are white or nearly white.

Case soils are mapped only in complex with Clark soils. They are similar to Clark soils and are associated with Ost, Blanket, Farnum, Albion, and Shellabarger soils. Case soils are less sandy throughout than Albion soils. They differ from the other soils in that they lack grayish-brown, dark grayish-brown, or brown colors in the A horizon; they lack a B horizon; and they are shallow to large amounts of lime in the form of soft masses and concretions.

Cc—Case-Clark clay loams, 2 to 6 percent slopes. This mapping unit consists of sloping, calcareous soils and is on the short, convex side slopes of drainageways and ridgetops on uplands. The Case and Clark soils were mapped in a complex because they were so closely intermingled that it was not practical to map them separately.

This complex consists of 40 percent Case clay loam, 35 percent Clark clay loam, and 25 percent small areas of Albion, Blanket, Ost, Shellabarger and calcareous, gray, clayey soils. The soils of this complex have the profile described as representative of their series.

Runoff is rapid.

Water erosion and soil blowing are management concerns, if the soil is not protected by native grasses, crops, or crop residue. The main management needs are reducing runoff, controlling erosion, and improving soil tilth and fertility.

Nearly all of the acreage has been or is used to grow dryland crops; small areas are used as range. Capabil-

ity unit IVe–5; Limy Upland range site; windbreak suitability group 7.

Clairemont Series

The Clairemont series consists of deep, nearly level, well-drained soils that formed in moderately alkaline, stratified, loamy, recent alluvium. These soils are on long, narrow flood plains 150 to 500 feet wide and are adjacent to the channels of major streams.

In a representative profile the surface layer is reddish-brown silt loam and silty clay loam about 14 inches thick. The underlying layer is yellowish-red silt loam.

Clairemont soils have a very high available water capacity, medium natural fertility, and moderate permeability. The water table is at depths of more than 6 feet. These soils are subject to frequent flooding.

These soils are well suited to dryland crops, native grasses, and the trees and shrubs commonly grown in the county. The major dryland crops are winter wheat, sorghum, and alfalfa.

A representative profile of Clairemont silt loam, 1,155 feet north and 80 feet east of the southwest corner of sec. 27, T. 33 S., R. 10 W., in a cultivated field:

Ap—0 to 10 inches, reddish-brown (5YR 5/4) silt loam, dark reddish brown (5YR 3/4) when moist; weak, fine, granular structure; slightly hard, friable; many roots; slightly effervescent; moderately alkaline; gradual, smooth boundary.

A12—10 to 14 inches, reddish-brown (5YR 4/4) silty clay loam, dark reddish brown (5YR 3/4) when moist; moderate, medium, granular structure; hard, friable; common roots; strongly effervescent; moderately alkaline; gradual, smooth boundary.

C—14 to 60 inches, yellowish-red (5YR 5/6) silt loam, yellowish red (5YR 4/6) when moist; weak, fine, granular structure; soft, very friable; few fine roots; violently effervescent; moderately alkaline.

The A horizon is 6 to 14 inches thick and commonly has 2 to 8 inches of overwash. It is reddish-brown, or light-brown silt loam, loam, silty clay loam, or clay loam. The C horizon is reddish-brown, light reddish-brown, reddish-yellow, or yellowish-red silt loam, silty clay loam, loam or clay loam. It is moderately alkaline.

Clairemont soils are associated with Lincoln, Mangum, Port, and Yahola soils. Clairemont soils are less clayey than Mangum soils. They are calcareous at the surface and have greater stratification of limy sediments than Port soils. They have less fine and medium sand in the profile than Lincoln soils or Yahola soils.

Cd—Clairemont silt loam. This soil is nearly level and is on long, narrow flood plains near intermittent streams. It is usually flooded more than once a year. Slopes are 0 to 2 percent. It has the profile described as representative for the series.

Included with this soil in mapping are some small areas of Mangum, Port, and Yahola soils. Slickspots, 1 to 3 acres in size, are shown by a symbol on the detailed soil map.

Runoff is slow. Unless protected by crops or crop residue, the soil is likely to blow.

The main management needs are protection from flooding, controlling soil blowing, and maintaining soil tilth and fertility. Water erosion where slopes are adjacent to upland soils is a minor management concern.

Nearly all of the acreage is used for dryland crops; small areas are used for range. Capability unit IIw–1; Loamy Lowland range site; windbreak suitability group 5.

Cf—Clairemont soils, channeled. These soils are on low flood plains along streams that have steep, rough, broken banks, and meandering channels that are 2 to 80 feet wide and 5 to 20 feet deep. They are usually flooded more than 3 times a year. Slopes are 0 to 2 percent.

This mapping unit consists of about 60 percent Clairemont soils; 15 percent banks and channels of streams; and 25 percent small areas of calcareous fine sandy loam, loamy fine sand, or loamy sand over sand, and clay over loamy sand or sand. Layers of gypsum in the form of crystals and fragments occur throughout these materials. The soils of this mapping unit have a profile similar to the one described as representative of the series, but they are more highly stratified. Areas of this soil are 200 to 500 feet wide and are more frequently flooded than Clairemont silt loam.

The main management needs are maintaining a cover of native grass and trees and controlling erosion of and deposition in the channel.

Nearly all of the acreage is used for range; some small fields are cultivated, but are not suited to this purpose because this soil is frequently flooded. Capability unit VIw–1; Loamy Lowland range site; windbreak suitability group 5.

Clark Series

The Clark series consists of deep, nearly level and gently sloping, well-drained, calcareous soils of the uplands. These soils formed in unconsolidated, highly calcareous, loamy old alluvium.

In a representative profile the surface layer is dark grayish-brown clay loam about 10 inches thick. The next layer is pale-brown, friable, clay loam about 10 inches thick. The underlying material is very pale brown clay loam that contains about 30 to 50 percent soft masses of lime.

Clark soils have a high available water capacity, high natural fertility, and moderate permeability. Surface soil tends to crust after rains and is susceptible to soil blowing.

These soils are well suited to dryland crops and the native or tame grasses commonly grown in the county. The major dryland crops are winter wheat, sorghum, and alfalfa. Sorghum crops are often affected by chlorosis.

Representative profile of Clark clay loam, 0 to 2 percent slopes, 411 feet north and 165 feet west of the southeast corner of sec. 4, T. 30 S., R. 14 W. in cultivated field:

A1—0 to 10 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; hard, friable; many fibrous roots; strongly effervescent; moderately alkaline; clear, wavy boundary.

AC—10 to 20 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) when moist; strong, medium, granular structure; hard, friable; many roots; violently effervescent; moderately alkaline; gradual, wavy boundary.

Cca—20 to 60 inches, very pale brown (10YR 7/4) clay loam, light yellowish brown (10YR 6/4) when moist; massive but breaking to fine and medium subangular blocky structure; hard, friable; few

fibrous roots; violently effervescent; moderately alkaline; about 30 to 50 percent soft masses of carbonate.

The A horizon is 4 to 14 inches. It is typically grayish-brown, dark-brown or dark grayish-brown clay loam, but it is loam or fine sandy loam in some places. The AC horizon is 6 to 15 inches thick. It is grayish-brown, dark grayish-brown, pale-brown, or brown clay loam. The Cca horizon is very pale brown, light yellowish brown, yellowish brown, and light brown. It commonly is clay loam, but it is loam in some places. This horizon is moderately alkaline and calcareous and contains many soft masses of lime.

Clark soils are similar to Case and Ost soils and are associated with Blanket and Farnum soils. Clark soils differ from Case soils in having an A horizon that is dark grayish brown instead of light brownish gray, and they are deeper to layers that contain a large amount of lime. Clark soils lack a B horizon, which the Ost, Blanket, and Farnum soils have.

Ck—Clark clay loam, 0 to 2 percent slopes. This soil is nearly level and gently sloping and is in areas of short and medium, convex side slopes and ridges.

Included with this soil in mapping are some small areas of Case and Ost soils. Also included are a few areas that have a fine sandy loam surface layer.

Runoff is medium. Unless protected by crops or crop residue, this soil is likely to blow. Large amounts of lime in the surface layer and the underlying material cause chlorosis in sorghum plants.

The main management needs are controlling water erosion and soil blowing, conserving moisture, and maintaining soil tilth and fertility.

Nearly all of the acreage is used for dryland crops; some small areas are used for range. Capability unit IIIe-5; Limy Upland range site; windbreak suitability group 7.

Farnum Series

The Farnum series consists of deep, nearly level and gently sloping, well-drained soils on uplands. These soils formed in stratified, loamy old alluvium that has layers of sand or clay in some places.

In a representative profile the surface layer is grayish-brown loam about 9 inches thick. The upper 7 inches of the subsoil is dark grayish-brown, friable, clay loam; the next 6 inches is dark grayish-brown, firm clay loam, below this is 14 inches of dark-brown, very firm clay loam; and the lower 12 inches is brown, firm clay loam. The underlying material is brown clay loam over reddish-brown sandy clay loam.

Farnum soils have a high available water capacity, high natural fertility, and moderately slow permeability.

Farnum soils are well suited to dryland crops, native and tame grasses, and the trees and shrubs commonly grown in the county. The major crops are winter wheat, sorghum, and alfalfa.

Representative profile of Farnum loam, 0 to 1 percent slopes, 1,815 feet north and 100 feet east of the southwest corner of sec. 10, T. 30 S., R. 11 W., in a cultivated field:

Ap—0 to 9 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft, very friable; many roots; slightly acid; gradual, smooth boundary.

B1—9 to 16 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, subangular blocky structure parting to moderate, medium, granular structure; hard, friable; many roots; slightly acid; gradual, smooth boundary.

B21t—16 to 22 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, subangular blocky structure; very hard, firm; many roots; neutral; gradual, smooth boundary.

B22t—22 to 36 inches, dark-brown (10YR 4/3) clay loam, dark brown (10YR 3/3) when moist; moderate, medium and fine, blocky structure; very hard, very firm; many fine roots; neutral; gradual, smooth boundary.

B3—36 to 48 inches, brown (10YR 5/3) clay loam, dark brown (10YR 4/3) when moist; moderate, medium and fine, subangular blocky structure; hard, firm; few fine roots; neutral; gradual, smooth boundary.

C1—48 to 58 inches, brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) when moist; massive; hard, firm; neutral; gradual, diffuse boundary.

C2—58 to 66 inches, reddish-brown (5YR 5/4) sandy clay loam, reddish brown (5YR 4/4) when moist; massive; hard, friable; neutral.

The A horizon is 6 to 12 inches thick. It is typically loam, but it is fine sandy loam or sandy loam in some places. It is grayish brown, dark grayish brown, or very dark grayish brown. The B horizon ranges from 24 to 48 inches in thickness. It is very dark grayish brown, dark grayish brown, grayish brown, brown, or dark brown. The B3 horizon is clay loam, heavy loam, or sandy clay loam. The C horizon is clay loam, sandy clay loam, or loam in most places, but it is sandy loam in some places. It is brown, yellowish brown, or strong brown in most places, but it is reddish brown in some places. Lime occurs as fine soft masses and fine concretions at a depth of 30 to more than 70 inches.

Farnum soils are similar to Blanket and Pond Creek soils and are associated with Naron, Ost, and Shellabarger soils. Farnum soils have less clay and more sand in the B2t horizon than Blanket soils. They have less reddish color and more sand in the B and C horizons than Pond Creek soils. Farnum soils have slightly more clay in the B2t horizon than Naron or Shellabarger soils. They differ from Ost soils in that they lack a high concretion of lime, which occurs as soft masses and concretions, in the lower part of the B horizon and in the C horizon.

Fa—Farnum fine sandy loam, 0 to 1 percent slopes. This soil is nearly level and has medium and long, convex slopes. It has a profile similar to the one described as representative of the series, but the surface layer is fine sandy loam 6 to 10 inches thick.

Included with this soil in mapping are some small areas of Naron fine sandy loam and Farnum loam. Some small areas have concave, nearly level slopes and are in depressions. In these areas the subsoil is sandy clay or clay. Slickspots, 1 to 3 acres in size, are shown by a symbol on the detailed soil map.

This Farnum soil absorbs water readily, and runoff is slow. Unless protected by crops or crop residue, this soil is likely to blow.

The main management needs are controlling soil blowing, conserving moisture, and maintaining soil fertility. The ponding of surface water in some fields after rains is a concern of management.

Nearly all of the acreage is used for dryland crops; some small fields are used for irrigated crops; and other small areas are used for range. Capability unit IIe-5; Sandy range site; windbreak suitability group 1.

Fm—Farnum loam, 0 to 1 percent slopes. This soil is nearly level, has long convex slopes, and is on some long, narrow, convex ridgetops. It has the profile described as representative of the series.

Included with this soil in mapping are some small areas of Naron fine sandy loam and Farnum fine sandy loam. Some small areas have nearly level, concave slopes and are in depressions. In these areas the subsoil is clay or sandy clay. Slickspots, 1 to 3 acres in size, are shown by a spot symbol on the detailed soil map.

Runoff is slow. Unless protected by crops or crop residue, this soil is likely to blow.

The main management needs are conserving moisture, controlling soil blowing, and maintaining soil tilth and fertility. Water erosion on long slopes is a concern of management. The ponding of surface water in some fields in low areas after rains is a management concern.

Nearly all of the acreage is used for dryland crops; some small areas are used for irrigated crops; and other small areas are used for range. Capability unit IIc–1; Loamy Upland range site; windbreak suitability group 1.

Fr—Farnum loam, 1 to 3 percent slopes. This soil is gently sloping and is on medium and long, convex ridges and side slopes. It has a profile similar to the one described as representative of the series, but the surface layer is about 4 to 8 inches thick and the subsoil is a few inches thinner.

Included with this soil in mapping are some small areas of Blanket, Naron, Ost, and Pond Creek soils. Also included are a few small eroded areas where the surface layer is clay loam and silty clay loam that has been mixed with coarse sand and gravel.

Runoff is medium. Water erosion is a concern of management, and unless protected, the soil is likely to blow.

The main management needs are controlling erosion, conserving moisture, and maintaining soil tilth and fertility.

Nearly all of the acreage is used for dryland crops; small areas are used for range. Capability unit IIe–1; Loamy Upland range site; windbreak suitability group 1.

Fu—Farnum clay loam, 1 to 3 percent slopes, eroded. This soil is gently sloping and is on short and medium length, convex ridges and divides along drainageways on uplands. It has a profile similar to the one described as representative of the series, but the surface layer is 4 to 8 inches thick. Some of the subsoil has been mixed in the surface layer. The surface layer is clay loam, but it is heavy loam in some places. This soil differs from the representative profile by having a thinner subsoil and by having many water rounded pebbles throughout.

Included with this soil in mapping are small areas of Albion and Shellabarger soils. Also included are some small areas of soil that have a loam or fine sandy loam surface layer, and small areas of soils that have gray, calcareous, clay surface soils and subsoils.

Runoff is medium.

Water erosion is a concern of management. Unless protected, the surface soil is likely to blow. Management of crops, crop residue, and native grasses is needed to conserve moisture, to reduce erosion, and to improve tilth and fertility. When this soil is used for crops, surface tilth and fertility are difficult to maintain. Native grasses provide the best cover to protect this soil from erosion.

Nearly all of the acreage of this soil has been used for dryland crops. Some small areas have been seeded to native grasses and used for range. Capability unit IIe–2; Loamy Upland range site; windbreak suitability group 1.

Grant Series

The Grant series consists of deep, nearly level to sloping, well-drained soils on uplands. These soils formed in unconsolidated, calcareous, loamy, residual or loess materials.

In a representative profile the surface layer is brown silt loam about 13 inches thick. The subsoil is reddish-brown and yellowish-red, friable, silt loam about 37 inches thick. The underlying material is yellowish-red silt loam.

Grant soils have a very high available water capacity, high fertility, and moderate permeability. They are easily tilled, but the surface tends to crust after rains.

These soils are well suited to dryland crops and the native or tame grasses commonly grown in the county. The major dryland crops are winter wheat, sorghum, and alfalfa.

Representative profile of Grant silt loam, 0 to 1 percent slopes, 2,310 feet south and 150 feet west of the northeast corner of sec. 2, T. 34 S., R. 11 W., in a cultivated field:

Ap—0 to 7 inches, brown (7.5YR 5/3) silt loam, dark brown (7.5YR 3/2) when moist; weak, fine, granular structure; soft, friable; many roots; slightly acid; gradual, smooth boundary.

A12—7 to 13 inches, brown (7.5YR 5/3) silt loam, dark brown (7.5YR 3/2) when moist; moderate, fine, granular structure; slightly hard, friable; many roots; neutral; gradual, smooth boundary.

B1—13 to 28 inches, reddish-brown (5YR 4/4) silt loam, dark reddish brown (5YR 3/4) when moist; moderate, medium, granular structure; slightly hard, friable; many roots; mildly alkaline; gradual, smooth boundary.

B2t—28 to 42 inches, reddish-brown (5YR 5/4) silt loam, reddish brown (5YR 4/4) when moist; weak, medium, subangular blocky structure parting to moderate, coarse, granular structure; hard, friable; common roots; moderately alkaline; gradual, smooth boundary.

B3—42 to 50 inches, yellowish-red (5YR 5/6) silt loam, yellowish-red (5YR 4/6) when moist; moderate, medium and fine, granular structure; slightly hard, friable; few roots; moderately alkaline; gradual, smooth boundary.

C—50 to 60 inches, yellowish-red (5YR 5/6) silt loam, yellowish-red (5YR 4/6) when moist; weak, fine, granular structure; soft, very friable; slight effervescence; moderately alkaline.

The A horizon is 10 to 18 inches thick. It is silt loam or loam in some places and is brown or dark brown. The B horizon ranges from 24 to 44 inches in thickness. The B1 horizon, typically, is silt loam, but it is heavy silt loam in some places. The B2t horizon is silt loam or silty clay loam. The B3 horizon is, typically, silt loam, but it is silty clay loam in some places. The C horizon is yellowish-red or reddish-brown silt loam or loam.

Grant soils are similar to Minco soils and are associated with Pond Creek and Woodward soils. Grant soils have a more clayey B horizon than Minco soils. They have less clay in the B horizon than Pond Creek soils. Grant soils are deeper to soft sandstone and shale than Woodward soils, and they have a more clayey B horizon.

Ga—Grant silt loam, 0 to 1 percent slopes. This soil

is nearly level and is on medium and long, convex ridges and divides. It has the profile described as representative of the series.

Included with this soil in mapping are some small areas of Minco, Pond Creek, and Woodward soils. Also included are some small areas where the underlying layer contains many water-rounded pebbles and coarse sand grains.

Runoff is slow. Unless protected by crops or crop residue, this soil is likely to blow.

The main management needs are controlling soil blowing, conserving moisture, and maintaining soil tilth and fertility.

Nearly all of the acreage is used for dryland crops; small areas are used for range. Capability unit IIc–1; Loamy Upland range site; windbreak suitability group 1.

Gb—Grant silt loam, 1 to 3 percent slopes. This soil is gently sloping and is on medium and long, convex ridges and divides. It has a profile similar to the one described as representative of the series, but the surface layer is about 8 to 16 inches thick and the subsoil is a few inches thinner.

Included with this in mapping are some small areas of Clairemont soils, channeled, and Minco, Pond Creek, and Woodward soils. Also included are a few small areas where the surface layer is fine sandy loam or clay loam and the subsoil is clay loam. Other small areas where the underlying layer contains thin strata of gypsum are included.

Runoff is medium. Unless protected by crops or crop residue, this soil is likely to blow.

Water erosion is a management concern. Management is needed to control erosion, to conserve moisture, and to maintain tilth and soil fertility.

Nearly all of the acreage is used for dryland crops; small areas are used for range. Capability unit IIe–1; Loamy Upland range site; windbreak suitability group 1.

Gc—Grant silt loam, 3 to 6 percent slopes. This sloping soil is on short and medium, convex ridges and side slopes. It has a profile similar to the one described as representative of the series, but the surface layer is about 10 to 14 inches thick and the subsoil is a few inches thinner.

Included with this soil in mapping are some small areas of Kingfisher, Woodward, and Quinlan soils. Also included are a few small areas where the subsoil is clay loam and substratum is high in content of gypsum. Other small, eroded areas along drainageways are included.

Runoff is rapid. Water erosion is a concern of management. Unless protected, this soil blows. Management is needed to maintain soil tilth and fertility.

Nearly all of the acreage is used for dryland crops; small areas are used for range. Capability unit IIIe–1; Loamy Upland range site; windbreak suitability group 1.

Kanza Series

The Kanza series consists of deep, nearly level, poorly drained soils on flood plains. These soils formed in sandy, recent alluvium along perennial streams. They are subject to flooding.

In a representative profile the surface layer is grayish-brown loamy fine sand 7 inches thick. The next layer is light brownish-gray, very friable loamy sand 7 inches thick. The underlying material is light-gray fine and medium sand.

Kanza soils have a low available water capacity above the water table, medium natural fertility, and rapid permeability. The water table fluctuates between the depths of 1 and 3 feet, except during wet seasons when it is at or near the surface.

These soils are not suited to cultivated crops. They are well suited to native grasses, especially the tall native grasses commonly grown in the county.

Representative profile of Kanza loamy fine sand, near center of sec. 36, T. 31 S., R. 11 W., in grass:

A1—0 to 7 inches, grayish-brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; slightly hard, very friable; many roots; slightly acid; gradual, smooth boundary.

AC—7 to 14 inches, light brownish-gray (10YR 6/2) loamy sand; few, fine, distinct mottles of yellowish brown (10YR 5/4), dark grayish brown (10YR 4/2) when moist; slightly hard, very friable; few roots; neutral; gradual boundary.

C—14 to 48 inches, light-gray (10YR 7/2) fine and medium sand; common, medium, distinct mottles of pinkish gray (7.5YR 7/3), light brownish gray (10YR 6/2) when moist; structureless; soft, very friable; few roots; neutral.

The A horizon is, typically, loamy fine sand or fine sandy loam, but it is clay loam and fine sand in some places. It is grayish brown or dark grayish brown and 6 to 10 inches thick. The AC horizon is grayish-brown or light brownish-gray loamy sand 5 to 15 inches thick. It has few, fine, faint to common, medium, distinct brownish mottles. The C horizon is light-gray or light brownish-gray loamy sand, fine sand, or medium sand. It has common, medium, distinct, brownish and grayish mottles.

Kanza soils are similar to Lincoln and Waldeck soils and are associated with Zenda soils. Kanza soils differ from Lincoln soils in that they lack calcareous horizons and are saturated with water during some period of the year. Kanza soils are more sandy than Waldeck or Zenda soils.

Ka—Kanza soils. These soils are nearly level and are on narrow flood plains adjacent to spring-fed, perennial streams. Slopes are 0 to 1 percent.

Included with these soils in mapping are some small areas of Lincoln, Waldeck, and Zenda soils. Also included are some small areas where the surface layer and subsurface layer are calcareous, dark grayish-brown clay loam. Other small areas where the horizons are reddish brown and reddish gray and some channels and sandbars of coarse sand and gravel are included.

Runoff is slow. These soils are usually flooded more than three times a year. The main management needs are maintaining native grasses, controlling brush, controlling channel erosion, and reducing deposition.

Nearly all of the acreage is used for range; some small areas are used for meadows; and others are used for ponds or stock-water pits. Capability unit Vw–1; Subirrigated range site; not assigned to a windbreak suitability group.

Kingfisher Series

The Kingfisher series consists of deep, gently sloping and sloping, well-drained soils on uplands. These

soils formed in moderately alkaline, partly weathered clayey-shale red beds.

In a representative profile the surface layer is brown silt loam about 9 inches thick. The upper part of the subsoil is brown, firm silty clay loam about 8 inches thick, and the lower part is reddish-brown, firm heavy silty clay loam about 11 inches thick. The underlying material is yellowish-red partly weathered clayey shale.

Kingfisher soils have a high available water capacity, medium natural fertility, and moderately slow permeability.

Kingfisher soils are well suited to dryland crops and the native or tame grasses commonly grown in the county. The major dryland crops are winter wheat, sorghum, and alfalfa.

Representative profile of Kingfisher silt loam, 1 to 3 percent slopes, 100 feet west and 100 feet south of the northeast corner of the southeast quarter of sec. 2, T. 33 S., R. 13 W., in grass:

A1—0 to 9 inches, brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) when moist; moderate, fine, granular structure; slightly hard, friable; many roots; slightly acid; gradual, smooth boundary.

B1—9 to 17 inches, brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 3/2) when moist; moderate, medium, subangular blocky structure; hard, firm; many fibrous roots; neutral; gradual, smooth boundary.

B2t—17 to 28 inches, reddish-brown (5YR 4/4) heavy silty clay loam, dark reddish brown (5YR 3/4) when moist; moderate, medium, blocky structure; hard, firm; many fine roots; thin patchy clay films on faces of peds; mildly alkaline; gradual, smooth boundary.

C—28 to 60 inches, yellowish-red (5YR 5/6) partly weathered clayey shale, yellowish red (5YR 4/6) when moist; massive; few roots; strongly effervescent; moderately alkaline.

The A horizon is, typically, silt loam but is silty clay loam in some places. It is 8 to 12 inches thick and is brown, dark brown, or dark reddish gray. The B horizon ranges from 14 to 28 inches in thickness. It is brown, strong brown, reddish brown, or yellowish red. The B1 horizon is 4 to 8 inches thick. The B2t horizon is heavy silty clay loam or silty clay, and it is 10 to 20 inches thick. The C horizon is reddish-brown, light reddish-brown, reddish-yellow, yellowish-red, light-red or red, partly weathered, clayey shale that contains fragments of gypsum.

Kingfisher soils are similar to Blanket, Grant, Pond Creek, and Vernon soils and are associated with Quinlan and Woodward soils. They are shallower to underlying bedrock than Blanket or Pond Creek soils. Kingfisher soils have a more clayey B horizon than Grant soils, and they are shallower to bedrock. Kingfisher soils have a B2t horizon and are deeper to bedrock than Vernon, Quinlan, or Woodward soils.

Kf—Kingfisher silt loam, 1 to 3 percent slopes. This soil is gently sloping and is on medium-length, convex ridges and divides. It has the profile described as representative of the series.

Included with this soil in mapping are some small areas of Blanket, Grant, Pond Creek, and Vernon soils. Slickspots 1 to 3 acres in size are shown by a symbol on the detailed soil map. Other small areas where the surface layer is clay loam are included.

Runoff is medium. Water erosion is a concern of management. Unless protected, the soil is likely to blow. Management is needed to control erosion, to conserve moisture, and to maintain soil tilth and fertility.

Nearly all of the acreage is used for dryland crops; small areas are used for range. Capability unit IIe–2; Loamy Upland range site; windbreak suitability group 1.

Kv—Kingfisher-Vernon complex, 1 to 3 percent slopes. This mapping unit is gently sloping and is on short and medium, convex ridges and divides.

This complex consists of about 50 percent Kingfisher silt loam, 30 percent Vernon clay loam, and 20 percent small areas of Grant soils and Clairemont soils. The Vernon soil in this complex has the profile described as representative of the series.

Included are small areas of stratified clay loam and silty clay loam on colluvial slopes and small areas where the lower part of the subsoil and the substratum contain lime in the form of visible soft masses and concretions.

Runoff is medium. The control of water erosion is a concern of management. Unless protected, the soils are likely to blow. Management of crops and grassland is needed to control erosion, to conserve moisture, to maintain soil fertility, and to maintain a good cover of native plants.

About half of the acreage is used for dryland crops; the other half is used for range. Capability unit IIIe–7; Kingfisher soil in Loamy Upland range site and windbreak suitability group 1; Vernon soil in Red Clay Prairie range site and windbreak suitability group 3.

Kz—Kingfisher-Vernon complex, 3 to 6 percent slopes. This mapping unit is sloping and is on long, narrow, convex ridges and divides.

This complex consists of about 50 percent Kingfisher silt loam; 40 percent Vernon clay loam; and 10 percent small areas of Grant, Blanket, Quinlan, and Woodward soils. Included are some small areas where there are spots of calcareous, gray clay.

Runoff is medium.

Erosion is a concern of management if the native grass cover is not maintained or if cultivated fields are not protected.

Nearly all of the acreage is used for range; small areas are cultivated. Capability unit IVe–2; Kingfisher soil in Loamy Upland range site and windbreak suitability group 1; Vernon soil in Red Clay Prairie range site and windbreak suitability group 3.

Lincoln Series

The Lincoln series consists of deep, nearly level, somewhat excessively drained soils on broad flood plains adjacent to the channels of major streams throughout the county. These soils formed in moderately alkaline, stratified, sandy recent alluvium. They are subject to frequent flooding.

In a representative profile the surface layer is brown sandy loam about 6 inches thick. The underlying material is reddish-yellow and pale-brown fine sand that has thin layers of fine sandy loam.

Lincoln soils have a low available water capacity, low natural fertility, and rapid permeability. The water table fluctuates between depths of 4 and 6 feet.

Lincoln soils are poorly suited to crops, but they are well suited to the native grasses, trees, and shrubs commonly grown in the county.

A representative profile of Lincoln sandy loam in an area of Lincoln soils, 2,430 feet north and 50 feet west of the center of sec. 31, T. 31 S., R. 12 W., in grass:

A1—0 to 6 inches, brown (7.5YR 5/3) sandy loam, dark brown (7.5YR 3/3) when moist; weak, fine, granular structure; soft, very friable; many fibrous roots; moderately alkaline; strongly effervescent; gradual, smooth boundary.

C1—6 to 24 inches, reddish-yellow (5YR 6/6) fine sand and thin layers of fine sandy loam and very fine sand, yellowish red (5YR 5/6) when moist; structureless; loose; few fine roots; moderately alkaline; violently effervescent; diffuse boundary.

C2—24 to 60 inches, pale-brown (10YR 6/3) fine sand, brown (10YR 5/3) when moist; structureless; loose when dry or moist; moderately alkaline; violently effervescent.

The A horizon is sandy loam, fine sandy loam or loamy fine sand and is 6 to 15 inches thick. It is light brownish gray, brown, yellowish brown, dark yellowish brown, light brown, dark brown, or strong brown. The C horizon is pale-brown, light reddish-brown, reddish-yellow, light-brown, reddish-yellow, very pale brown, light yellowish-brown or brownish-yellow fine sand or coarse sand and fine gravel.

Lincoln soils are similar to Yahola soils and are associated with Canadian, Kanza, Waldeck, Tivoli, and Zenda soils. Lincoln soils have a more sandy C horizon than any of the associated soils, except Kanza or Tivoli soils. They are calcareous and their A horizon is less dark colored than that of Kanza soils. Lincoln soils are nearly level and calcareous, but Tivoli soils are rolling and hilly, and noncalcareous.

Ln—Lincoln soils. These soils are nearly level and are on broad flood plains adjacent to major streams. They are usually flooded more than three times a year. The surface layer is sandy loam, fine sandy loam, and loamy fine sand. Slopes are 0 to 1 percent.

Included with these soils in mapping are some small areas of Yahola, Clairemont, Mangum, Waldeck, Kanza, Zenda, and Tivoli soils. Also included are some small areas where the surface layer is slightly acid and the underlying layers are slightly acid coarse sand and fine gravel. Other small areas where the surface layer is thin clay loam are also included.

Runoff is slow.

The main management needs are maintaining a cover of grass and trees, controlling channel erosion, and reducing deposition.

Nearly all of the acreage is used for range. Some small fields are cultivated, but they are not suited to this use because they are frequently flooded. Capability unit Vw–2; Sandy Lowland range site; windbreak suitability group 5.

Mangum Series

The Mangum series consists of deep, nearly level, moderately well drained soils on long, narrow flood plains along the larger creeks and rivers. These soils formed in moderately alkaline, recent, clayey alluvium. They are subject to frequent flooding.

In a representative profile the surface layer is reddish-brown clay about 6 inches thick. The next layer is reddish-brown very firm clay about 4 inches thick. The underlying material is reddish-brown clay and light clay loam.

Mangum soils have a moderate available water capacity, low natural fertility, and very slow permeability. The water table is at depths of 40 inches to over 60 inches.

Mangum soils are not well suited to crops, but a small acreage is used for winter wheat and sorghum. These soils are well suited to the native grasses commonly grown in the county. Nearly all of the acreage is used for range.

A representative profile of Mangum clay, 2,310 feet east and 495 feet south of the center of sec. 11, T. 32 S., R. 12 W., in grass:

A1—0 to 6 inches, reddish-brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) when moist; weak, fine, granular structure; hard, firm; many roots; neutral; gradual, smooth boundary.

AC—6 to 10 inches, reddish-brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) when moist; moderate, fine, subangular blocky structure; very hard, very firm; many roots; strongly effervescent; moderately alkaline; gradual, smooth boundary.

C1—10 to 50 inches, reddish-brown (2.5YR 5/4) clay, dark reddish brown (2.5YR 3/4) when moist; weak, fine, subangular blocky structure in the upper part but massive in the lower part; very hard, very firm; common fine roots; strongly effervescent; moderately alkaline; gradual, smooth boundary.

IIC—50 to 60 inches, reddish-brown (5YR 5/4) light clay loam, reddish brown (5YR 4/4) when moist; massive; few roots; violently effervescent; moderately alkaline.

The A horizon is, typically, clay or silty clay but is silty clay loam in some places. It is 3 to 6 inches thick and it is reddish brown or yellowish red. The AC horizon is reddish-brown, red, or yellowish-red silty clay or clay 4 to 8 inches thick. The C horizon is light reddish-brown, reddish-brown, light-red, red, reddish-yellow, or yellowish-red clay. It is silty clay and heavy silty clay loam in some places. Underlying is a IIC horizon that has layers of reddish and brownish light clay loam and sandy loam in most places but loamy sand and sand in some places.

Mangum soils are associated with Clairemont, Lincoln, and Yahola soils. Mangum soils have layers directly below the A horizon that are more clayey than those in Clairemont, Lincoln, or Yahola soils. Mangum clay has a loamy substratum and a water table at a depth of 40 to 60 inches, but in Mangum-Slickspots complex the depth is more than 60 inches.

Ma—Mangum clay. This soil is nearly level and is on long, narrow flood plains adjacent to major streams. It is flooded more than once during the year. It has the profile described as representative of the series. Slopes are 0 to 1 percent.

Included with this soil in mapping are small areas of reddish-brown clayey soils that are shallow to an underlying layer of sand and small areas of dark grayish-brown clayey soils that are underlain by sand.

Runoff is slow. Unless protected by crops or crop residue, this soil is likely to blow.

The main management needs are maintaining a cover of grass and trees and reducing scouring and deposition of soil material, controlling soil blowing in small fields, and maintaining soil tilth and fertility.

Nearly all of the acreage of this soil is used for range; some small fields are used for winter wheat and sorghum. Capability unit IIIw–1; Clay Lowland range site; windbreak suitability group 5.

Mg—Mangum-Slickspots complex. This mapping unit consists of nearly level and gently sloping Mangum soils and Slickspots. These soils are in complex patterns on alluvial fans and long, colluvial slopes. Flooding occurs at least once every year or may occur several times a year. The floodwater is heavily laden with silt and clay particles that are deposited as the velocity of water decreases over a broad fan area. These soils are associated with clayey upland soils that formed in red shale material. Slopes are 0 to 2 percent.

This complex consists of 50 percent Mangum clay, 35

percent Slickspots, and 15 percent small areas of Clairemont silt loam and Clairemont soils, channeled.

The Slickspots have a nearly white surface crust, ½ to 2 inches thick, and are underlain by calcareous, platy, stratified, clayey and loamy layers. Many of these layers are high in content of gypsum.

Runoff is medium.

Water erosion, silt deposition, and soil blowing are concerns of management if these soils are not protected by native grasses, crops, or crop residue. The main management needs are controlling channel erosion, reducing deposition, and maintaining a good protective cover of native grasses, crops, or crop residue.

Nearly all the acreage is used for range; some small fields are cultivated but are not well suited to this use because the soils have low natural fertility and are subject to flooding, soil deposition, water erosion, and soil blowing. Capability unit IVs–1; Mangum soil in Clay Lowland range site and windbreak suitability unit 5; Slickspots in Saline Lowland range site and windbreak suitability group 6.

Minco Series

The Minco series consists of deep, nearly level and gently sloping, well-drained soils on uplands. These soils formed in loamy, eolian sediments.

In a representative profile the surface layer is brown silt loam about 14 inches thick. The subsoil is brown, friable silt loam about 13 inches thick. The underlying material is light-brown silt loam.

Minco soils have a high available water capacity, high fertility, and moderate permeability.

Minco soils are well suited to dryland crops and the native and tame grasses commonly grown in the county. The major dryland crops are winter wheat, sorghum, and alfalfa.

Representative profile of Minco silt loam, 0 to 2 percent slopes, 2,391 feet east and 330 feet south of the northwest corner of sec. 13, T. 34 S., R. 10 W., in a cultivated field:

Ap—0 to 6 inches, brown (7.5YR 5/3) silt loam, dark brown (7.5YR 3/3) when moist; weak, fine, granular structure; soft, very friable; many roots; slightly acid; gradual, smooth boundary.

A12—6 to 14 inches, brown (7.5YR 4/3) silt loam, dark brown (7.5YR 3/2) when moist; weak, fine, granular structure; soft, very friable; many roots; neutral; gradual, smooth boundary.

B2—14 to 27 inches, brown (7.5YR 5/3) silt loam, dark brown (7.5YR 4/3) when moist; moderate, medium, granular structure; slightly hard, friable; common roots; many earthworm casts; neutral; gradual, smooth boundary.

C—27 to 60 inches, light-brown (7.5YR 6/4) silt loam, brown (7.5YR 4/4) when moist; weak, fine, granular structure in the upper part, but massive in the lower part; soft, very friable; mildly alkaline.

The A horizon is typically brown or dark-brown silt loam but is loam or fine sandy loam in some places. It is 10 to 20 inches thick. The B2 horizon is 12 to 24 inches thick. It is reddish-brown, yellowish-red, brown, or light-brown silt loam in most places, but it is loam in some places. The C horizon is silt loam or loam. It is mildly alkaline or moderately alkaline.

Minco soils are similar to Canadian and Port soils and are associated with Grant and Pond Creek soils. Minco soils are less sandy than Canadian soils and have a thinner brown or dark brown A horizon than Port soils. They are less clayey than Grant or Pond Creek soils.

Mn—Minco silt loam, 0 to 2 percent slopes. This soil is nearly level and gently sloping and is on medium-length, convex ridges and side slopes. It has the profile described as representative of the series.

Included with this soil in mapping are some small areas of Grant soils. Also included are some small areas, along the Medicine River, where the subsoil is fine sandy loam and the underlying layer is loamy fine sand.

Runoff is medium in gentle sloping areas and slow on nearly level areas. Unless protected by crops or crop residue, this soil blows.

Water erosion is a concern of management. The main management needs are controlling soil blowing and water erosion, conserving moisture, and maintaining soil fertility.

Nearly all of the acreage is used for dryland crops; the rest is in native grass that is used for grazing. Capability unit IIe–1; Loamy Upland range site; windbreak suitability group 1.

Naron Series

The Naron series consists of deep, nearly level and gently sloping, well-drained soils on uplands. These soils formed in loamy, eolian deposits underlain by old alluvium.

In a representative profile the surface layer is brown and dark grayish-brown light fine sandy loam and fine sandy loam about 12 inches thick. The upper 6 inches of the subsoil is brown, friable heavy fine sandy loam; the next 10 inches is dark yellowish-brown, friable sandy clay loam; and the lower 9 inches is brown, friable light sandy clay loam. The underlying material is brown light fine sandy loam.

Naron soils have a moderate available water capacity, high fertility, and moderate permeability.

Naron soils are well suited to dryland crops and the native or tame grasses commonly grown in the county. The major crops are winter wheat, sorghum, and alfalfa.

Representative profile of Naron fine sandy loam, 0 to 1 percent slopes, 876 feet north and 80 feet east of the southwest corner of sec. 15, T. 32 S., R. 11 W., in a cultivated field:

Ap—0 to 4 inches, brown (10YR 5/3) light fine sandy loam, dark brown (10YR 3/3) when moist; weak, fine, granular structure; soft, friable; slightly acid; gradual, smooth boundary.

A11—4 to 12 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; hard, friable; many roots; slightly acid; gradual, smooth boundary.

B1—12 to 18 inches, brown (10YR 4/3) heavy fine sandy loam, dark brown (10YR 3/3) when moist; weak, medium, granular structure; hard, friable; common roots; slightly acid; gradual, smooth boundary.

B2t—18 to 28 inches, dark yellowish-brown (10YR 4/4) sandy clay loam, dark yellowish brown (10YR 3/4) when moist; moderate, medium, granular structure; hard, friable; common roots; neutral; gradual, smooth boundary.

B3—28 to 37 inches, brown (7.5YR 5/4) light sandy clay loam, dark brown (7.5YR 3/4) when moist; moderate, medium, granular structure; hard, friable; few, fine roots; neutral; diffuse, smooth boundary.

C—37 to 60 inches, brown (7.5YR 5/4) light fine sandy loam; dark brown (7.5YR 4/4) when moist; massive; few, fine roots; neutral.

The A horizon is grayish-brown, dark grayish-brown or brown fine sandy loam 6 to 15 inches thick. The B1 horizon is grayish-brown, brown, or dark-brown fine sandy loam, heavy sandy loam, or sandy clay loam 4 to 7 inches thick. The B2t horizon is yellowish-brown, dark-brown, brown or light-brown sandy clay loam 10 to 18 inches thick. The B3 and C horizons are light-brown, brown, pale-brown or yellowish-brown sandy clay loam, fine sandy loam, sandy loam in most places, but it is loamy sand in some places. Silty and clayey layers are at a depth of more than 40 inches.

Naron soils are similar to Attica, Farnum, and Shellabarger soils and are associated with Canadian and Port soils. Naron soils have more clay in the B horizon than Attica or Canadian soils. They also have a thinner dark grayish-brown or grayish-brown surface layer than Farnum soils, and they have slightly less clay in the B horizon. Naron soils have less reddish color in the B horizon than Shellabarger or Port soils.

Na—Naron fine sandy loam, 0 to 1 percent slopes. This soil is nearly level and has long, convex slopes. It has the profile described as representative of the series.

Included with this soil in mapping are some small areas of Farnum and Shellabarger soils. Also included are some small nearly level, concave areas that have a surface layer and subsoil of clay loam.

Runoff is slow. Unless protected by crops or crop residue, this soil blows.

The main management needs are controlling soil blowing, conserving soil moisture, and maintaining soil fertility.

Nearly all of the acreage is used for dryland crops; some fields are irrigated; and the rest is in native grassland that is used for grazing. Capability unit IIe–5; Sandy range site; windbreak suitability group 1.

Nb—Naron fine sandy loam, 1 to 3 percent slopes. This soil is gently sloping and has medium and long, convex slopes. This soil is similar to the one described as representative of the series, but the surface layer is slightly thinner.

Included with this soil in mapping are some small areas of Attica, Albion, Farnum, and Shellabarger soils. Also included are some small areas where the subsoil is moderately alkaline and the underlying layers contain soft masses of lime and are moderately alkaline.

Runoff is slow. Unless protected by crops or crop residue, this soil blows. Water erosion is a minor hazard.

The main management needs are controlling soil blowing, conserving moisture, and maintaining fertility.

Nearly all of the acreage is used for dryland crops; some small fields are irrigated; and the rest is in native grassland that is used for grazing. Capability unit IIe–3; Sandy range site; windbreak suitability group 1.

Ost Series

This series consists of deep, nearly level and gently sloping, well-drained soils on uplands. These soils formed in highly calcareous, loamy, old alluvium.

In a representative profile the surface layer is dark grayish-brown clay loam about 8 inches thick. The subsoil is brown, firm clay loam about 20 inches thick. The underlying material is light-brown, calcareous clay loam.

Ost soils have a high available water capacity, high natural fertility, and moderately slow permeability.

Ost soils are well suited to dryland crops and the native or tame grasses commonly grown in the county. The major dryland crops are winter wheat, sorghum, and alfalfa.

Representative profile of Ost clay loam, 1 to 3 percent slopes, 1,980 feet south and 100 feet east of the northwest corner of sec. 2, T. 30 S., R. 14 W., in a cultivated field:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium and fine, granular structure; slightly hard, friable; many roots; slightly acid; gradual, smooth boundary.

B21t—8 to 16 inches, brown (10YR 4/3) clay loam, dark brown (10YR 3/3) when moist; moderate, medium and fine, subangular blocky structure; hard, firm; many roots; neutral; gradual, smooth boundary.

B22t—16 to 22 inches, brown (10YR 5/3) clay loam, brown (10YR 4/3) when moist; moderate, medium, subangular blocky structure; hard, firm; few fine roots; few, thin, discontinuous clay films; mildly alkaline; gradual, smooth boundary.

B3ca—22 to 28 inches, brown (10YR 5/3) and light yellowish-brown (10YR 6/4) clay loam, dark brown (10YR 4/3) and yellowish brown (10YR 5/4) when moist; moderate, medium, blocky structure; hard, firm; few, fine roots; calcareous and moderately alkaline; lime in the form of a few, soft films and fine concretions; gradual, wavy boundary.

Cca—28 to 60 inches, light-brown (7.5YR 6/4) clay loam, brown (7.5YR 5/4) when moist; weak, medium and fine, granular structure; hard, friable; calcareous; violently effervescent; moderately alkaline; the soil mass contains about 35 percent lime in the form of soft whitish masses.

The A horizon is dark grayish-brown, very dark grayish-brown, brown, or dark-brown clay loam 7 to 10 inches thick. The B2t horizon is grayish-brown, dark grayish-brown, brown, or dark-brown clay loam 12 to 22 inches thick. The B3ca horizon is brown or dark-brown clay loam 5 to 10 inches thick. The Cca horizon is very pale brown, pale-brown, brown, light yellowish-brown, yellowish-brown, and light-brown clay loam and 20 to 40 percent, by volume, soft masses of lime.

Ost soils are similar to Blanket soils and are associated with Clark and Farnum soils. Ost soils have less clay in the B horizon and more lime in the underlying material than Blanket soils. They are deeper to a high concentration of lime than Clark soils. This lime occurs as soft masses. Ost soils have a high concentration of lime in the lower part of the B horizon and in the C horizon, but Farnum soils do not. The lime is in the form of soft masses and concretions.

Os—Ost clay loam, 0 to 1 percent slopes. This soil is nearly level and is on broad, convex ridges and divides. It has a profile similar to the one described as representative of the series, but the surface layer is thicker and the depth to lime is slightly greater.

Included with this soil in mapping are some small areas of Blanket and Clark soils. Also included are some small, low areas where the surface layer and subsoil are gray clay and the underlying material is calcareous gray clay.

Runoff is slow. Unless protected by crops or crop residue, this soil blows.

Water erosion on long slopes and the ponding of water in a few low areas after rains is a concern of management. The main management needs are controlling soil blowing and water erosion, draining low areas, conserving moisture, and maintaining soil tilth and fertility.

Nearly all of the acreage is used for dryland crops; small areas are in native grass that is used for grazing.

Capability unit IIc–3; Loamy Upland range site; windbreak suitability group 1.

Ot—Ost clay loam, 1 to 3 percent slopes. This soil is gently sloping and is on medium length, convex side slopes. It has the profile described as representative of the series. Included in mapping are some small areas of Blanket, Clark, and Farnum soils.

Runoff is medium. Unless protected by crops or crop residue, this soil is likely to blow.

Water erosion is a concern of management. The main management needs are controlling water erosion and soil blowing, conserving moisture, and maintaining soil tilth and fertility.

Nearly all of the acreage is used for dryland crops; small areas are used for range. Capability unit IIe–2; Loamy Upland range site; windbreak suitability group 1.

Pond Creek Series

The Pond Creek series consists of deep, nearly level and gently sloping, well-drained soils on uplands. These soils formed in loamy, loessal, residual, and old alluvial sediments.

In a representative profile the surface layer is brown and dark grayish-brown silt loam about 11 inches thick. The subsoil is brown and reddish-brown firm silty clay loam about 34 inches thick. The underlying layer is reddish-brown heavy silt loam.

Pond Creek soils have a high available water capacity, high fertility, and moderately slow permeability.

Pond Creek soils are well suited to dryland crops and native or tame grasses commonly grown in the county. The major crops are winter wheat, sorghum, and alfalfa.

Representative profile of Pond Creek silt loam, 0 to 1 percent slopes, 485 feet east and 270 feet north of the southwest corner of the northwest quarter of sec. 16, T. 35 S., R. 12 W., in a cultivated field:

Ap—0 to 6 inches, brown (10YR 4/3) silt loam, dark brown (10YR 3/3) when moist; moderate, fine, granular structure; slightly hard, friable; many roots; slightly acid; gradual, smooth boundary.

A12—6 to 11 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; slightly hard, friable; many roots; slightly acid; gradual, smooth boundary.

B21t—11 to 21 inches, brown (10YR 4/3) silty clay loam, dark brown (10YR 3/3) when moist; moderate, medium, subangular blocky structure; hard, firm; many roots; neutral; gradual, smooth boundary.

B22t—21 to 35 inches, brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 3/2) when moist; moderate, medium, subangular blocky structure; hard, firm; common roots; thin discontinuous clay films; neutral; gradual, smooth boundary.

B3—35 to 45 inches, reddish-brown (5YR 5/4) silty clay loam, reddish brown (5YR 4/4) when moist; moderate, fine, subangular blocky structure; hard, firm; common roots; neutral; gradual, smooth boundary.

C—45 to 60 inches, reddish-brown (5YR 5/5) heavy silt loam, reddish brown (5YR 4/5) when moist; moderate, medium, granular structure; slightly hard, friable; few fine roots; slightly effervescent; mildly alkaline; fine soft masses of carbonate and films of lime.

The A horizon is brown and dark grayish-brown and 10 to 26 inches thick. The B2t horizon is brown, dark grayish-brown, dark-brown, or reddish-brown silty clay loam 13 to 38 inches thick. In nearly all places this soil contains lime in the form of films, soft masses, and some concretions at a depth of more than 45 inches.

Pond Creek soils are similar to Blanket and Farnum soils and are associated with Grant and Kingfisher soils. Pond Creek soils have less clay in the B horizon than Blanket soils. They have more reddish-colors and less sand in the B and C horizons than Farnum soils. They have more clay in the B horizon than Grant soils. Pond Creek soils lack an underlying layer of clayey shale, which is characteristic of Kingfisher soils.

Pa—Pond Creek silt loam, 0 to 1 percent slopes. This soil is nearly level and has long, broad, convex slopes. It has the profile described as representative of the series.

Included with this soil in mapping are some small areas of Blanket, Grant, and Kingfisher soils. Also included are some small areas where the subsoil is gray silty clay. Slickspots, 1 to 3 acres in size, are shown by a symbol on the detailed soil map.

Runoff is slow. Unless protected by crops or crop residue, this soil is likely to blow.

The main management needs are conserving moisture, controlling soil blowing, and maintaining soil tilth and fertility. Water erosion on long slopes is a concern of management.

Nearly all of the acreage is used for crops; small areas are used for range. Capability unit IIc–1; Loamy Upland range site; windbreak suitability group 1.

Pd—Pond Creek silt loam, 1 to 3 percent slopes. This soil is gently sloping and has medium and long, convex slopes. It has a profile similar to the one described as representative of the series, but the surface layer and subsoil are slightly thinner.

Included with this soil in mapping are small areas of Blanket, Grant, and Kingfisher soils. Also included are some small areas where soft masses of lime are at a depth of 2 to 3 feet. Slickspots, 1 to 3 acres in size, and eroded areas along intermittent drainageways are shown by symbols on the detailed soil map.

Runoff is medium. Unless it is protected by crops or crop residue, the soil is likely to blow.

Water erosion is a concern of management. The main management needs are controlling water erosion and soil blowing, conserving moisture, and maintaining tilth and fertility.

Nearly all of the acreage is used for dryland crops; small areas are used for range. Capability unit IIe–1; Loamy Upland range site; windbreak suitability group 1.

Port Series

Port series consists of deep, nearly level, well-drained soils on stream terraces. These soils formed in loamy, alluvial sediments.

In a representative profile the surface layer is brown silt loam about 20 inches thick. The subsoil is reddish-brown, friable heavy silt loam about 12 inches thick. The underlying layer is reddish-brown silt loam.

Port soils have a high available water capacity, high natural fertility, and moderate permeability.

Port soils are well suited to dryland crops and the native or tame grasses commonly grown in the county. The major crops are winter wheat, sorghum, and alfalfa.

Representative profile of Port silt loam, 1,320 feet north and 200 feet west of center of sec. 7, T. 32 S., R. 12 W., in a cultivated field:

A1—0 to 20 inches, brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) when moist; moderate, fine, granular structure; soft, friable; many roots; slightly acid; gradual, smooth boundary.

B2—20 to 32 inches, reddish-brown (5YR 4/3) heavy silt loam, dark reddish brown (5YR 3/3) when moist; moderate, medium, granular structure; slightly hard, friable; many roots; many earthworm casts; mildly alkaline; gradual, smooth boundary.

C—32 to 60 inches, reddish-brown (5YR 5/4) silt loam, reddish brown (5YR 4/4) when moist; weak, medium, granular structure in the upper part but massive in the lower part; slightly hard, friable; common roots; moderately alkaline; films and fine concretions of lime.

The A horizon is grayish-brown, dark grayish-brown, brown, or dark-brown silt loam in most places, but it is loam in some places. It is 20 to 24 inches thick. The B2 horizon is heavy silt loam or silty clay loam 10 to 20 inches thick. The B2 and C horizons are brown, dark-brown, light-brown, or reddish-brown. The C horizon is silt loam or silty clay loam in most places, but it is loam or clay loam in some places.

Port soils are similar to Minco soils and are associated with Clairemont, Canadian, Grant, Pond Creek, and Yahola soils. Port soils have more clay in the B horizon than Minco, Canadian, and Yahola soils. They have a darker colored A horizon and are deeper to a calcareous layer than Clairemont soils. Port soils have a less well developed B horizon than Pond Creek or Grant soils.

Ph—Port silt loam. This soil is nearly level and is on long, broad, convex stream terraces 3 to 12 feet above the flood plains of major streams. It is subject to flooding of short duration in periods of heavy rain. It has the profile described as representative of the series. Slopes are 0 to 1 percent.

Included with this soil in mapping are some small areas of Canadian and Clairemont soils. Also included are some small areas of soil that has a subsoil of clay or silty clay. Slickspots, 1 to 3 acres in size, are shown by a symbol on the detailed soil map.

Runoff is slow. Unless protected by crops or crop residue, this soil blows. The main management needs are conserving moisture, controlling soil blowing, and maintaining soil tilth and fertility.

Nearly all of this soil is used for crops; small areas are used for range. Capability unit I–1; Loamy Terrace range site; windbreak suitability group 8.

Pk—Port-Slickspots complex. This complex is nearly level and is on short and medium, convex stream terraces 3 to 12 feet above the flood plains of major streams. These soils are subject to flooding of short duration in periods of heavy rains. Slopes are 0 to 1 percent.

This complex consists of 70 percent Port silt loam and 30 percent Slickspots.

Included with the Slickspots in mapping were some small areas of calcareous, gray clay. Also included are some small areas near the flood plain where lime occurs within 30 inches of the surface. The lime is in the form of soft masses and concretions.

The Port soil has the profile described as representative of the series.

Slickspots have a surface layer of light-gray, light-brown, or pale-brown loam or clay loam and nearly white, vesicular surface crusts ½ to 1 inch thick. The subsoil is light brown, pale brown, or reddish brown. The underlying material is loamy and has lime in the form of soft masses and concretions as well as other salts that do not effervesce. Slickspots are underlain by clayey and sandy material or by layers of sandstone and shale at a depth of more than 4 feet.

Runoff is slow. The water table is below a depth of 6 feet. Unless protected by crops or crop residue, this soil blows. Salt accumulation in the subsoil and underlying material slows and restricts the downward movement of water and roots.

The main management needs are controlling soil blowing, maintaining a cover of plants as well as fertility for slickspots, and conserving moisture.

Nearly all of the acreage is used for dryland crops; small areas are used for range. Capability unit IVs–2; Port soil in Loamy Terrace range site and windbreak suitability group 8; Slickspots in Saline Lowland range site and windbreak suitability group 6.

Pratt Series

The Pratt series consists of deep, rolling, well-drained soils on uplands. These soils formed in sandy eolian sediments.

In a representative profile the surface layer is brown loamy fine sand about 7 inches thick. The subsoil is brown very friable heavy loamy fine sand about 23 inches thick. The underlying material is brown loamy fine sand.

Pratt soils have a low available water capacity, medium fertility, and rapid permeability.

Pratt soils are suited to dryland crops and the native tame grasses commonly grown in the county. The major crops are winter wheat and sorghum.

Representative profile of Pratt loamy fine sand, 5 to 10 percent slopes, 900 feet west and 60 feet north of the southeast corner of sec. 3, T. 30 S., R. 11 W., in grass:

A1—0 to 7 inches, brown (10YR 5/3) loamy fine sand, dark brown (10YR 4/3) when moist; weak, fine, granular structure; soft, very friable; many fine roots; slightly acid; gradual, smooth boundary.

B2t—7 to 30 inches, brown (7.5YR 5/4) heavy loamy fine sand, dark brown (7.5YR 4/4) when moist; weak, coarse, prismatic structure breaking to weak, medium, granular structure; slightly hard, very friable; common fine roots; slightly acid; diffuse boundary.

C—30 to 60 inches, brown (7.5YR 5/4) loamy fine sand, dark brown (7.5YR 4/4) when moist; structureless; loose; few fine roots; neutral.

The A horizon is brown or grayish brown and 7 to 14 inches thick. The B2t horizon is brown or yellowish brown and 15 to 36 inches thick. The C horizon is brown, light-brown, yellowish-brown, or pale-brown loamy fine sand or loamy sand.

Pratt soils are similar to Attica soils and are associated with Farnum, Naron, Shellabarger, and Tivoli soils. Pratt soils have a more sandy B horizon than Attica, Farnum, Naron or Shellabarger soils and are less sandy than Tivoli soils.

Ps—Pratt loamy fine sand, 5 to 10 percent slopes. This soil has short and medium, rolling slopes in complex, wind-modified areas. This soil has the profile described as representative of the series.

Included with this soil in mapping are some small areas of Attica, Farnum, Naron, and Tivoli soils. Also included are some small areas in depressions where the

subsoil is gray clay and other small areas where the subsoil and underlying material are calcareous loamy fine sand.

Runoff is slow.

Soil blowing is a concern of management. Careful management of growing crops and crop residue is needed to protect this soil from blowing, to conserve moisture, and to maintain soil fertility. Careful management of the range is needed to maintain a good cover of native grass and to protect this soil from blowing.

Nearly all the acreage is used for range; small fields are used for crops. Capability unit IVe–4; Sands range site; windbreak suitability group 4.

Pt—Pratt-Tivoli loamy fine sands, 5 to 15 percent slopes. This complex has short, convex, rolling slopes in complex, wind-modified areas.

This complex consists of about 70 percent Pratt loamy fine sand, 20 percent Tivoli loamy fine sand, and 10 percent small areas of Albion and Shellabarger soils.

Included with these soils in mapping are small areas of stratified, loamy fine sand, sand, and gravel that are alluvial and are in channels and on fans. Also included are some small areas where layers of clay or shale are at a depth of 2 to 5 feet.

The only Tivoli loamy fine sand mapped in the county is in this complex. It has a profile similar to the one described as representative of the series, but the surface layer is loamy fine sand.

Runoff is slow.

Soil blowing is a concern of management. Careful management of range is needed to maintain a good cover of native grass and to protect the soils from blowing.

All of the acreage is used for range. Capability unit VIe–5; Sands range site; windbreak suitability group 4.

Quinlan Series

The Quinlan series consists of shallow, nearly level to moderately steep, well-drained soils on uplands. These soils formed in material weathered from calcareous, soft, fine-grained sandstone.

In a representative profile the surface layer is reddish-brown loam about 6 inches thick. The subsoil is yellowish-red, friable loam about 8 inches thick. The underlying material is yellowish-red, weakly cemented sandstone.

Quinlan soils have a low available water capacity, low natural fertility, and moderately rapid permeability.

These soils are suited to dryland crops or tame grasses, but they are better suited to the native grasses commonly grown in the county. The major crops are winter wheat and sorghum. Most sorghum fields turn yellow because of the lack of some plant nutrients.

Representative profile of Quinlan loam, 1 to 3 percent slopes, 250 feet north and 50 feet east of the southwest corner of sec. 27, T. 32 S., R. 10 W., in grassland:

A1—0 to 6 inches, reddish-brown (5YR 5/4) loam, dark reddish brown (5YR 3/4) when moist; weak, fine, granular structure; soft, very friable; many roots; violently effervescent; moderately alkaline; gradual, wavy boundary.

B2—6 to 14 inches, yellowish-red (5YR 5/6) loam, yellowish red (5YR 4/6) when moist; weak, medium, granular structure; slightly hard, friable; many roots; few, fine, soft fragments of soft sandstone; violently effervescent; moderately alkaline; gradual, wavy boundary.

C—14 to 60 inches, yellowish-red (5YR 5/6), weakly cemented, calcareous sandstone, yellowish red (5YR 4/6) when moist.

The A horizon is light reddish-brown, reddish-brown, brown, or light-brown loam 4 to 8 inches thick, but it is fine sandy loam or silt loam in some places. The B horizon is reddish-brown or yellowish-red loam or silt loam 6 to 12 inches thick. The C horizon is yellowish-red or reddish-yellow weakly cemented sandstone.

Quinlan soils are similar to Vernon and Woodward soils and are associated with Grant, Kingfisher, and Pond Creek soils. Quinlan soils have less clay in the B horizon than Grant, Kingfisher, Pond Creek, and Vernon soils. They are shallower to soft fine-grained sandstone than Woodward soils.

Qn—Quinlan loam, 1 to 3 percent slopes. This soil is gently sloping and is on short and medium, convex ridges and divides. It has the profile described as representative of the series.

Included with this soil in mapping are small areas of Grant and Woodward soils and of Clairemont soils, channeled. Also included are small areas of soils that have a surface layer and subsoil of fine sandy loam, and soils that are underlain by noncalcareous sandstone. Other inclusions are spots of rock and shale. Slickspots, 1 to 3 acres in size, are shown by a spot symbol on the detailed soil map.

Runoff is medium. Water erosion and low natural soil fertility are concerns of management. Unless protected, this soil is likely to blow.

Management is needed to control erosion, to conserve moisture, and to maintain soil fertility.

Nearly all the acreage is used for crops; small areas are used for range. Capability unit IIIe–3; Shallow Prairie range site; windbreak suitability group 2.

Qw—Quinlan-Woodward complex, 5 to 15 percent slopes. This mapping unit is sloping to moderately steep and is on short, convex side slopes and ridges.

This complex consists of 55 percent Quinlan loam and 30 percent Woodward loam. The rest consists of small areas of rock outcrops and breaks, Clairemont soils, Grant soils, and areas of grayish loamy and sandy soils.

Surface runoff is rapid. Erosion is a hazard unless native grass cover is maintained and cultivated fields are protected.

Nearly all of the acreage is used for range, but small areas, mainly of Woodward, Grant, or Clairemont soils, are cultivated. Capability unit VIe–3; Quinlan soil in Shallow Prairie range site and windbreak suitability group 2; Woodward soil in Loamy Upland range site and windbreak suitability group 1.

Rough Broken Land

Rb—Rough broken land, shaly (15 to 80 percent slopes), consists of steep, excessively drained areas on uplands. It is 80 percent Rough broken land, shaly; 8 percent rock outcrops of gypsum and soils weathered from it; 10 percent Clairemont soils, channeled; and 2 percent granular clay loam on colluvial slopes.

Rough broken land, shaly, is unconsolidated, reddish, calcareous shale bedrock that has many thin lenses of gypsum.

Rock outcrops are heavy, massive, gypsum that contains layers of selenite, satin spar, and gypsum anhydrite. The rocks are 5 to many feet thick. Small areas of a shallow soil that formed in loamy material overlying the gypsum rock are included.

Clairemont soils, channeled, have a profile that is similar to the one described as representative of the series, but slopes are 5 to 10 percent and channels are 2 to 100 feet wide and 10 to 50 feet deep.

Surface runoff is rapid. Very low natural fertility and water erosion are severe hazards. Heavy loads of silt are common in stream channels after rain. Management of native grass cover is needed to maintain good soil fertility, control erosion, and conserve moisture.

All the acreage is used for range, but bare shale is a difficult grazing area (fig. 9) because it is high in gypsum content and is steep. Capability unit VIIs–1; Red Shales range site; not assigned to a windbreak suitability group.

Shellabarger Series

The Shellabarger series consists of deep, well-drained, gently sloping to moderately steep soils on uplands. These soils formed in loamy and sandy, old alluvium.

In a representative profile the surface layer is brown sandy loam about 14 inches thick. The upper part of the subsoil is brown, firm sandy clay loam about 10 inches thick, and the lower part is reddish-brown, firm sandy clay loam about 24 inches thick. The underlying material is reddish-brown and reddish-yellow sandy loam and loamy sand.

Shellabarger soils have a moderate available water capacity, medium natural fertility, and moderate permeability.

Shellabarger soils are well suited to dryland crops and the native and tame grasses grown in the county. The major dryland crops are winter wheat, sorghum, and alfalfa.

Representative profile of Shellabarger sandy loam, 3 to 6 percent slopes, 900 feet north and 240 feet west of center of sec. 15, T. 30 S., R. 12 W., in grassland:

A1—0 to 14 inches, brown (7.5YR 5/2) sandy loam, dark brown (7.5YR 3/2) when moist; moderate, fine, granular structure; slightly hard, friable; many roots; slightly acid; gradual, smooth boundary.

B1—14 to 24 inches, brown (7.5YR 5/3) sandy clay loam, dark brown (7.5YR 4/3) when moist; weak, medium, granular structure; hard, firm; many roots; slightly acid; gradual, smooth boundary.

B2t—24 to 38 inches, reddish-brown (5YR 5/4) sandy clay loam, reddish brown (5YR 4/4) when moist; weak, coarse, subangular blocky structure breaking to strong, coarse, granular structure; hard, firm; common roots; slightly acid; diffuse boundary.

B3—38 to 48 inches, reddish-brown (5YR 5/4) sandy clay loam, reddish brown (5YR 4/4) when moist; moderate, medium and fine, granular structure; hard, firm; few roots; slightly acid; gradual, smooth boundary.

C1—48 to 60 inches, reddish-brown (5YR 5/4) sandy loam, reddish brown (5YR 4/4) when moist; massive to weak, fine, granular structure; slightly hard, friable; few roots; many fine pebbles; neutral; diffuse boundary.

C2—60 to 68 inches, reddish-yellow (5YR 6/6) loamy sand, yellowish red (5YR 5/6) when moist; massive; loose; many, fine and medium, water-rounded pebbles.

The A horizon is brown or dark brown and 6 to 16 inches thick. It is dominantly sandy loam but is loamy fine sand in some places. The B1 horizon is 6 to 12 inches thick. The C horizon is reddish-brown, light reddish-brown, reddish-yellow, or yellowish-red sandy loam in most places, but it consists of alternating layers of loamy sand and sandy loam in some places.

Shellabarger soils are similar to Albion and Naron soils and are associated with Attica, Farnum, and Pratt soils. Shellabarger soils have a more clayey subsoil than Albion, Attica, or Pratt soils. They are deeper to a coarse-textured layer than Albion soils. Shellabarger soils are distinguished from Naron soils by a reddish B horizon and sandy underlying layers. They have slightly less clay in the B2t horizon, are more reddish in the lower part of the B horizon and in the C horizon, and have a more sandy underlying layer than Farnum soils.

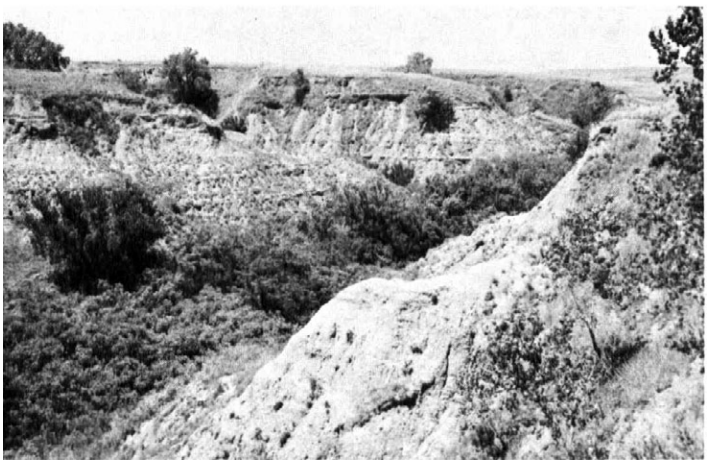

Figure 9.—**Area of Rough broken land, shaly. Tall prairie grasses grow on the narrow flood plain and in some gullies on the steep slopes.**

Sb—Shellabarger sandy loam, 3 to 6 percent slopes. This soil is sloping and is on medium-length, convex ridges and side slopes. It has the profile described as representative of the series.

Included with this soil in mapping are some small areas of Albion and Naron soils. Also included are some small areas where the lower part of the subsoil and the underlying material are calcareous, and other small areas where the underlying material is reddish, calcareous clay shale.

Runoff is medium. Unless protected by growing crops or crop residue, this soil blows.

The control of water erosion is a concern of management. The main management needs are controlling water erosion and soil blowing, conserving soil moisture, and maintaining soil fertility and tilth.

Nearly all the acreage is used for dryland crops; small areas are used for range. Capability unit IIIe–2; Sandy range site; windbreak suitability group 1.

Sc—Shellabarger sandy loam, 3 to 6 percent slopes, eroded. This soil is sloping and is on short convex side slopes along intermittent upland drainageways. It has a profile similar to the one described as representative of the series, but the surface layer is 4 to 8 inches thick and the subsoil is somewhat thinner. In some places the surface layer is sandy clay loam or clay

loam and many fine and medium pebbles are on the surface.

Included with this soil in mapping are some small areas of Albion soils and gravel beds. Also included are some small areas where the surface layer and subsoil are dark grayish-brown clay loam and the underlying material is yellowish-brown clay loam.

Runoff is medium. Unless protected, the surface soil is likely to blow.

Water erosion is a concern of management. Management of crops, crop residue, and native-grass cover is needed to control water erosion and soil blowing, to conserve moisture, and to improve fertility. When this soil is used for crops, soil tilth is difficult to maintain. A cover of native grass provides the best protection against further erosion.

Nearly all of the acreage has been used for dryland crops; small areas have been seeded to native grass and used for range. Capability unit IVe–3; Sandy range site; windbreak suitability group 1.

Tivoli Series

The Tivoli series consists of deep, excessively drained, rolling and hilly soils on uplands. These soils formed in sandy eolian sediments.

In a representative profile the surface layer is light brownish-gray fine sand about 5 inches thick. The underlying material is pale-brown fine sand.

Tivoli soils have a low available water capacity, low natural fertility, and rapid permeability.

Tivoli soils are suited to the native grasses commonly grown in the county.

Representative profile of Tivoli fine sand, 5 to 20 percent slopes, 330 feet west and 45 feet south of the northeast corner of sec. 11, T. 32 S., R. 11 W., in grassland:

A1—0 to 5 inches, light brownish-gray (10YR 6/2) fine sand, dark grayish brown (10YR 4/2) when moist; single grained; loose; common roots; slightly acid; diffuse boundary.

C—5 to 60 inches, pale-brown (10YR 6/3) fine sand, brown (10YR 5/3) when moist; single grained; loose; few roots; slightly acid.

The A horizon is dominantly fine loamy sand, but it is fine sand in some places. It is light brownish gray, grayish brown, pale brown, brown, yellowish brown or light brown 4 to 7 inches thick. The C horizon is light-brown, reddish-yellow, brown, pale-brown, very pale brown or light yellowish-brown fine sand. Coarse sand, gravel, or clay loam is at a depth of more than 40 inches in some places.

Tivoli soils are associated with Attica and Pratt soils. They are more sandy than Attica or Pratt soils.

Tv—Tivoli fine sand, 5 to 20 percent slopes. This soil is rolling and hilly on short, steep, convex side slopes in complex, wind-modified areas. It has the profile described as representative of the series.

Included with this soil in mapping are some small areas of Pratt soils and Yahola soils. Also included are some small areas of soils that have an underlying layer of calcareous fine sand and loamy fine sand.

Runoff is slow.

Soil blowing is a concern of management. The main management needs are maintaining a cover of native grass in good condition and controlling soil blowing.

This soil is in native grassland and is used for grazing. Capability unit VIIe–1; Choppy Sands range site; not assigned to windbreak suitability group.

Vernon Series

The Vernon series consists of moderately deep, gently sloping to moderately steep, well-drained soils on uplands. These soils formed in material weathered from moderately alkaline, clayey shale red beds that have much gypsum.

In a representative profile the surface layer is reddish-brown clay loam about 5 inches thick. The subsoil is reddish-brown, very firm clay about 17 inches thick. The underlying material is red clay shale.

Vernon soils have a low available water capacity, low natural fertility, and very slow permeability.

Vernon soils are not well suited to dryland crops or tame grasses. They are better suited to the native grasses commonly grown in the county.

Representative profile of Vernon clay loam, in an area of Kingfisher-Vernon complex, 1 to 3 percent slopes, 90 feet east and 110 feet north of the southwest corner of the southeast quarter of sec. 32, T. 33 S., R. 15 W., in grassland:

A1—0 to 5 inches, reddish-brown (2.5YR 4/4) clay loam, dark reddish brown (2.5YR 3/4) when moist; moderate, medium and fine, subangular blocky structure; hard, firm; many roots; slightly effervescent; moderately alkaline; gradual, smooth boundary.

B—5 to 22 inches, reddish-brown (2.5YR 4/4) clay, dark red (2.5YR 3/6) when moist; moderate, medium, subangular blocky structure; very hard, very firm; many roots; strongly effervescent, few fine concretions of lime; moderately alkaline; diffuse, wavy boundary.

C—22 to 60 inches, red (2.5YR 4/6) clay shale, dark red (2.5YR 3/6) when moist; massive; few roots; some clay films in cracks; violently effervescent, few fine and medium concretions of lime; moderately alkaline; many gypsum fragments.

The A horizon is reddish-brown, light reddish-brown, or brown clay loam or clay 4 to 10 inches thick. The B horizon is reddish brown, or yellowish red and 12 to 24 inches thick. The C horizon is red, reddish-brown, or yellowish-red, massive, gypsiferous heavy clay loam shale or clay shale.

Vernon soils are similar to Quinlan and Woodward soils and are associated with Grant, Kingfisher, and Pond Creek soils. Vernon soils have a more clayey B horizon than any of these soils. They also are deeper than Quinlan soils to underlying red beds.

Vn—Vernon clay loam, 3 to 5 percent slopes. This soil is sloping and is on short convex ridges and side slopes. It has a profile similar to the one described as representative of the series, but the surface layer and the subsoil are slightly thinner.

Included with this soil in mapping are some small areas of Kingfisher, Quinlan, and Woodward soils. Also included are some small areas that have a loam surface layer and subsoil overlying thick rock gypsum and other small areas that have a gray calcareous clay surface layer and subsoil overlying grayish old alluvium.

Runoff is rapid. Water erosion is a major concern of management. Unless protected, the surface soil is likely to blow. Management of crops, crop residue, and native grass cover is needed to conserve moisture, to control erosion, and to improve tilth and fertility. When this soil is used for crops, soil erosion is difficult to control. Also soil tilth and fertility are difficult to

maintain. Native grasses provide the best cover to protect this soil against erosion.

Nearly all the acreage of this soil is used for grassland. Much of the acreage that was used for crops has now reverted to native grass; small areas are used for winter wheat and sorghum. Capability unit IVe–2; Red Clay Prairie range site; windbreak suitability group 3.

Vr—Vernon clay loam, 5 to 15 percent slopes. This soil is sloping to moderately steep and is on short convex ridges and side slopes. It has a profile similar to the one described as representative of the series, but the surface layer and the subsoil are thinner.

Included with this soil in mapping are some small areas of Kingfisher, Quinlan, Woodward, Grant, and Clairemont soils. Massive outcrops of gypsum, and shallow, loamy, gypsiferous soil that formed in partly weathered gypsum are included. Also included are some small areas of colluvium where the soil material consists of deep, granular, calcareous, highly stratified clay and clay loam and many fragments of gypsum and shale.

Runoff is rapid. A large load of sediment is common in the stream channels after rain.

The control of water erosion is a major concern of management. Management of native-grass cover is needed to control erosion and to conserve moisture.

All of the acreage is used for range. Capability unit VIe–2; Red Clay Prairie range site; windbreak suitability group 3.

Vs—Vernon-Shale outcrop complex. This mapping unit is gently sloping and sloping and is on short and medium, convex side slopes, some of which are in gullies and on buttes and pinnacles. Slopes are 1 to 5 percent.

This complex consists of 45 percent Vernon clay loam and 45 percent clay Shale outcrop. The remaining 10 percent is inclusions. The Vernon soil in this complex has a profile similar to the one described as representative of the series, but the surface layer and the subsoil are thinner. The surface layer is heavy clay loam or clay. The Shale component consists of reddish-brown, calcareous, gypsiferous clay loam, or clay shale, many thin layers of gypsum, and thin layers of gray and green shale.

Included are small areas where gypsum crops out and a shallow loamy soil has formed in partly weathered gypsum; small areas of colluvium where the soil material consists of deep, highly stratified, calcareous clay and clay loam and many fragments of gypsum and shale; and small areas where the underlying material is 10 to 30 percent lime that occurs as soft masses and concretions.

Runoff is rapid. If native vegetation is not maintained in good condition, the soil material in areas of bare shale blows.

Low fertility, a root zone of clayey shale, and control of water erosion are concerns of management. Management of native grass is needed to maintain fertility, to control erosion, and to conserve moisture.

All the acreage is used for range. Capability unit VIIs–2; Vernon soil in Red Clay Prairie range site and windbreak suitability group 3; Shale outcrop in Eroded Red Clay range site; not assigned to a windbreak suitability group.

Waldeck Series

The Waldeck series consists of deep, nearly level, somewhat poorly drained soils on low terraces. These soils formed in loamy alluvium that is underlain by sandy alluvium.

In a representative profile the surface layer is dark grayish-brown sandy loam about 12 inches thick. The next layer is light brownish-gray, friable sandy loam about 14 inches thick. The underlying material is grayish-brown sandy loam and, beginning at a depth of 36 inches, pale-brown fine and medium sand.

Waldeck soils have moderately rapid permeability above the water table, which is seasonally high. They have a moderate available water capacity and high natural fertility.

Waldeck soils are well suited to dryland crops, trees, and the native or tame grasses commonly grown in the county. The major crops are winter wheat, sorghum, and alfalfa.

Representative profile of Waldeck sandy loam, 1,650 feet east and 690 feet north of center of sec. 20, T. 30 S., R. 12 W., in a cultivated field:

A1—0 to 12 inches, dark grayish-brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft, very friable; many roots; calcareous; mildly alkaline; gradual, smooth boundary.

AC—12 to 26 inches, light brownish-gray (10YR 6/2) sandy loam; common, fine, faint mottles of brown (7.5YR 5/3) and few, fine, faint mottles of gray (10YR 6/1), grayish brown (10YR 5/2) when moist; weak, medium, granular structure; slightly hard, friable; few roots; calcareous; moderately alkaline; gradual, smooth boundary.

C—26 to 36 inches, grayish-brown (10YR 5/2) sandy loam; common, fine, distinct mottles of brown (7.5YR 5/4) and common, fine, faint mottles of gray (10YR 5/1) but dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure in the upper part, but massive in the lower part; slightly hard, friable; few roots; calcareous; moderately alkaline; gradual, smooth boundary.

IIC—36 to 60 inches, pale-brown (10YR 6/3) fine and medium sand, brown (10YR 5/3) when moist; single grained; loose; weakly calcareous; mildly alkaline.

The A horizon is dark grayish brown, grayish brown, or dark brown, and is 10 to 18 inches thick. It is dominantly sandy loam but is loamy fine sand in some places. The AC and C horizons are sandy loam or fine sandy loam 16 to 38 inches thick. Beneath the A horizon, beginning at a depth of 20 to 30 inches, are distinct mottles. The underlying IIC horizon is brown, grayish-brown, light brownish-gray, or pale-brown fine and medium sand.

Waldeck soils are similar to Zenda soils and are associated with Canadian, Kanza, and Lincoln soils. Waldeck soils are more sandy than Zenda soils. They are shallower to a seasonal high water table than Canadian soils, and they are shallower to distinctly mottled layers. Waldeck soils are less sandy than Kanza or Lincoln soils.

Wa—Waldeck sandy loam. This soil is nearly level and is on short and medium, low terraces adjacent to major streams. During periods of heavy rain, it is subject to flooding of short duration.

Included with this soil in mapping are some small areas of Zenda and Kanza soils. Also included are some small areas where depth to a coarse-textured layer is less than 24 inches and some small areas where the surface layer is clay loam.

Runoff is slow. The water table fluctuates at a depth

between 2 and 5 feet. Unless protected by crops or crop residue, this soil blows.

The main management needs are controlling soil blowing and maintaining soil fertility.

Nearly all the acreage is used for dryland crops; some small areas are used for range. Capability unit IIIw–2; Subirrigated range site; windbreak suitability group 5.

Woodward Series

The Woodward series consists of moderately deep, nearly level to moderately steep, well-drained soils on uplands. These soils formed in material weathered from soft, calcareous, fine-grained sandstone and shale red beds.

In a representative profile the surface layer is brown loam about 10 inches thick. The subsoil is reddish-brown and yellowish-red, friable heavy loam or loam about 30 inches thick. The underlying material is yellowish-red, fine-grained sandstone.

Woodward soils have a moderate available water capacity, medium natural fertility, and moderate permeability.

Woodward soils are well suited to dryland crops and the native or tame grasses commonly grown in the county. The major crops are winter wheat, sorghum, and alfalfa.

Representative profile of Woodward loam, in an area of Woodward-Quinlan loams, 0 to 3 percent slopes, 600 feet west and 300 feet north of the southeast corner of sec. 2, T. 34 S., R. 11 W., in a cultivated field:

A1—0 to 10 inches, brown (7.5YR 5/4) loam, dark brown (7.5YR 3/4) when moist; weak, fine, granular structure; soft, friable; many roots; mildly alkaline; gradual, smooth boundary.

B2—10 to 24 inches, reddish-brown (5YR 5/4) heavy loam, reddish brown (5YR 4/4) when moist; moderate, medium, granular structure; slightly hard, friable; many roots; calcareous; moderately alkaline; thin films of lime; gradual, smooth boundary.

B3—24 to 40 inches, yellowish-red (5YR 5/6) loam, yellowish red (5YR 4/6) when moist; weak, medium, granular structure; slightly hard, friable; many roots; calcareous; moderately alkaline; lime occurs as a few soft masses and as concretions; a few fragments of weathered sandstone in the lower part; gradual, smooth boundary.

C—40 to 60 inches, yellowish-red (5YR 5/6) fine-grained sandstone, yellowish red (5YR 4/6) when moist; highly calcareous; moderately alkaline.

The A horizon is brown or reddish-brown and 7 to 12 inches thick. It is dominantly loam but is fine sandy loam or silt loam in some places. The B2 and B3 horizons are light reddish-brown, reddish-brown, reddish-yellow, yellowish-red, light-red, or red loam. The B2 horizon is 9 to 20 inches thick, and the B3 horizon is 4 to 16 inches thick.

Woodward soils are similar to Quinlan and Vernon soils and are associated with Grant, Kingfisher, and Pond Creek soils. Woodward soils are deeper to fine-grained, soft sandstone than Quinlan soils. They have less clay in the B horizon than Grant, Kingfisher, Pond Creek, or Vernon soils.

Wo—Woodward-Quinlan loams, 0 to 3 percent slopes. This mapping unit is nearly level and gently sloping and is on medium length, convex ridges and side slopes. Woodward soils occur only in complex with Quinlan soils. The Woodward soil in this complex has the profile described as representative of the series.

This complex consists of 70 percent Woodward loam and 20 percent Quinlan loam. The remaining 10 percent consists of small areas of Clairemont soils, channeled, and Grant soils.

Included with this soil in mapping are some small areas where the surface layer and subsoil are clay loam and the underlying material is calcareous, violently effervescent clay loam and is 20 to 40 percent soft masses and concretions of lime.

Runoff is medium. Unless protected by crops or crop residue, these soils are likely to blow.

Water erosion is a concern of management. Management of crops and grassland is needed to control erosion, to conserve moisture, to maintain soil fertility, and to maintain a good cover of native grass.

Nearly all the acreage is used for dryland crops; small areas are used for range. Capability unit IIIe–3; Woodward soil in Loamy Upland range site and windbreak suitability group 1; Quinlan soil in Shallow Prairie range site and windbreak suitability group 2.

Ws—Woodward-Quinlan loams, 3 to 6 percent slopes. This mapping unit is sloping and is on short, convex ridges and side slopes.

This complex consists of 55 percent Woodward loam, 35 percent Quinlan loam, and 10 percent inclusions. The Woodward soil has a profile similar to the one described as representative of the series, but the surface layer and subsoil are slightly thinner.

Included with these soils in mapping are small areas of Clairemont soils, channeled, Grant soils, and Kingfisher soils; small areas where the surface layer is fine sandy loam and the subsoil is sandy clay loam; and other small areas where the surface layer, subsoil, and underlying material consist of clay loam and 20 to 40 percent soft masses and concretions of lime. Small eroded spots, 1 to 3 acres in size, are shown by a spot symbol on the detailed soil map.

Runoff is medium. Unless protected by growing crops or crop residue, the soils blow.

The control of water erosion is a concern of management. Management of crops and grass is needed to control water erosion and soil blowing, to conserve moisture, and to maintain soil fertility.

Nearly all the acreage is used for dryland crops; small areas are used for range. Capability unit IVe–1; Woodward soil in Loamy Upland range site and windbreak suitability group 1; Quinlan soil in Shallow Prairie range site and windbreak suitability group 2.

Yahola Series

The Yahola series consists of deep, nearly level, well-drained soils formed in moderately alkaline, stratified, loamy, and sandy, recent alluvium. These soils are subject to flooding.

In a representative profile the surface layer is brown sandy loam about 14 inches thick. The upper 22 inches of underlying material is light-brown fine sandy loam; the middle 24 inches is light reddish-brown fine sandy loam, and the lower layer is light-brown medium sand.

Yahola soils have a moderate available water capacity, medium fertility, and moderately rapid permeability. The water table fluctuates between the depths of 4 to 6 feet.

Yahola soils are well suited to dryland crops, trees, and the native or tame grasses commonly grown in the

county. The major crops are winter wheat, sorghum, and alfalfa.

Representative profile of Yahola sandy loam, 150 feet north and 150 feet east of the southwest corner of sec. 32, T. 34 S., R. 10 W., in cultivated field:

A1—0 to 14 inches, brown (7.5YR 5/3) sandy loam, dark brown (7.5YR 4/3) when moist; weak, fine, granular structure; soft, very friable; many roots; strong effervescence; moderately alkaline; gradual, smooth boundary.

C1—14 to 36 inches, light brown (7.5YR 6/4) fine sandy loam, brown (7.5YR 4/4) when moist; moderate, medium, granular structure; slightly hard, friable; common roots; strong effervescence; moderately alkaline; diffuse boundary.

C2—36 to 60 inches, light reddish-brown (5YR 6/4) fine sandy loam, reddish brown (5YR 4/4) when moist; structureless; loose; few roots; violent effervescence; moderately alkaline; gradual, wavy boundary.

IIC—60 to 66 inches, light-brown (7.5YR 6/4) medium sand, brown (7.5YR 4/4) when moist; structureless; loose; mildly alkaline.

The A horizon is light brown, brown, light reddish brown or reddish brown and 10 to 20 inches thick. It is dominantly sandy loam but is fine sandy loam or loamy fine sand in some places. The C1 and C2 horizons range from 26 to 50 inches in combined thickness. They are slightly redder than the A horizon. These horizons have a texture range that averages fine sandy loam, but thin layers of clay loam or loamy fine sand occur in some places. The IIC horizon of fine or medium sand is at a depth of 40 to 70 inches.

Yahola soils are similar to Clairemont and Lincoln soils and are associated with Canadian, Mangum, and Port soils. Yahola soils are more sandy than Clairemont, Mangum, or Port soils and less sandy than Lincoln soils. They differ from Canadian soils in having brownish and reddish colors and in being moderately alkaline throughout the profile. They are also on floodplains, but Canadian soils are on stream terraces.

Ya—Yahola sandy loam. This soil is nearly level and is on the long narrow flood plains of major streams. Flooding can be expected at least once each year but is of short duration.

Included with this soil in mapping are some small areas of Canadian, Clairemont, and Lincoln soils. Also included are some small areas where the surface layer and subsoil average less than 36 inches thick and consist of clay loam and soft masses of lime. Other inclusions are small areas that are shallow to sand and fine gravel. Slickspots, 1 to 2 acres in size, are shown by a symbol on the detailed soil map.

Runoff is slow. Unless protected by crops or crop residue, this soil blows.

The main management needs are controlling soil blowing and maintaining soil fertility.

Nearly all the acreage is used for dryland crops; some small areas are used for range. Capability unit IIw–2; Subirrigated range site; windbreak suitability group 5.

Zenda Series

The Zenda series consists of deep, nearly level, somewhat poorly drained soils on low stream terraces. These soils are subject to occasional flooding. They formed in loamy, calcareous alluvium.

In a representative profile the surface layer is grayish-brown and dark grayish-brown clay loam about 20 inches thick. The underlying layers are mottled brown and very pale brown clay loam.

Zenda soils have a high available water capacity, medium fertility, and moderate permeability. They have a seasonally high water table at a depth of 3 to 6 feet.

Zenda soils are well suited to dryland crops, trees, and the native or tame grasses commonly grown in the county. The major crops are winter wheat, sorghum, and alfalfa.

Representative profile of Zenda clay loam, 1,070 feet west and 825 feet south of the northeast corner of sec. 35, T. 30 S., R. 12 W., in a cultivated field:

Ap—0 to 7 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine granular structure; slightly hard, friable; many roots; neutral; gradual, smooth boundary.

A12—7 to 12 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; hard, friable; many roots; neutral; gradual, smooth boundary.

A13—12 to 20 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; hard, firm; common roots; mildly alkaline; gradual, smooth boundary.

C1—20 to 40 inches, brown (10YR 5/3) clay loam, common, fine, faint mottles of brown (7.5YR 5/4), dark brown (10YR 4/3) when moist; weak, medium, granular structure; slightly hard, friable; few roots; strong effervescence; moderately alkaline; diffuse boundary.

C2—40 to 60 inches, very pale brown (10YR 7/3) clay loam, common, medium, faint mottles of brown (7.5YR 5/4), brown (10YR 5/3) when moist; massive; many fine concretions; violent effervescence; moderately alkaline.

The A horizon is grayish brown, dark grayish brown, brown, or dark brown and 10 to 20 inches thick. It is dominantly clay loam but is loam or light clay loam in some places. The C horizon is grayish-brown, light brownish-gray, very pale brown, pale-brown, brown, light yellowish-brown, and light brown clay loam. The C horizon has mottles ranging from common, fine, and faint in the upper part to common, medium, and distinct in the lower part. The C horizon has layers of fine sandy loam and loamy sand layers at a depth of less than 40 inches in some places.

Zenda soils are similar to Waldeck soils and are associated with Canadian, Kanza, and Lincoln soils. Zenda soils are less sandy than any of these soils.

Ze—Zenda clay loam. This soil is nearly level, and is on short and medium, low terraces along major streams. Flooding can be expected at least once each year but is of short duration. Slopes are 0 to 1 percent.

Included with this soil in mapping are some small areas of Waldeck soils. Also included are some small areas that have a thick, dark grayish-brown or dark-brown surface layer and some small areas that are shallow to a coarse-textured layer.

Runoff is slow. The main management needs are maintaining a good protective cover of crops, crop residue, grasses, or trees; and maintaining soil fertility.

Nearly all of the acreage is used for dryland crops. Some small areas are used for range. Capability unit IIw–3; Subirrigated range site; windbreak suitability group 5.

Use and Management of the Soils

The soils of Barber County are used mainly for range and dryfarming, but a small acreage in Sharon Valley, an area along the Medicine River, and an area near Isabel are irrigated.

In the following pages the system of capability grouping used by the Soil Conservation Service is explained; the management of both dryland and irrigated soils is discussed; and predicted yields of important crops under a high level of management are given. Also discussed are the management of soils for range, windbreaks, recreation, and wildlife habitat. The properties and features that affect engineering practices are listed, mainly in tables. The use and management of each mapping unit is discussed under "Descriptions of the Soils."

Capability Grouping

The capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when they are used for field crops, the risk of damage when they are so used, 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 they are used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils 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. These are discussed in the following paragraphs.

CAPABILITY CLASSES, the broadest grouping, are designated by Roman numerals I through VIII. In class I are the soils that have few limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, so shallow, or otherwise so limited that they do not produce worthwhile yields of crops, forage, or wood products.

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

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

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe–4 or IIIw–2. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

The capability classes, subclasses, and units in Barber County are described in the following list. The capability classification for each mapping unit is given in the "Guide to Mapping Units" and at the end of each mapping unit description in the section "Descriptions of the Soil."

Class I. Soils that have few limitations that restrict their use.
- Unit I–1. Deep, nearly level, well-drained soils that have a surface layer of silt loam and a subsoil of heavy silt loam or silty clay loam.

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

Subclass IIe. Soils, on uplands, that are subject to moderate erosion if they are not protected.
- Unit IIe–1. Deep, nearly level and gently sloping, well-drained soils that have a surface layer of silt loam or loam and a subsoil of silt loam, clay loam, or silty clay loam.
- Unit IIe–2. Deep, gently sloping, well-drained soils that have a surface layer of clay loam or silt loam and a subsoil of clay loam or silty clay loam.
- Unit IIe–3. Deep, gently sloping, well-drained soils that have a surface layer of fine sandy loam and a subsoil of sandy clay loam.
- Unit IIe–4. Deep, gently sloping, well-drained soils that have a surface layer of silt loam and a subsoil of silty clay or heavy silty clay loam.
- Unit IIe–5. Deep, nearly level, well-drained soils that have a surface layer of fine sandy loam and a subsoil of sandy clay loam or clay loam.
- Unit IIe–6. Deep, nearly level, well-drained soils that have a surface layer and subsoil of fine sandy loam.

Subclass IIw. Soils, on flood plains, that have moderate limitations because of excess water.
- Unit IIw–1. Deep, nearly level, well-drained soils that have a surface layer and subsoil of calcareous silt loam.

Unit IIw–2. Deep, nearly level, well-drained soils that have a surface layer and subsoil of sandy loam and a sandy substratum.

Unit IIw–3. Deep, nearly level, somewhat poorly drained soils that have a surface layer and subsoil of clay loam.

Subclass IIc. Soils, on uplands, that have only the climate of the county as the major hazard to use.

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

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

Unit IIc–3. Deep, nearly level, well-drained soils that have a surface layer of clay loam and a subsoil of calcareous clay loam.

Class III. Soils that have severe limitations that reduce the choice of plants, or 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, sloping, well-drained soils that have a surface layer and subsoil of silt loam.

Unit IIIe–2. Deep and moderately deep, gently sloping and sloping, well-drained and somewhat excessively drained soils that have a surface layer of sandy loam, a subsoil of sandy clay loam or sandy loam, and a substratum of sandy loam or loamy sand.

Unit IIIe–3. Moderately deep and shallow, nearly level and gently sloping, well-drained, calcareous loam underlain by soft, fine-grained sandstone.

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

Unit IIIe–5. Deep, nearly level and gently sloping, well-drained, calcareous soils that have a surface layer and subsoil of clay loam and a substratum of semihard calcareous clay loam.

Unit IIIe–6. Deep, gently sloping, well-drained soils that have a surface layer of eroded silty clay loam and a subsoil of silty clay.

Unit IIIe–7. Deep and moderately deep, gently sloping, well-drained soils that have a surface layer of silt loam or clay loam, a subsoil of silty clay loam, silty clay, or clay, and a substratum of calcareous clayey shale.

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

Unit IIIw–1. Deep, nearly level, moderately well drained, calcareous clay underlain by a loamy and sandy substratum.

Unit IIIw–2. Deep, nearly level, somewhat poorly drained soils that have a surface layer and subsoil of sandy loam underlain by a sandy substratum.

Class IV. Soils that have very severe limitations that restrict the choice of plants, or 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. Moderately deep and shallow, sloping, well-drained, calcareous loam underlain by soft, fine-grained sandstone.

Unit IVe–2. Deep and moderately deep, sloping, well-drained soils that have a surface layer of silt loam or clay loam, a subsoil of silty clay loam, silty clay or clay, and a substratum of calcareous clay shale.

Unit IVe–3. Deep, sloping, well-drained soils that have a surface layer of eroded sandy loam, a subsoil of sandy clay loam, and a substratum of sandy loam or loamy sand.

Unit IVe–4. Deep, rolling, well-drained soils that have a sandy surface layer, subsoil, and substratum.

Unit IVe–5. Deep, sloping, well-drained calcareous soils that have a surface layer and subsoil of clay loam underlain by a substratum of semihard, calcareous clay loam.

Subclass IVs. Soils, on flood plains or stream terraces, that have very severe limitations for cultivation because of salinity.

Unit IVs–1. Deep, nearly level, moderately well drained, salt-affected soils that have a surface layer of clay or silty clay, a calcareous stratified clayey subsoil, and a loamy or sandy substratum.

Unit IVs–2. Deep, nearly level, well-drained, salt-affected soils that have a surface layer of silt loam, a subsoil of heavy silt loam or silty clay loam, and a loamy substratum.

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

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

Unit Vw–1. Moderately deep, nearly level, poorly drained soils that have a surface layer of loamy fine sand, fine sandy loam and clay loam, and underlying layers of loamy sand, fine sand, or fine gravel.

Unit Vw–2. Deep, nearly level, calcareous, frequently flooded, somewhat excessively drained soils that have a surface layer of sandy loam, fine sandy loam, and loamy sand, underlain by sand and fine gravel; a fluctuating water table in the substratum.

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

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

Unit VIe–1. Moderately deep and deep, sloping to moderately steep, somewhat excessively drained and well-drained soils that have a surface layer of sandy loam, a subsoil of sandy loam or sandy clay loam, and a substratum of sandy loam, loamy sand, or sand and gravel.

Unit VIe–2. Moderately deep, sloping to moderately steep, well-drained soils that have a surface layer of clay loam, a subsoil of clay, and a substratum of gypsiferous heavy clay loam shale or clay shale.

Unit VIe–3. Shallow and moderately deep, sloping to moderately steep, well-drained, calcareous loam underlain by soft fine-grained sandstone.

Unit VIe–4. Steep, loamy breaks and rock outcrops; and deep, nearly level or gently sloping, frequently flooded, loamy soils.

Unit VIe–5. Deep, rolling loamy fine sand.

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

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

Subclass VIs. Soils severely limited by excessive quantities of saline and alkali salts.

Unit VIs–1. Deep, nearly level, somewhat poorly drained, loamy, calcareous, salt-affected soils.

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

Subclass VIIe. Soils very severely limited by risk of soil blowing as well as by low available water capacity and low natural fertility.

Unit VIIe–1. Deep, excessively drained, fine sand; on hilly topography.

Subclass VIIs. Soils very severely limited by depth to shale and by steep, rough, broken topography.

Unit VIIs–1. Steep, clayey shale outcrops.

Unit VIIs–2. Deep, gently sloping and sloping, clayey soils and clayey-shale outcrops.

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

Management of Dryland Soils[3]

In Barber County the management of dryland soils involves a combination of practices that control water erosion and soil blowing, help maintain good soil structure, help maintain an adequate organic-matter content, and conserve as much rainfall as possible.

Terracing and contouring can be used to control water erosion and help conserve rainfall on nearly all the sloping soils in the county, except for the Breaks part of Breaks-Clairemont complex; Rough broken land, shaly, Tivoli fine sand, and the shale outcrop part of Vernon-Shale outcrop complex. These practices, alone or in combination, also can be beneficial for some nearly level soils that have long slopes. 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. Applying manure and returning crop residue to the soil help to maintain soil fertility and tilth.

Proper management of crop residue should be used on all cropped soils in Barber County. Management of crop residue helps maintain good soil structure, improve the infiltration of water, and helps control both water erosion and soil blowing. Residue on the surface helps to hold the soil in place and to reduce the puddling caused by the beating of raindrops. Stripcropping can be used to control soil blowing. It is especially applicable on some of the nearly level soils that have a surface layer of loamy sand, sandy loam, or loam.

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 causes the formation of a tillage pan.

Wheat, grain, sorghum, and alfalfa are the major crops grown in Barber County, but forage sorghum is also grown. Alfalfa is mainly grown on bottom lands, but some is grown on uplands. The sequence of crops affects the combination of practices that is needed for a particular soil. Wheat and other closely spaced crops provide more protection for the soil than grain sorghum and other widely spaced crops. Also, the residue from wheat provides more protection than the residue from grain sorghum.

Management of Irrigated Soils[4]

The factors to be considered in planning an irrigation system are the characteristics and properties of the soil, the quality and quantity of irrigation water available, the crops to be irrigated, and the type of system to be used for irrigation. It is especially important to know the quality of the irrigation water so that the long time effect of irrigation contains some soluble salts. If water of poor quality is used on a soil that has slow permeability and no leaching is done, harmful salts are likely to accumulate in the soil. If harmful salts do accumulate, water in excess of the needs of the crop should be applied so that some of the water passes through the root zone.

Some of the soil features that are important to irrigation are depth, available water capacity, permeability, drainage, and slope. Susceptibility to stream overflow is also important. 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, which is determined mainly by the depth and texture of the soil. Permeability affects the rate at which water enters the soil as well as internal drainage. The rate of water intake is also affected by the condition of the surface layer.

[3] EARL J. BONDY, conservation agronomist, Soil Conservation Service, helped prepare this section.

[4] EARL J. BONDY, conservation agronomist, and VICTOR A. GRISWOLD, district conservationist, Soil Conservation Service, helped prepare this section.

TABLE 2.—*Predicted average yields per acre of dryland crops under high level management*

Soil	Winter wheat	Grain sorghum	Alfalfa	Tame pasture
	Bushels	*Bushels*	*Tons*	*AUM* [1]
Albion-Shellabarger sandy loams, 2 to 4 percent slopes	22	38	2.0	
Attica loamy fine sand, 1 to 5 percent slopes	26	40	3.0	5.0
Blanket silt loam, 0 to 1 percent slopes	32	44	3.0	
Blanket silt loam, 1 to 3 percent slopes	30	40	2.5	
Blanket silty clay loam, 1 to 3 percent slopes, eroded	26	36	2.0	
Canadian fine sandy loam	36	52	4.0	6.5
Case-Clark clay loams, 2 to 6 percent slopes	18	30		
Clairemont silt loam	26	44	2.5	
Clark clay loam, 0 to 2 percent slopes	24	38	2.5	
Farnum fine sandy loam, 0 to 1 percent slopes	32	52	3.0	5.0
Farnum loam, 0 to 1 percent slopes	32	50	3.0	5.0
Farnum loam, 1 to 3 percent slopes	30	48	2.5	5.0
Farnum clay loam, 1 to 3 percent slopes, eroded	28	44	2.0	5.0
Grant silt loam, 0 to 1 percent slopes	34	48	3.0	6.0
Grant silt loam, 1 to 3 percent slopes	32	44	2.5	5.5
Grant silt loam, 3 to 6 percent slopes	28	38	2.0	5.0
Kingfisher silt loam, 1 to 3 percent slopes	30	40	2.0	5.5
Kingfisher-Vernon complex, 1 to 3 percent slopes	22	30		
Kingfisher-Vernon complex, 3 to 6 percent slopes	18	26		
Mangum clay	18	20		
Mangum-Slickspots complex	12	16		
Minco silt loam, 0 to 2 percent slopes	34	48	3.0	6.5
Naron fine sandy loam, 0 to 1 percent slopes	32	52	3.0	6.0
Naron fine sandy loam, 1 to 3 percent slopes	30	50	3.0	6.0
Ost clay loam, 0 to 1 percent slopes	28	46	2.5	5.0
Ost clay loam, 1 to 3 percent slopes	26	44	2.0	5.0
Pond Creek silt loam, 0 to 1 percent slopes	34	48	3.0	6.5
Pond Creek silt loam, 1 to 3 percent slopes	32	46	2.5	6.5
Port silt loam	36	50	4.0	7.0
Port-Slickspots complex	20	30	1.5	
Pratt loamy fine sand, 5 to 10 percent slopes	20	40	2.0	
Quinlan loam, 1 to 3 percent slopes	16	26		
Shellabarger sandy loam, 3 to 6 percent slopes	24	42	2.0	5.0
Shellabarger sandy loam, 3 to 6 percent slopes, eroded	20	36	1.5	4.5
Vernon clay loam, 3 to 5 percent slopes	16	20		
Waldeck sandy loam	24	46	3.5	7.0
Woodward-Quinlan loams, 0 to 3 percent slopes	24	30	2.0	5.0
Woodward-Quinlan loams, 3 to 6 percent slopes	20	26	1.5	4.5
Yahola sandy loam	30	44	3.5	7.5
Zenda clay loam	26	42	4.0	7.0

[1] Animal-unit-month is a term used to express the carrying capacity of pasture. It is the number of months during the year that 1 acre will provide grazing for 1 animal unit (1 cow, 1 horse, 5 hogs, or 7 sheep) without damage to the pasture.

Irrigation is limited to three general areas because of the suitability of soils and the availability of water. These areas are Sharon Valley, Medicine River Valley, and the northeastern corner and the northern edge of the county. Corn, grain sorghum, alfalfa, and wheat are the main irrigated crops. Among the approximately 1,025 acres that are irrigated are 545 acres of alfalfa, 190 acres of forage sorghums, 170 acres of corn, 45 acres of wheat, and 75 acres of bermudagrass.

Predicted Yields

The predicted average yields per acre that can be expected for the principal crops grown in the 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 agricultural agencies, demonstration plots, and research data.

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

1. Crop varieties are chosen that are suited to the soil and climate.
2. Proper seeding rates are used; methods of tillage, planting, and harvesting are suitable and timely.
3. Weeds, plant diseases, and insects are controlled by the full and timely use of suitable practices.
4. Fertilizer is applied as needed for optimum efficiency in crop production.
5. Terraces, contour farming, grassed waterways, and stubble-mulch tillage are used to conserve moisture and control runoff.
6. Good cropping systems and management of crop residue are used to control water erosion and soil blowing and to keep the soil in good physical condition.

Range[5]

Range is land on which the natural or climax vegetation is principally native grasses, grasslike plants, forbs, and shrubs that are suitable for the grazing of livestock. It produces forage for livestock, provides needed wildlife habitat, and water. It may also provide for recreation, esthetic values, and other uses.

In Barber County livestock and livestock products amount to about 56 percent of the agricultural income (*6*). The number of cattle and calves in the county ranges from 75,000 to 94,000.

Most production of livestock forage is from range that has supplemental feeds coming from crops and their by-products. Range makes up about 61 percent of the total land area in the county or about 445,000 acres.

Range sites and condition classes

Different kinds of soil vary in their capacity to produce grass and other plants for grazing. Soils that produce about the same kinds and amounts of forage, if the range is in similar condition, make up a range site.

Range sites are kinds of range that differ in their ability to produce vegetation. The soils of any one range site produce about the same kind of climax vegetation. Climax vegetation is the stabilized plant community; it reproduces itself and does not change as long as the environment remains unchanged. Throughout the prairie and the plains, the climax vegetation consists of the plants that were growing there when the region was first settled. If cultivated crops are not grown, the most productive combination of forage plants on a range site is generally the climax vegetation.

Decreasers are plants in the climax vegetation that tend to decrease in relative amount under close grazing. They generally are the tallest and most productive perennial grasses and forbs and the most palatable to livestock.

Increasers are plants in the climax vegetation that increase in relative amount as the more desirable decreaser plants are reduced by close grazing. They are commonly shorter than decreasers and are generally less palatable to livestock.

Invaders are plants that cannot compete with plants in the climax plant community for moisture, nutrients, and light. Hence, invaders come in and grow along with increasers after the climax vegetation has been reduced by grazing. Many are annual weeds, and some are shrubs that have some grazing value, but others have little value for grazing.

Four range condition classes are used to indicate the degree of departure from the potential, or climax, vegetation brought about by grazing or other uses. The classes show the present condition of the native vegetation on a range site in relation to the native vegetation that could grow there.

A range is in excellent condition if 76 to 100 percent of the vegetation is of the same kind as that in the climax stand. It is in good condition if the percentage is 51 to 75; in fair condition if the percentage is 26 to 50; and in poor condition if the percentage is less than 25.

Range condition is judged according to standards that apply to the particular range site. It expresses the present kind and amount of vegetation in relation to the climax plant community for that site.

Potential forage production depends on the range site. Current forage production depends on the range condition and the moisture available to plants during their growing season.

A primary objective of good range management is to keep the range in excellent or good condition. If this is done, water is conserved, yields are improved, and the soils are protected. The problem is recognizing important changes in the kind of cover on a range site. These changes take place gradually and can be misinterpreted or overlooked. Growth encouraged by heavy rainfall may lead to the conclusion that the range is in good condition, when actually the cover is weedy and the long-term trend is toward lower production. On the other hand, some range that has been closely grazed for short periods, under the supervision of a careful manager, may have a degraded appearance that temporarily conceals its quality and ability to recover.

Descriptions of range sites

In the following pages, the range sites of Barber County are described and the climax plants and principal invaders on the sites are named. Also given is an estimate of the potential annual yield of air-dry herbage for each site when 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 survey.

CHOPPY SANDS RANGE SITE

Tivoli fine sand, 5 to 20 percent slopes, is the only soil in this range site. The surface soil is loose, and blowouts occur in some areas. This soil is excessively drained. It has rapid permeability and low available water capacity.

The climax vegetation supported by this site is a mixture of decreaser grasses. The decreaser grasses make up about 70 percent of the vegetation, and increaser grasses make up the rest. Sand sagebrush and sand plum generally occur on this site in small amounts, but they may become a brush control problem if range management is poor.

Common decreaser plants on this site are sand bluestem, little bluestem, switchgrass, indiangrass, sand lovegrass, big sandreed, and Scribner panicum. The main increasers are sand dropseed, sand paspalum, blue grama, hairy grama, sand sagebrush, and sand plum. Annual eriogonum, annual three-awn, sandbur, common sunflower, and other annuals are common invaders.

When this site is in excellent condition, the average annual yield of air-dry herbage is approximately 2,500 pounds per acre, but it ranges from 1,500 pounds per acre in unfavorable years to 3,500 pounds per acre in favorable years, depending on moisture supply.

CLAY LOWLAND RANGE SITE

Mangum clay is the only soil in this range site. It is a deep, nearly level, and moderately well drained soil on flood plains. The underlying layers are loamy and sandy, and they have a water table that fluctuates be-

[5] By ARNOLD G. MENDENHALL, range conservationist, Soil Conservation Service, Harper.

tween depths of 4 and 6 feet or more. The available water capacity is moderate, and internal drainage is very slow. The soil is susceptible to flooding, and runoff is slow.

A mixture of warm-season decreaser grasses and forbs are dominant when this range site is in excellent condition. The decreaser plants make up about 90 percent of the vegetation, and increaser plants make up the rest.

Common decreaser plants on this site are big bluestem, indiangrass, little bluestem, switchgrass, eastern gamagrass, prairie cordgrass, compassplant, Canada wildrye, and maximilian sunflowers. The main increasers are western wheatgrass, sideoats grama, sand dropseed, vine mesquite, Baldwin ironweed, and blue grama. Silver bluestem, windmillgrass, snow-on-the-mountain, tumblegrass, cocklebur, and annual brome are common invaders.

When this site is in excellent condition, the average annual yield of air-dry herbage is approximately 3,500 pounds per acre, but it ranges from 2,000 pounds per acre in unfavorable years to 4,000 pounds per acre in favorable years, depending on the moisture supply.

ERODED RED CLAY RANGE SITE

Only the Shale outcrop part of Vernon-Shale outcrop complex is in this range site. The soil materials consist of gently sloping and sloping, eroded, shallow clay or clay loam and outcrops of raw shale that contains large amounts of gypsum. Deep, stratified, calcareous clay loam and silty clay loam on alluvial fans are included. These soils and soil materials have low available water capacity, and are very slowly permeable. The site is droughty because nearly all precipitation is lost through runoff and evaporation (fig. 10).

Decreaser plants make up about 75 percent of the vegetation, and increasers make up the rest.

Common decreasers on this site are side-oats grama, which is dominant, little bluestem, big bluestem, switchgrass, black samson, catclaw sensitivebrier, dotted gayfeather, and prairie-clover. The dominant decreaser is side-oats grama. Main increasers are blue grama, hairy grama, buffalograss, silver bluestem, western wheatgrass, western ragweed, and sagewort. The main invaders are annual broomweed, broom snakeweed, and annual three-awn.

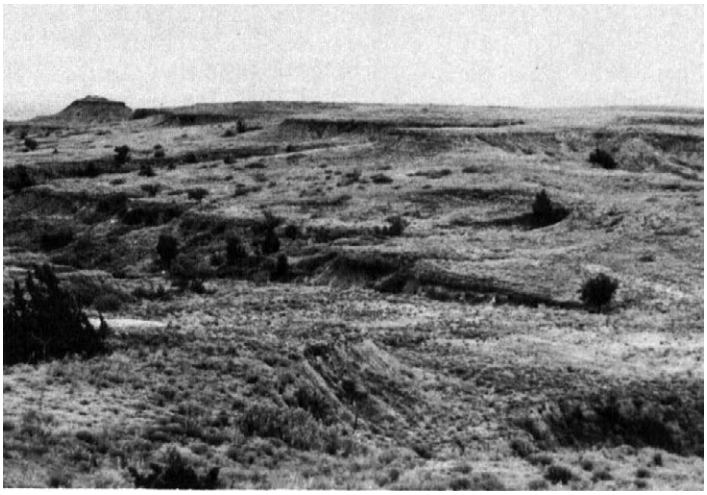

Figure 10.—An area of Eroded Red Clay range site that is in good condition. Because the site is droughty, range management is essential to maintain a good plant cover.

When this site is in excellent condition, the average annual yield of air-dry herbage is approximately 600 pounds per acre, but it ranges from 400 pounds per acre in unfavorable years to 800 pounds per acre in favorable years, depending on moisture supply.

LIMY UPLAND RANGE SITE

This range site consists of deep, nearly level, gently sloping and sloping, limy soils of the Case and Clark series. The surface layer and subsoil are calcareous clay loam. These soils are well drained and have moderate permeability and high available water capacity. Runoff is medium to rapid.

A mixture of decreaser grasses and other decreaser plants are dominant in the climax vegetation. The decreaser plants make up about 75 percent of the vegetation, and increaser grasses and forbs make up the rest.

Common decreaser plants are little bluestem, big bluestem, switchgrass, indiangrass, leadplant, catclaw sensitivebrier, and black samson. The main increasers are side-oats grama, blue grama, hairy grama, tall dropseed, western wheatgrass, broom snakeweed, and buffalograss. Silver bluestem, windmillgrass, tumblegrass, annual broomweed, and annual three-awn are common invaders.

When this site is in excellent condition, the average annual yield of air-dry herbage is approximately 3,000 pounds per acre, but it ranges from 2,000 pounds per acre in unfavorable years to 4,000 pounds per acre in favorable years, depending on moisture supply.

LOAMY LOWLAND RANGE SITE

This range site consists of deep, well-drained, loamy soils of the Clairemont series that are on nearly level to sloping bottom lands along major streams. These soils have a high available water capacity. They receive extra moisture from the flooding of streams or the runoff from adjacent areas.

A mixture of warm-season decreaser grasses are dominant when this range site is in excellent condition. The decreaser plants make up about 80 percent of the vegetation, and increaser plants make up the rest. Cottonwood and willows grow naturally along the streambanks.

Common decreasers are big bluestem, indiangrass, little bluestem, switchgrass, Canada wildrye, maximilian sunflower, and Illinois bundleflower. The main increasers are western wheatgrass, tall dropseed, sideoats grama, silver bluestem, annual bromes, common sunflower, and cocklebur; and other annuals are common invaders.

When this site is in excellent condition, the average annual yield of air-dry herbage is approximately 5,500 pounds per acre, but it ranges from 4,000 pounds per acre in unfavorable years to 7,000 pounds per acre in favorable years, depending on the moisture supply.

LOAMY TERRACE RANGE SITE

This range site consists of deep, well-drained, nearly level soils of the Port series. These soils formed in alluvium on stream terraces. The surface layer is silt loam. In most areas the subsoil is silt loam or silty clay loam, but in some areas it is silty clay. The soils have

moderate permeability and a high available water capacity. These soils receive extra moisture in runoff from the nearby uplands.

A mixture of decreaser plants are supported by this range site. The decreaser plants make up at least 70 percent of the vegetation, and increaser plants make up the rest.

Common decreaser plants on this site are big bluestem, switchgrass, little bluestem, indiangrass, Canada wildrye, and Illinois bundleflower. The main increasers are western wheatgrass, side-oats grama, tall dropseed, sedges, western ragweed, and blue grama. Silver bluestem, tumblegrass, annual bromes, annual broomweed, and windmillgrass are common invaders.

When this site is in excellent condition, the average annual yield of air-dry herbage is approximately 4,000 pounds per acre, but it ranges from 3,000 pounds per acre in unfavorable years to 5,000 pounds per acre in favorable years, depending on the moisture supply.

LOAMY UPLAND RANGE SITE

This range site consists of deep or moderately deep, nearly level to moderately steep, well-drained soils of the Blanket, Farnum, Grant, Kingfisher, Minco, Ost, Pond Creek, and Woodward series. These soils have a moderate to very high available water capacity and have moderately slow or moderate permeability.

The climax vegetation on this range site is decreaser plants. The decreaser plants make up at least 60 percent of the total plant cover, and increaser plants make up the rest.

Common decreasers on this site are little bluestem, big bluestem, switchgrass, indiangrass, and Canada wildrye. The main increasers are side-oats grama, blue grama, western wheatgrass, tall dropseed, western ragweed, and buffalograss. Silver bluestem, windmillgrass, annual bromes, and other annuals are common invaders.

When this site is in excellent condition, the average annual yield of air-dry herbage is approximately 3,000 pounds per acre, but it ranges from 2,000 pounds per acre in unfavorable years to 5,000 pounds per acre in favorable years, depending on the moisture supply.

RED CLAY PRAIRIE RANGE SITE

This range site consists of gently sloping to moderately steep, well-drained soils of the Vernon series. These soils have a low available water capacity and very slow permeability. Large areas of this range site are in the southwestern part of the county (fig. 11).

Dominant decreaser grasses on this site are little bluestem and side-oats grama. These grasses along with other decreaser plants make up about 70 percent of the vegetation, and increaser plants make up the rest.

Common decreaser plants on this site are side-oats grama, little bluestem, big bluestem, switchgrass, indiangrass, leadplant, catclaw sensitivebrier, and black samson. The main increasers are blue grama, hairy grama, tall dropseed, western wheatgrass, western ragweed, and buffalo grass. Annual broomweed, little barley, tumblegrass, silver bluestem, redcedar, and annual bromes are common invaders.

When this site is in excellent condition, the average annual yield of air-dry herbage is approximately 1,800 pounds per acre, but it ranges from 1,200 pounds per acre in unfavorable years to 2,600 pounds per acre in favorable years, depending on the moisture supply.

RED SHALES RANGE SITE

The Breaks part of Breaks-Clairemont complex and Rough broken land, shaly, are the only soils in this range site.

Breaks consists of large ravines or natural drainageways and steep, rough, broken, calcareous clay loam and clay shale that contain large amounts of gypsum. Outcrops of shale, sandstone, and gypsum are common. In many places vegetation is either sparse or lacking on sides of ravines (fig. 12).

The climax vegetation on this site is a mixture of decreaser plants. The decreaser plants make up about 60 percent of the vegetation, and increaser plants make up the rest. Because redcedar is increasing, brush control is a problem on this site in some parts of the county.

Common decreaser plants on this site are little bluestem, side-oats grama, big bluestem, switchgrass, bigtop dalea, catclaw sensitivebrier, and black samson. The main increasers are side-oats grama, tall dropseed,

Figure 11.—An area of Red Clay Prairie range site in good condition. If good range management is practiced, this site can produce more forage.

Figure 12.—An area of Red Shales range site in good condition. Because erosion is a hazard, good range management is essential in this area.

blue grama, hairy grama, western wheatgrass, buffalograss, silver bluestem, and western ragweed. Redcedar, annual broomweed, tumblegrass, and other annuals are common invaders.

When this site is in excellent condition, the average annual yield of air-dry herbage is approximately 1,500 pounds per acre, but it ranges from 1,000 pounds per acre in unfavorable years to 2,000 pounds per acre in favorable years, depending on the moisture supply.

SALINE LOWLAND RANGE SITE

The Slickspots portion of Mangum and Port series and Alluvial land, saline are the only units in this site. It consists of deep, nearly level saline or salt-affected soils on flood plains, stream terraces, and alluvial fans. Soils of this site are subject to flooding, are somewhat poorly drained, moderately well drained or well drained. Seepy areas form on the surface and wet layers form beneath the surface on shale, or clayey old alluvium, or sandstone layers during periods of high rainfall.

The climax plant cover is a mixture of decreasers. The decreaser plants make up about 75 percent of the vegetation and increaser plants make up the rest. Tamarisk is a serious invader on this site in many parts of the county (fig. 13).

Common decreaser plants on this site are switchgrass, alkali sacaton, western wheatgrass, side-oats grama, and alkali cordgrass. The main increasers are inland saltgrass, tall dropseed, western ragweed, blue grama, sand dropseed, and sedges. Silver bluestem, annual brome, tamarisk, and annuals are common invaders.

When this site is in excellent condition, the average annual yield of air-dry herbage is approximately 3,000 pounds per acre, but it ranges from 2,000 pounds per acre in unfavorable years to 4,000 pounds per acre in favorable years, depending on the moisture supply.

SANDS RANGE SITE

This range site consists of deep, gently rolling and rolling soils of the Attica, Pratt, and Tivoli series. The surface layer is loamy sand, and the subsoil is fine sandy loam, loamy sand and fine sand. These soils absorb moisture rapidly but have low to moderate available water capacity.

Figure 13.—An area of Saline Lowland range site in fair condition. Because this site has been overgrazed in the past, weeds and brush are invading what was once a high producing site.

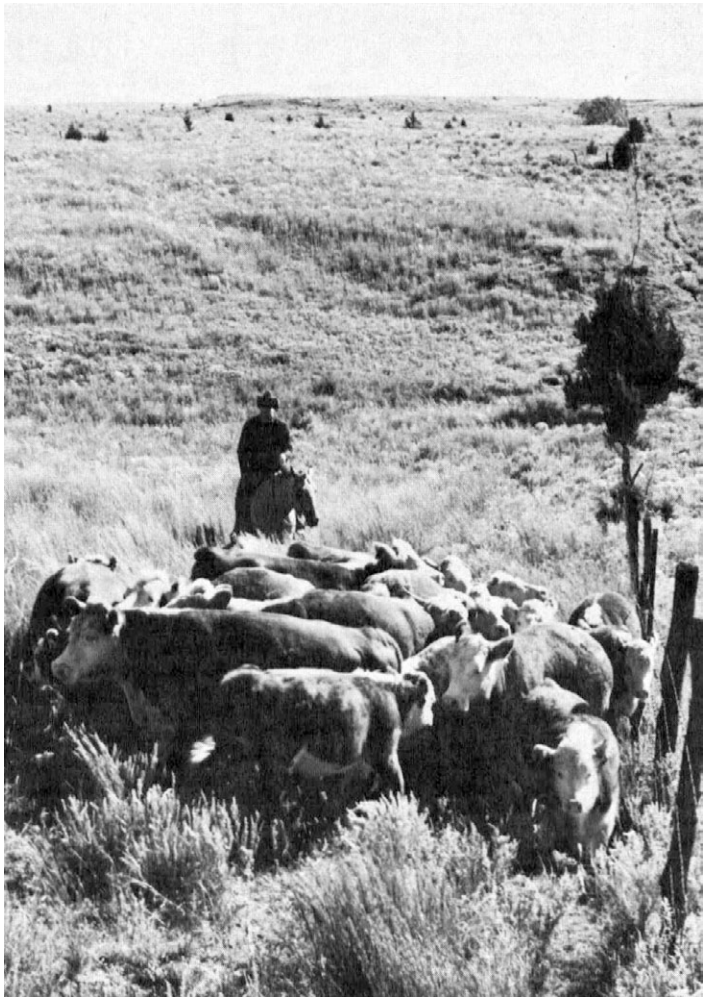

Figure 14.—An area of Sandy range site in good condition. If this site is managed well, a high level of production can be maintained.

The climax vegetation consists of decreasers. When the site is in excellent condition decreaser plants make up about 75 percent of the vegetation, and increaser plants make up the rest. Sand sagebrush and sand plum generally are on this site in small amounts, but they may increase if range management is poor.

Common decreaser plants on this site are sand bluestem, little bluestem, switchgrass, sand lovegrass, big sandreed, indiangrass, and leadplant. The main increasers are sand dropseed, sand paspalum, side-oats grama, blue grama, western ragweed, sand sagebrush, Scribner panicum, and sand plum. Sandbur, annual eriogonum, prairie three-awn, and other annuals are common invaders.

When this site is in excellent condition, the average annual yield of air-dry herbage is approximately 3,500 pounds per acre, but it ranges from 2,500 pounds per acre in unfavorable years to 4,500 pounds per acre in favorable years, depending on the moisture supply.

SANDY RANGE SITE

This range site (fig. 14) consists of moderately deep and deep, nearly level to moderately steep soils of the

Albion, Farnum, Naron, and Shellabarger series. The surface layer is sandy loam or fine sandy loam, and the subsoil is sandy loam, sandy clay loam, or clay loam. The dominant soils have moderately slow, moderate, and moderately rapid permeability and have a low to high available water capacity. Moisture intake is moderate to rapid, and runoff is slow.

A mixture of decreasers are dominant when this range site is in excellent condition. The decreaser plants make up about 65 percent of the vegetation, and increaser plants make up the rest. Redcedar has increased in some areas of the county on this site.

Common decreaser plants on this site are sand bluestem, little bluestem, switchgrass, indiangrass, sand lovegrass, and leadplant. The main increasers are sand dropseed, sand paspalum, side-oats grama, blue grama, Scribner panicum, sand sagebrush, sand plum, soapweed, and buffalograss. Silver bluestem, annual eriogonum, annual broomweed, tumblegrass, and other annuals are common invaders.

When this site is in excellent condition, the average annual yield of air-dry herbage is approximately 3,500 pounds per acre, but it ranges from 2,000 pounds per acre in unfavorable years to 4,500 pounds per acre in favorable years, depending on the moisture supply.

SANDY LOWLAND RANGE SITE

Lincoln soils are the only soils in this range site. They are deep, nearly level and somewhat excessively drained and are on flood plains. These soils have a surface layer of sandy loam, fine sandy loam, or loamy fine sand and underlying layers of fine sand or coarse sand and fine gravel. They have low available water capacity, but they have an intermittent high water table that fluctuates at depths between 4 and 6 feet. Flooding and the intermittent high water table may contribute moisture, during periods of high rainfall, that results in the better growth of plants.

The climax vegetation supported by this site is a mixture of decreaser plants. The decreaser plants make up about 60 percent of the vegetation, and increaser plants make up the rest. Cottonwood and willows are common. The control of eastern redcedar and sand sagebrush, which are brush, is a problem on this site in some areas of the county.

Common decreaser plants on this site are sand bluestem, little bluestem, switchgrass, indiangrass, sand lovegrass, Scribner panicum, and Canada wildrye. The main increasers are side-oats grama, western wheatgrass, sand dropseed, blue grama, sand paspalum, and sand sagebrush. Annual bromes, tumblegrass, and other annuals are common invaders.

When this site is in excellent condition, the average annual yield of air-dry herbage is approximately 3,500 pounds per acre, but it ranges from 2,500 pounds per acre in unfavorable years to 4,500 pounds in favorable years, depending on the moisture supply.

SANDY TERRACES RANGE SITE

Canadian fine sandy loam is the only soil in this range site. It is deep and nearly level. It is on stream terraces but is rarely flooded. The surface layer and subsoil are fine sandy loam. It has a moderate available water capacity and moderately rapid permeability. In most places, the water table is at a depth of more than 6 feet, but locally, it is at depths of 3 or 4 feet.

The decreaser plants make up about 65 percent of the vegetation, and increaser plants make up the rest. In some areas of the county, the control of sand sagebrush and eastern redcedar, which are brush, is a problem.

Common decreaser plants on this site are little bluestem, sand bluestem, sand lovegrass, indiangrass, switchgrass, and Canada wildrye. The main increasers are sand dropseed, sand paspalum, side-oats grama, western wheatgrass, blue grama, and sand sagebrush. Silver bluestem, windmillgrass, sandbur, redcedar, and other annuals are common invaders.

When this site is in excellent condition, the average annual yield of air-dry herbage is approximately 4,500 pounds per acre, but it ranges from 3,500 pounds per acre in unfavorable years to 5,500 pounds per acre in favorable years, depending on the moisture supply.

SHALLOW PRAIRIE RANGE SITE

This range site consists of nearly level to moderately steep, shallow soils of the Quinlan series. The surface layer and subsoil are loam underlain by bedrock that is soft calcareous sandstone and shale. Runoff is medium to rapid. The soils have moderately rapid permeability and have very low available water capacity.

Little bluestem is the principal decreaser on this site. The decreaser plants make up about 65 percent of the vegetation, and increaser plants make up the rest.

Common decreaser plants on this site are little bluestem, big bluestem, indiangrass, and switchgrass. The main increasers are side-oats grama, blue grama, hairy grama, buffalograss, and western ragweed. Silver bluestem, eastern redcedar, annual broomweed, tumblegrass, and other annuals are common invaders.

When this site is in excellent condition, the average annual yield of air-dry herbage is approximately 2,000 pounds per acre, but it ranges from 1,000 pounds per acre in unfavorable years to 3,000 pounds per acre in favorable years, depending on the moisture supply.

SUBIRRIGATED RANGE SITE

This range site consists of nearly level, sandy and loamy soils of the Kanza, Waldeck, Yahola, and Zenda

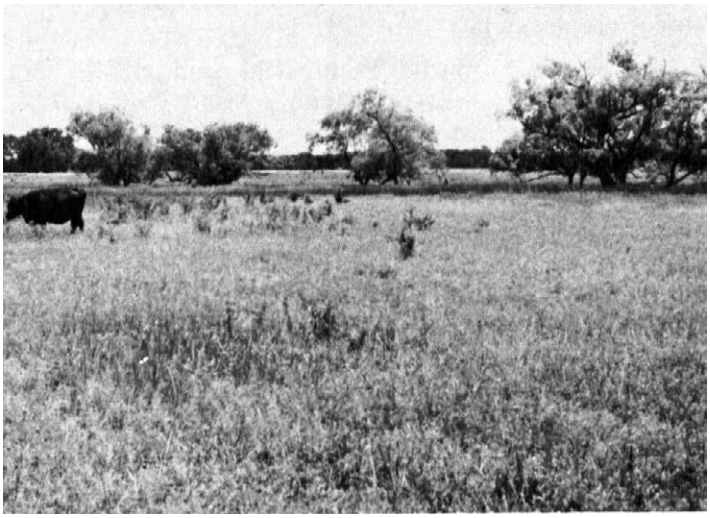

Figure 15.—**An area of Subirrigated range site in good condition. If managed well, this range site is the most productive in the county.**

series. These soils formed in alluvium on floodplains. The underlying layers are sandy or loamy. A fluctuating high water table is at depths of 1 to 6 feet.

The climax vegetation supported by this site is a mixture of decreaser grasses. The decreaser plants make up about 80 percent of the vegetation, and increasers and invaders make up the rest. Tamarisk is a serious invader on this site in some areas of the county. Cottonwood and willows are common.

Common decreaser plants on this site are big bluestem, sand bluestem, indiangrass, switchgrass, eastern gamagrass, prairie cordgrass, Canada wildrye, maximilian sunflower, Illinois bundleflower, and compassplant. The main increasers are sideoats grama, western wheatgrass, blue grama, sedges, sand dropseed, tall dropseed, knotroot bristlegrass, and foxtail barley. Silver bluestem, windmillgrass, annual bromes, annual bristlegrass, tamarisk, annual sedges, and other annual weeds and grasses are common invaders.

When this site is in excellent condition, the average annual yield of air-dry herbage is approximately 8,000 pounds per acre (fig. 15). Because this is a subirrigated site, there is little difference between yields in years of unfavorable rainfall and those in years of favorable rainfall.

Engineering Uses of the Soils [6]

This section is useful to those who need information about soils used as structural material or as foundation 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 farm 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. Table 3 shows several estimated soil properties significant to engineering; table 4 gives interpretations for land-use planning; table 5 gives interpretations for various engineering uses; and table 6 gives the results of engineering laboratory tests on soil samples.

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 tables 3, 4, and 5, and it also can be used to make other useful maps.

This information, however, does not eliminate the need for further investigations at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths greater than 6 feet. Also, inspection of sites, especially the small ones, is needed 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 suitability or limitations for soil engineering.

Some of the terms used in this soil survey have a special meaning in soil science that may not be used in engineering. The Glossary defines many of the terms commonly used in soil science.

Engineering soil classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system used by SCS engineers, the Department of Defense, and others, and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO).

In the Unified system (*12*) soils are classified according to particle size distribution, plasticity, liquid limit, and organic matter. Soils are grouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as 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 ranging 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, 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

[6] GENE F. BOHNENBLUST, civil engineer, Soil Conservation Service, McPherson, helped prepare this section. Norman Clark, soils engineer, and Herbert E. Worley, soils research engineer, Kansas Highway Commission, helped prepare the columns, in table 5, headed "Road subgrade," "Roadfill," and "Highway location."

classification for tested soils, with the group index number in parentheses, is shown in table 6; the estimated classification, without group index numbers, is given in table 3 for all soils mapped in the survey area.

Estimated soil properties significant to engineering

Several estimated soil properties significant in engineering are given in table 3. These estimates are made for typical soil profiles, by layers sufficiently different to have different significance for soil engineering. 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 column headings in table 3.

Depth to bedrock is distance from the surface of the soil to the rock layer.

Depth to seasonal high water table is 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 3 in the standard terms used by the Department of Agriculture. These terms take into account relative percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loamy sand." "Sand," "silt," "clay," and some of the other terms used in USDA textural classification are defined in the Glossary of this soil survey.

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a semisolid to a plastic. If the moisture content is further increased, the material changes from a plastic to a liquid. The plastic limit is the moisture content at which the soil material changes from the semisolid to plastic, and the liquid limit, from a plastic to a liquid. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic. Liquid limit and plasticity index are estimated in table 3, but in table 6 the data on liquid limit and plasticity index are based on tests of soil samples.

Permeability is that quality of a soil that enables it to transmit water or air. It is estimated on the basis of those soil characteristics observed in the field, particularly structure and texture. The estimates in table 3 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

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

Reaction is the degree of acidity or alkalinity of a soil, expressed in pH values. The pH value and terms used to describe soil reaction are explained in the Glossary.

Shrink-swell potential is the relative change in volume to be expected of soil material with changes in moisture content, that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. Extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils causes much damage to building foundations, roads, and other structures. A *high* shrink-swell potential indicates a hazard to maintenance of structures built in, on, or with material having this rating.

Soil dispersion due to sodium saturation is not estimated in table 3 because it is not a common problem in Barber County soils. However, Vernon soils contain large amounts of gypsum. The gypsum is easily dissolved and transported by water. Therefore, piping and soil collapse are severe problems in Vernon soils.

Corrosivity is not estimated in table 3 because many soils of Barber County have high corrosivity to uncoated steel while corrosivity to concrete is quite low. For example, Kanza, Mangum, and Zenda soils on flood plains or low terraces have high corrosivity to uncoated steel. On the upland, Rough broken land, shaly, and the underlying materials of Kingfisher and Vernon soils have high corrosivity to uncoated steel.

Engineering interpretations of soils

The estimated interpretations in tables 4 and 5 are based on the engineering properties of soils shown in table 3, 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 Barber County. In tables 4 and 5, ratings are 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, tables 4 and 5 list 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 soil properties generally are 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 soil properties are so unfavorable and so difficult to correct or overcome as to require major soil reclamation and special designs.

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

Following are explanations of some of the column headings in table 4.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute 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 cost.

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

TABLE 3.—*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
as indicated in the first column of this table. The symbol

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification	
	Bedrock	Seasonal high water table			Unified	AASHTO
	Feet	*Feet*	*Inches*			
*Albion: Ad, Ae	>5	>5	0–8	Sandy loam	SM	A–2
			8–28	Heavy sandy loam	SM or SC	A–2 or A–6
			28–60	Sand and fine gravel	SP, SM, or SW	A–2 or A–1
For Shellabarger part, see Shellabarger series.						
Alluvial land, saline: As. Too variable to be estimated.						
Attica: At	>5	>5	0–12	Loamy fine sand	SM	A–2 or A–4
			12–30	Fine sandy loam	SM	A–4
			30–60	Loamy fine sand	SM	A–2
Blanket: Ba, Bb, Bc	>5	>6	0–9	Silt loam	ML or CL	A–4
			9–46	Silty clay and silty clay loam.	CH or CL	A–7
			46–60	Clay loam	CL	A–6
*Breaks: Bf. Too variable to be estimated. For Clairemont part, see Clairemont series.						
Canadian: Ca	>5	>5	0–60	Fine sandy loam	SM	A–4
*Case: Cc	>5	>6	0–60	Clay loam	CL	A–6
For Clark part, see Clark series.						
Clairemont: Cd, Cf	>5	>5	0–10	Silt loam	ML or CL	A–4
			10–14	Silty clay loam	ML or CL	A–6
			14–60	Silt loam	ML or CL	A–4
Clark: Ck	>5	>6	0–60	Clay loam	CL	A–6
Farnum: Fa, Fm, Fr, Fu	>5	>5	0–9	Loam and fine sandy loam.	ML, CL, SM or SC	A–4
			9–58	Clay loam	CL	A–7
			58–66	Sandy clay loam	CL	A–6 or A–7
Grant: Ga, Gb, Gc	>5	>6	0–13	Silt loam	ML or CL	A–4
			13–60	Silt loam	ML or CL	A–4 or A–6
Kanza: Ka	>5	1–3	0–14	Loamy fine sand	SM	A–2
			14–48	Fine sand	SP or SM	A–2 or A–3
*Kingfisher: Kf, Kv, Kz	>5	>6	0–9	Silt loam	ML or CL	A–4
			9–28	Silty clay loam	CL	A–6
			28–60	Partially weathered clay shale.	CL or CH	A–6 or A–7
For Vernon part of Kv and Kz, see Vernon series.						
Lincoln: Ln	>5	4–6	0–6	Sandy loam	SM	A–4
			6–60	Fine sand	SM	A–2
Mangum: Ma, Mg	>5	3½–6	0–50	Clay	CL or CH	A–7
			50–60	Light clay loam	CL	A–6 or A–4
For Slickspots part of Mg, properties too variable to be estimated.						
Minco: Mn	>5	>6	0–60	Silt loam	ML or CL	A–4
Naron: Na, Nb	>5	>5	0–12	Fine sandy loam	SM	A–4
			12–37	Sandy clay loam	SC	A–6
			37–60	Fine sandy loam	SM	A–4

See footnote at end of table.

significant to engineering

soils in such mapping units may have different properties and limitations, and for this reason it is necessary to refer to other series
> means greater than; the symbol < means less than]

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
						Inches per hour	*Inches per inch of soil*	*pH*	
100	95–100	70–80	25–35	15–20	1–7	2.0–6.0	0.13–0.15	6.1–6.5	Low.
100	95–100	70–80	30–40	15–20	1–7	2.0–6.0	0.13–0.15	6.1–6.5	Low.
85–100	70–100	25–50	4–20	<20	[1] NP–4	6.0–10.0	0.03–0.08	6.1–7.3	Low.
100	100	60–95	30–50	NP	NP	6.0–20.0	0.10–0.12	6.1–6.5	Low.
100	100	70–95	35–50	15–25	NP–7	2.0–6.0	0.15–0.17	6.1–6.5	Low.
100	100	60–95	15–30	NP	NP	6.0–20.0	0.08–0.10	6.6–7.3	Low.
100	100	90–100	70–90	20–35	4–10	0.6–2.0	0.22–0.24	6.1–6.5	Low.
100	100	95–100	80–95	35–55	12–33	0.2–0.6	0.11–0.13	6.6–8.4	High.
100	100	95–100	85–95	25–40	7–20	0.2–0.6	0.18–0.20	7.9–8.4	Moderate.
100	100	60–85	35–50	15–25	NP–7	2.0–6.0	0.12–0.14	6.1–8.4	Low.
100	100	90–100	70–80	25–40	10–15	0.6–2.0	0.15–0.19	7.9–8.4	Moderate.
100	100	90–100	70–90	20–35	4–10	0.6–2.0	0.22–0.24	7.9–8.4	Low.
100	100	95–100	85–95	25–40	10–20	0.6–2.0	0.21–0.23	7.9–8.4	Low to moderate.
100	100	90–100	70–90	20–35	4–12	0.6–2.0	0.20–0.22	7.9–8.4	Low.
100	100	90–100	60–80	25–35	10–15	0.6–2.0	0.15–0.19	7.9–8.4	Moderate.
100	100	70–95	40–75	15–30	5–10	0.6–2.0	0.20–0.22	6.1–6.5	Low.
100	100	90–100	70–80	40–50	20–30	0.2–0.6	0.15–0.19	6.1–7.3	Moderate.
100	100	80–90	50–65	25–45	12–25	0.2–0.6	0.15–0.17	6.6–7.3	Moderate.
100	100	90–100	75–95	20–35	4–10	0.6–2.0	0.22–0.24	6.1–7.3	Low.
100	100	90–100	85–100	20–40	4–15	0.6–2.0	0.20–0.22	7.4–8.4	Low to moderate.
100	100	75–95	15–30	NP	NP	6.0–20.0	0.10–0.12	6.6–7.3	Low.
100	100	65–80	5–15	NP	NP	6.0–20.0	0.06–0.08	6.6–7.3	Low.
100	100	90–100	75–95	20–35	4–12	0.6–2.0	0.22–0.24	6.1–6.5	Low.
100	100	90–100	85–95	20–40	8–20	0.2–0.6	0.18–0.20	6.6–7.8	Moderate.
90–100	85–100	65–100	60–90	30–60	15–35	<0.06	0.08–0.14	7.9–8.4	High.
100	100	50–90	36–50	NP	NP	6.0–20.0	0.13–0.15	7.9–8.4	Low.
100	90–100	50–90	15–35	NP	NP	6.0–20.0	0.05–0.07	7.9–8.4	Low.
100	100	100	90–100	40–70	18–45	<0.06	0.11–0.13	7.3–8.4	High.
100	100	80–90	60–75	25–40	15–25	0.2–0.6	0.14–0.16	7.9–8.4	Low.
100	100	90–100	70–90	20–35	4–10	0.6–2.0	0.20–0.22	6.1–7.3	Low.
100	100	90–100	35–50	15–25	4–7	2.0–6.0	0.16–0.18	6.1–6.5	Low.
100	100	90–100	35–50	25–35	10–15	0.6–2.0	0.18–0.20	6.1–7.3	Low.
100	100	90–100	35–50	15–25	4–7	2.0–6.0	0.14–0.16	6.6–7.3	Low.

TABLE 3.—*Estimated soil properties*

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification	
	Bedrock	Seasonal high water table			Unified	AASHTO
	Feet	*Feet*	*Inches*			
Ost: Os, Ot	>5	>6	0–8	Clay loam	CL	A–6
			8–28	Clay loam	CL	A–7
			28–60	Clay loam	CL	A–6
Pond Creek: Pa, Pd	>5	>6	0–11	Silt loam	ML or CL	A–4
			11–45	Silty clay loam	CL	A–6 or A–7
			45–60	Heavy silt loam	CL	A–6
Port: Ph, Pk	>5	>6	0–20	Silt loam	ML or CL	A–4
For Slickspots part of Pk, properties too variable to be estimated.			20–32	Heavy silt loam	CL	A–4 or A–6
			32–60	Silt loam	CL	A–6
*Pratt: Ps, Pt	>5	>5	0–60	Loamy fine sand	SM	A–2
For Tivoli part of Pt, see Tivoli series.						
*Quinlan: Qn, Qw	1–1½	>6	0–14	Loam	ML or CL	A–4
For Woodward part of Qw, see Woodward series.				Weakly cemented sandstone.		
Rough broken land, shaly: Rb. Too variable to be estimated.						
Shale outcrop. Mapped only in a complex with Vernon series. Properties too variable to be estimated.						
Shellabarger: Sb, Sc	>5	>6	0–14	Sandy loam	SM	A–4 or A–2
			14–48	Sandy clay loam	SC	A–6
			48–60	Sandy loam	SM or SC	A–2
Slickspots. Mapped only in complexes with Mangum and Port series. Too variable to be estimated.						
Tivoli: Tv	>5	>5	0–60	Fine sand	SP or SM	A–2 or A–3
Vernon: Vn, Vr, Vs	2–4	>10	0–5	Clay loam	CL	A–6 or A–7
For Shale outcrop part of Vs, properties too variable to be estimated.			5–22	Clay	CL or CH	A–7
			22–60	Clay shale	CL or CH	A–6 or A–7
Waldeck: Wa	>5	2–5	0–36	Sandy loam	SM or ML	A–4
			36–60	Fine and medium sand	SP or SM	A–3 or A–2
*Woodward: Wo, Ws	1½–4	>6	0–40	Loam	ML or CL	A–4
Mapped only in complexes with Quinlan soils. For Quinlan parts, see Quinlan series.			40–60	Fine-grained sandstone.		
Yahola: Ya	>5	4–6	0–60	Sandy loam	SM or ML	A–4 or A–2
			60–66	Medium sand	SM	A–2
Zenda: Ze	>5	3–6	0–60	Clay loam	CL	A–6

[1] NP means nonplastic.

significant to engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
						Inches per hour	*Inches per inch of soil*	*pH*	
100	100	90–100	80–95	25–40	8–18	0.6–2.0	0.17–0.19	6.1–6.5	Moderate.
100	100	90–100	80–95	40–50	20–30	0.2–0.6	0.15–0.19	6.6–8.4	Moderate.
100	100	90–100	80–95	25–40	8–18	0.2–0.6	0.14–0.16	7.9–8.4	Moderate.
100	100	95–100	90–100	20–35	4–10	0.6–2.0	0.22–0.24	6.1–6.5	Low.
100	100	95–100	90–100	30–45	10–25	0.2–0.6	0.18–0.20	6.6–7.3	Moderate.
100	100	95–100	80–95	25–40	8–20	0.2–0.6	0.18–0.20	7.4–7.8	Moderate.
100	100	90–100	70–90	20–35	4–10	0.6–2.0	0.22–0.24	6.1–6.5	Low.
100	100	95–100	75–95	25–40	8–20	0.6–2.0	0.20–0.22	7.4–7.8	Moderate.
100	100	95–100	85–95	25–40	10–20	0.6–2.0	0.20–0.22	7.9–8.4	Low.
100	100	85–100	15–25	NP	NP	6.0–20.0	0.09–0.11	6.1–7.3	Low.
100	100	90–100	55–85	20–35	3–8	2.0–6.0	0.20–0.22	7.9–8.4	Low.
100	100	70–85	30–50	15–25	2–7	0.6–2.0	0.13–0.15	6.1–6.5	Low.
100	100	70–85	36–50	25–40	11–25	0.6–2.0	0.16–0.18	6.1–6.5	Low.
100	100	50–75	20–35	25–40	11–25	0.6–2.0	0.09–0.13	6.1–7.3	Low.
100	100	85–95	5–15	NP	NP	6.0–20.0	0.05–0.07	6.1–6.5	Very low.
100	100	90–100	80–95	30–50	10–30	0.06–0.2	0.17–0.19	7.9–8.4	Moderate.
100	100	95–100	85–100	35–60	20–40	<0.06	0.09–0.11	7.9–8.4	High.
90–100	85–100	65–100	60–100	30–60	15–35	<0.06	0.08–0.14	7.9–8.4	High.
100	100	80–95	40–70	NP–26	NP–6	2.0–6.0	0.13–0.15	7.4–8.4	Low.
100	90–100	80–95	5–20	NP	NP	6.0–20.0	0.05–0.07	7.4–8.4	Low.
100	100	90–100	65–100	20–30	4–10	0.6–2.0	0.17–0.19	7.4–8.4	Low.
100	100	85–95	30–60	NP–26	NP–6	2.0–6.0	0.15–0.17	7.9–8.4	Low.
100	90–100	50–90	15–35	NP	NP	6.0–20.0	0.05–0.07	7.9–8.4	Low.
100	95–100	85–95	60–75	30–40	15–25	0.6–2.0	0.15–0.19	6.6–8.4	Moderate.

TABLE 4.—*Soil interpretations*

[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 as indicated in the first

Soil series and map symbols	Degree and kind of limitation for—		
	Septic tank absorption fields	Sewage lagoons	Shallow excavations
*Albion: Ad, Ae For interpretations of Shellabarger part, see Shellabarger series.	Slight if slope is 2 to 8 percent. Moderate if 8 to 15 percent.	Severe: moderately rapid permeability.[1]	Slight if slope is 2 to 8 percent. Moderate if 8 to 15 percent. Severe below 2 feet.
Alluvial land, saline: As. No interpretations made; properties too variable.			
Attica: At	Slight[1]	Severe: moderately rapid permeability.	Moderate: sides slough below 30 inches.
Blanket: Ba, Bb, Bc	Severe: moderately slow permeability.	Slight	Slight
*Breaks: Bf. No interpretations made; properties too variable. For interpretations of Clairemont part, see Clairemont series.			
Canadian: Ca	Severe[2]: occasional flooding.[1]	Severe: moderately rapid permeability.	Severe[2]: occasional flooding.
*Case: Cc For interpretations of Clark part, see Clark series.	Slight to moderate: moderate permeability.	Moderate: moderate permeability.	Moderate: possible side wall instability.
Clairemont: Cd, Cf	Severe: frequent flooding	Severe: frequent flooding	Severe: frequent flooding
Clark: Ck	Slight to moderate: moderate permeability.	Moderate: moderate permeability.	Moderate: possible side wall instability.
Farnum: Fa, Fm, Fr, Fu	Severe: moderately slow permeability.	Slight if slope is less than 2 percent. Moderate if 2 to 3 percent.	Moderate: possible side wall instability.
Grant: Ga, Gb, Gc	Slight	Moderate: moderate permeability.	Slight
Kanza: Ka	Severe: high water table; frequent flooding.	Severe: high water table; frequent flooding.	Severe: poorly drained; high water table; frequent flooding.
*Kingfisher: Kf, Kv, Kz For interpretations of Vernon part of Kv and Kz, see Vernon series.	Severe: moderately slow permeability.	Slight if slope is 1 to 2 percent. Moderate if 2 to 6 percent.	Slight: to depth of 2 feet. Severe: 2–5 feet; weathered shale.
Lincoln: Ln	Severe: frequent flooding	Severe: rapid permeability; frequent flooding.	Severe: frequent flooding
*Mangum: Ma, Mg For Slickspots part of Mg, see Slickspots.	Severe: very slow permeability; frequent flooding.	Severe: frequent flooding	Severe: frequent flooding
Minco: Mn	Slight	Moderate: moderate permeability.	Slight
Naron: Na, Nb	Slight	Moderate: moderate permeability.	Slight
Ost: Os, Ot	Severe: moderately slow permeability.	Slight	Moderate: side wall instability.

See footnote at end of table.

for land use planning

soils in such mapping units may have different properties and limitations, and for this reason it is necessary to refer to other series column of this table]

Degree and kind of limitation for—Continued			
Dwellings	Local roads and streets	Sanitary landfill	
		Trench type	Area type
Slight if slope is 2 to 8 percent. Moderate if 8 to 15 percent.	Slight if slope is 2 to 8 percent. Moderate if 8 to 15 percent.	Severe: moderately rapid permeability.[1]	Severe: moderately rapid permeability.[1]
Slight	Slight	Severe: moderately rapid permeability.[1]	Severe: moderately rapid permeability.[1]
Severe: high shrink-swell	Severe: high shrink-swell	Severe: workability	Slight.
Severe[2]: occasional flooding.	Moderate: occasional flooding.	Severe: occasional flooding; permeability.	Severe: occasional flooding; moderately rapid permeability.
Moderate: moderate shrink-swell.	Moderate: moderate shrink-swell.	Moderate: workability	Slight.
Severe: frequent flooding	Severe: frequent flooding	Severe: frequent flooding	Severe: frequent flooding.
Moderate: moderate shrink-swell.	Moderate: moderate shrink-swell.	Moderate: workability	Slight.
Moderate: moderate shrink-swell.	Moderate: moderate shrink-swell.	Moderate: workability	Slight.
Slight	Moderate: medium soil support.	Slight	Slight.
Severe: poorly drained; high water table; frequent flooding.	Severe: poorly drained; frequent flooding.	Severe: high water table; frequent flooding.	Severe: high water table; poorly drained; frequent flooding.
Moderate to severe: moderate to high shrink-swell.	Moderate: moderate shrink-swell.	Severe: workability	Slight.
Severe: frequent flooding	Severe: frequent flooding	Severe: frequent flooding	Severe: frequent flooding.
Severe: frequent flooding; high shrink-swell.	Severe: frequent flooding; high shrink-swell.	Severe: frequent flooding; workability.	Severe: frequent flooding.
Slight	Moderate: medium soil support.	Slight	Slight.
Slight	Slight	Slight	Slight.
Moderate: moderate shrink-swell.	Moderate to severe: moderate shrink-swell.	Moderate: workability	Slight.

TABLE 4.—*Soil interpretations*

Soil series and map symbols	Degree and kind of limitation for—		
	Septic tank absorption fields	Sewage lagoons	Shallow excavations
Pond Creek: Pa, Pd	Severe: moderately slow permeability.	Slight	Slight
*Port: Ph, Pk For Slickspots part of Pk, see Slickspots.	Severe [2]: occasional flooding.	Severe [2]: occasional flooding.	Severe [2]: occasional flooding.
*Pratt: Ps, Pt For interpretations of Tivoli part of Pt, see Tivoli series.	Slight if slope is 5 to 8 percent. Moderate if 8 to 12 percent.	Severe: rapid permeability	Severe: side wall instability.
*Quinlan: Qn, Qw For interpretations of Woodward part of Qw, see Woodward series.	Severe: shallow over bedrock.	Severe: rapid permeability; shallow over bedrock.	Moderate: shallow over rippable bedrock.
Rough broken land, shaly: Rb. No interpretations made; properties too variable.			
Shale outcrop. Mapped only in a complex with Vernon series. No interpretations made; properties too variable.			
Shellabarger: Sb, Sc	Slight if slope is 2 to 8 percent. Moderate if 8 to 12 percent.	Moderate: moderate permeability; slope is 2 to 7 percent. Severe if slope is more than 7 percent.	Slight if slope is 2 to 8 percent. Moderate if 8 to 12 percent.
Slickspots. Mapped only in complexes with Mangum and Port series. No interpretations made; properties too variable.			
Tivoli: Tv	Slight if slope is 5 to 8 percent. Moderate if 8 to 15 percent. Severe if more than 15 percent.[1]	Severe: rapid permeability	Severe: side wall instability.
*Vernon: Vn, Vr, Vs For Shale outcrop part of Vs, see Shale outcrop.	Severe: very slow permeability.	Slight if slope is 1 to 2 percent. Moderate if 2 to 7 percent. Severe if 7 to 15 percent.	Severe: workability
Waldeck: Wa	Severe: high water table; occasional flooding.	Severe: high water table; moderately rapid permeability.	Severe: high water table; occasional flooding.
*Woodward: Wo, Ws Mapped only in complexes with Quinlan soils. For interpretations of Quinlan part, see Quinlan series.	Severe: about 40 inches to bedrock.	Severe: about 40 inches to bedrock.	Moderate: about 40 inches to bedrock; slopes 8 to 15 percent.
Yahola: Ya	Severe: high water table; occasional flooding.	Severe: high water table; moderately rapid permeability; occasional flooding.	Severe: occasional flooding; high water table.
Zenda: Ze	Severe: high water table; occasional flooding.	Severe: high water table; occasional flooding.	Severe: somewhat poorly drained; occasional flooding.

[1] Pollution is a hazard to water supplies.

[2] Limitation is slight if the soil is protected from flooding.

for land use planning—Continued

Degree and kind of limitation for—Continued			
Dwellings	Local roads and streets	Sanitary landfill	
		Trench type	Area type
Moderate: moderate shrink-swell.	Moderate: moderate shrink-swell; medium support.	Moderate: workability	Slight.
Severe[2]: occasional flooding.	Moderate: occasional flooding.	Severe: occasional flooding	Severe: occasional flooding.
Slight if slope is 5 to 8 percent. Moderate if 8 to 12 percent.	Slight if slope is 5 to 8 percent. Moderate if 8 to 12 percent.	Severe: rapid permeability	Severe: rapid permeability.
Moderate: shallow over rippable bedrock.	Moderate: shallow over rippable bedrock.	Severe: shallow over rippable bedrock.	Slight if slope is 0 to 8 percent. Moderate if 8 to 15 percent.
Slight if slope is 2 to 8 percent. Moderate if 8 to 12 percent.	Moderate: fair to good compaction, medium soil support.	Slight	Slight.
Slight if slope is 5 to 8 percent. Moderate if 8 to 15 percent. Severe if more than 15 percent.	Slight if slope is 5 to 8 percent. Moderate if 8 to 15 percent. Severe if more than 15 percent.	Severe: rapid permeability	Severe: rapid permeability.
Severe: high shrink-swell	Severe: plastic material; high shrink-swell.	Severe: workability	Slight if slope is 1 to 8 percent. Moderate if 8 to 15 percent.
Severe: somewhat poorly drained; high water table; occasional flooding.	Severe: flooding more than once in 5 years.	Severe: high water table; occasional flooding; moderately rapid permeability.	Severe: high water table; occasional flooding; moderately rapid permeability.
Slight to moderate: about 40 inches to rippable bedrock.	Slight	Moderate: about 40 inches to rippable bedrock.	Slight if slope is less than 8 percent. Moderate if 8 to 15 percent.
Severe: high water table; occasional flooding.	Severe: flooding more than once in 5 years.	Severe: high water table; occasional flooding; moderately rapid permeability.	Severe: high water table; occasional flooding; moderately rapid permeability.
Severe: somewhat poorly drained; high water table; occasional flooding.	Severe: occasional flooding	Severe: high water table; occasional flooding.	Severe: high water table; occasional flooding.

TABLE 5.—*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 as indicated in the first

Soil series and map symbols	Suitability as source of—			
	Sanitary landfill, cover material	Topsoil	Sand and gravel	Road subgrade
*Albion: Ad, Ae For interpretations of Shellabarger part, see Shellabarger series.	Fair: thin layer	Good if slope is 0 to 8 percent. Moderate if 8 to 15 percent.	Poor to depth of 2 feet. Fair to depth of 5 feet.	Good if confined
Alluvial land, saline: As. No interpretations made; properties too variable.				
Attica: At	Fair: susceptible to soil blowing.	Poor: sandy	Poor	Good if confined
Blanket: Ba, Bb, Bc	Poor: thin layer	Fair: thin layer	Unsuited	Fair: medium soil support; medium plasticity.
*Breaks: Bf. No interpretations made; properties too variable. For interpretations of Clairemont part, see Clairemont series.				
Canadian: Ca	Good	Good	Poor	Good
*Case: Cc For interpretations of Clark part of this unit, see Clark series.	Fair: clay loam; workability.	Fair: workability	Unsuited	Fair: medium soil support.
Clairemont: Cd, Cf	Good	Fair: thin layer	Unsuited	Fair: medium soil support.

See footnote at end of table.

engineering properties of the soils

soils in such mapping units may have different properties and limitations, and for this reason it is necessary to refer to other series column of this table]

Suitability—Cont'd	Soil features affecting—				
Road fill	Highway location	Pond reservoir areas	Embankments, dikes, and levees	Terraces, diversions, and waterways	Irrigation
Good	Erodible; slope is 2 to 5 percent.	Moderately rapid permeability; slope is 2 to 15 percent; medium storage.	Medium to high susceptibility to piping; fair to good compaction characteristics; medium shear strength.	Moderately rapid permeability; moderate depth to coarse layers; low available water capacity; low natural fertility.	Moderately rapid permeability; low available water capacity; moderate depth to sand and gravel; slope is 2 to 15 percent.
Good	Erodible; slope is 1 to 5 percent.	Moderately rapid permeability; short, uneven slopes; low storage.	Good stability; medium shear strength; fair to good compaction characteristics; susceptible to piping.	Short, uneven slopes; susceptible to soil blowing.	Moderately rapid permeability; moderate available water capacity; short, uneven slopes; susceptible to soil blowing.
Fair: fair shear strength.	Poor workability; nearly level and gently sloping.	Moderately slow permeability.	Medium to low shear strength; medium to high compressibility.	Well drained; gentle slopes; moderately slow permeability.	Moderately slow permeability; high available water capacity; slope is 1 to 3 percent.
Good	Erodible; nearly level; subject to flooding.	Moderately rapid permeability.	Medium shear strength; fair to good compaction characteristics; poor resistance to piping.	(1)	Moderately rapid permeability; susceptible to blowing; moderate available water capacity; nearly level slope.
Good	Erodible; difficult to vegetate; slope is 3 to 6 percent.	Moderate permeability; low storage capacity.	Medium to low shear strength; fair to good stability and compaction characteristics; medium compressibility; erodible slope; highly calcareous.	Moderate permeability; highly calcareous; erodible slope; medium natural fertility.	Moderate permeability; moderate available water capacity; slope is 3 to 6 percent; highly calcareous.
Good	Frequent flooding; nearly level.	Moderate permeability.	Medium to low shear strength; medium compressibility; susceptible to piping; fair to poor compaction characteristics.	(1)	Frequent flooding; nearly level slope; moderate permeability; high available water capacity.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Suitability as source of—			
	Sanitary landfill, cover material	Topsoil	Sand and gravel	Road subgrade
Clark: Ck	Fair: workability.	Fair: workability.	Unsuited	Fair: medium soil support.
Farnum: Fa, Fm, Fr, Fu	Fair: workability.	Fair: thin layer.	Unsuited	Fair: medium soil support; medium plasticity.
Grant: Ga, Gb, Gc	Good	Fair: thin layer.	Unsuited	Fair: medium soil support.
Kanza: Ka	Poor: sandy; poorly drained.	Poor: sandy	Poor	Good
*Kingfisher: Kf, Kv, Kz For interpretations of Vernon parts of Kv and Kz, see Vernon series.	Fair: workability.	Fair: workability; thin layer.	Unsuited	Fair: medium soil support.
Lincoln: Ln	Poor: sandy; susceptible to soil blowing.	Poor: sandy	Poor	Good if confined
*Mangum: Ma, Mg For Slickspots part of Mg, no interpretations made; properties too variable.	Poor: workability.	Poor: clay; workability.	Unsuited	Poor: poor soil support; high plasticity.
Minco: Mn	Good	Good	Unsuited	Fair: medium soil support.

See footnote at end of table.

properties of the soils—Continued

Suitability—Cont'd	Soil features affecting—				
Road fill	Highway location	Pond reservoir areas	Embankments, dikes, and levees	Terraces, diversions, and waterways	Irrigation
Good	Erodible; difficult to vegetate; slope is 0 to 6 percent.	Moderate permeability; highly calcareous; low storage capacity.	Medium to low shear strength; fair to good compaction characteristics; medium compressibility.	Moderate permeability; highly calcareous; erodible slope; high natural fertility.	Moderate permeability; high available water capacity; slope is 0 to 6 percent; highly calcareous.
Fair: fair shear strength.	Nearly level to gently sloping.	Moderately slow permeability; low storage.	Medium to low shear strength; fair to good compaction characteristics; medium compressibility.	Erodible slope; moderately slow permeability; susceptible to soil blowing; high natural fertility.	Moderately slow permeability; high available water capacity; slope is 0 to 3 percent; susceptible to soil blowing.
Good	Erodible; slope is 0 to 6 percent.	Moderate permeability; low storage.	Medium to low shear strength; medium compressibility.	Erodible slope; susceptible to soil blowing.	Moderate permeability; high available water capacity; susceptible to soil blowing; slope is 0 to 6 percent.
Good	Frequent flooding; high water table; erodible.	Seasonal high water table; rapid permeability.	Medium shear strength; low compressibility; fair to good compaction characteristics; susceptible to piping; poorly drained; high water table.	(1)	(1)
Fair: fair shear strength.	Erodible; slope is 1 to 6 percent.	Moderately slow permeability; low to medium storage.	Medium to low shear strength; medium to high compressibility; fair to poor compaction characteristics.	Short and medium slopes; moderately slow permeability; susceptible to soil blowing; erodible slope; medium natural fertility.	Moderately slow permeability; high available water capacity; susceptible to soil blowing; slope is 1 to 6 percent; medium natural fertility.
Good	Erodible; frequent flooding; nearly level.	Rapid permeability	Low to medium compressibility; fair compaction characteristics.	(1)	Rapid permeability; high water table; low available water capacity.
Fair: fair shear strength.	Poor workability; frequent flooding; nearly level.	Very slow permeability.	Medium to low shear strength; high compressibility; fair to poor compaction characteristics; medium to high content of gypsum.	(1)	Very slow permeability; high available water capacity; frequent flooding; slope is 1 to 6 percent; medium to high content of gypsum.
Good: erodible; nearly level to gently sloping.	Erodible; well drained; nearly level to gently sloping.	Moderate permeability; low storage.	Medium to low shear strength; low compressibility; fair to poor compaction characteristics; susceptible to piping.	Erodible slope; siltation of channels; susceptible to soil blowing; high natural fertility.	High available water capacity; moderate permeability; slope is 0 to 2 percent; susceptible to soil blowing.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Suitability as source of—			
	Sanitary landfill, cover material	Topsoil	Sand and gravel	Road subgrade
Naron: Na, Nb	Good	Fair: thin layer	Unsuited	Good
Ost: Os, Ot	Fair: workability	Fair: workability; thin layer.	Unsuited	Fair: medium soil support; medium plasticity.
Pond Creek: Pa, Pd	Fair: workability	Fair: thin layer	Unsuited	Fair: medium soil support.
Port: Ph, Pk For Slickspots part of Pk, no interpretations made; properties too variable.	Good	Good	Unsuited	Fair: medium soil support.
*Pratt: Ps, Pt For interpretations of Tivoli part of Pt, see Tivoli series.	Fair: susceptible to soil blowing.	Poor: sandy; susceptible to soil blowing.	Poor	Good if confined
*Quinlan: Qn, Qw For interpretations of Woodward part of Qw, see Woodward series.	Poor: thin layer	Fair: thin layer	Unsuited	Good
Rough broken land, shaly: Rb. No interpretations made; properties too variable.				
Shale outcrop. Mapped only in a complex with Vernon series. No interpretations made; properties too variable.				
Shellabarger: Sb, Sc	Good if slope is 2 to 8 percent. Fair if 8 to 12 percent.	Fair: thin layer	Poor	Fair: medium soil support; fair to good compaction.
Slickspots. Mapped only in complexes with Mangum and Port series. No interpretations made; properties too variable.				

See footnote at end of table.

properties of the soils—Continued

Suitability—Cont'd	Soil features affecting—				
Road fill	Highway location	Pond reservoir areas	Embankments, dikes, and levees	Terraces, diversions, and waterways	Irrigation
Good	Erodible; nearly level to gently sloping.	Moderate permeability; low storage.	Medium to low shear strength; low to medium compaction characteristics.	Erodible slope; susceptible to soil blowing; moderate permeability; high natural fertility.	Moderate available water capacity; moderate permeability; susceptible to soil blowing; slope is 0 to 3 percent.
Good	Difficult to vegetate; nearly level to gently sloping.	Moderately slow permeability; low storage.	Medium to low shear strength; medium compressibility; fair to good compaction characteristics.	Erodible slope; moderately slow permeability; high natural fertility.	Moderately slow permeability; high available water capacity; slope is 0 to 3 percent.
Good	Nearly level to gently sloping.	Moderately slow permeability; low storage.	Medium to low shear strength; medium compressibility; fair to good compaction characteristics.	Erodible slope; susceptible to soil blowing; moderately slow permeability; high natural fertility.	Moderately slow permeability; high available water capacity; slope is 0 to 3 percent.
Good	Subject to flooding; nearly level.	Moderate permeability.	Medium to low shear strength; medium compressibility; fair to good compaction characteristics.	(1)	Moderate permeability; high available water capacity; slope is 0 to 1 percent.
Good if confined	Erodible; slope is 5 to 15 percent.	Rapid permeability; low storage.	Medium shear strength; low to medium compressibility; fair to good compaction characteristics.	(1)	Rapid permeability; low available water capacity; slope is 5 to 15 percent; susceptible to soil blowing.
Good: erodible; slope is 1 to 15 percent.	Erodible; slope is 1 to 15 percent; depth to sandstone less than 20 inches.	Shallow over bedrock; moderately rapid permeability; low storage.	Medium to low shear strength; medium compressibility; fair to poor compaction characteristics.	Shallow over bedrock; erodible slope; moderately rapid permeability; low natural fertility.	Very low available water capacity; shallow over bedrock; moderately rapid permeability.
Good: fair to good compaction.	Erodible: slope is 2 to 15 percent.	Moderate permeability; medium storage.	Medium to low shear strength; low to medium compressibility; fair to good compaction characteristics.	Erodible slope; susceptible to soil blowing; moderate permeability; medium natural fertility.	Moderate available water capacity; moderate permeability; susceptible to soil blowing.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Suitability as source of—			
	Sanitary landfill, cover material	Topsoil	Sand and gravel	Road subgrade
Tivoli: Tv	Poor: sandy; susceptible to soil blowing.	Poor: sandy	Fair to poor	Good if confined
Vernon: Vn, Vr, Vs For Shale outcrop part of Vs, no interpretations made; properties too variable.	Poor: workability	Poor: workability; thin layer.	Unsuited	Poor: low soil support; high plasticity.
Waldeck: Wa	Fair: thin layer	Good	Fair: at depth of 2 to 5 feet.	Good in upper 36 inches, and below if confined.
*Woodward: Wo, Ws Mapped only in complexes with Quinlan soils. For interpretations of Quinlan parts, see Quinlan series.	Fair: thin layer	Good	Unsuited	Good
Yahola: Ya	Good	Good	Poor	Good
Zenda: Ze	Fair: workability	Fair: workability	Unsuited	Fair: medium soil support.

[1] Practice not applicable or not needed.

level floor, and sides, or embankments, of compacted soil material. It is assumed that the embankment is compacted to medium density and that 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, and if the floor needs to be leveled, depth to bedrock becomes 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.

Dwellings, as rated in table 4, are not 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

properties of the soils—Continued

Suitability—Cont'd	Soil features affecting—				
Road fill	Highway location	Pond reservoir areas	Embankments, dikes, and levees	Terraces, diversions, and waterways	Irrigation
Good	Highly erodible; erodible slopes; slope is 5 to 20 percent; difficult to vegetate.	Rapid permeability; hilly topography; erodible slopes; low storage.	Medium shear strength; low compressibility; good compaction characteristics.	(1)	Low available water capacity; rapid permeability; hilly landscape; susceptible to soil blowing.
Fair: fair shear strength; less than 40 inches to shale; poor workability; difficult to vegetate.	Moderately steep slopes; plastic materials; gypsum rock.	Very slow permeability; seepage near gypsum rock; medium storage.	Medium to low shear strength; high compressibility; fair compaction characteristics; susceptible to piping near layers of gypsum.	Erodible slope; plastic materials; high siltation hazard; low natural fertility.	Low available water capacity; slope is 1 to 15 percent; very slow permeability; low natural fertility.
Good	Erodible; subject to flooding; fluctuating water table 2 to 5 feet; nearly level.	Seasonal high water table; moderately rapid permeability.	Medium shear strength; low compressibility; good compaction characteristics.	(1)	Moderate available water capacity; moderately rapid permeability; high water table; susceptible to soil blowing.
Good	Erodible; about 40 inches to rippable bedrock.	Moderate permeability; about 40 inches to rippable bedrock; low storage.	Medium to low shear strength; medium compressibility; fair to poor compaction characteristics.	Erodible slope; about 40 inches to rippable bedrock; siltation hazard; susceptible to soil blowing.	Moderate available water capacity; moderate permeability; slope is 0 to 6 percent; susceptible to soil blowing.
Good	Subject to flooding; nearly level; erodible.	Moderately rapid permeability.	Medium shear strength; low to medium compressibility; fair to good compaction characteristics.	(1)	Moderate available water capacity; nearly level slope; high water table; susceptible to soil blowing.
Good	Subject to flooding; fluctuating water table at depth of 3 to 6 feet; nearly level.	(1)	Medium to low shear strength; medium compressibility; fair to good compaction characteristics.	(1)	High available water capacity; high water table; moderate permeability; nearly level slope.

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 4 apply only to a depth of about 6 feet, and 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 to 15 feet, but regardless of that, every site should be investigated before it is selected.

Following are explanations of some of the column headings in table 5.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability

TABLE 6.—*Engineering*

[Tests performed by the State Highway Commission of Kansas under a cooperative agreement with the Bureau of Public Officials

Soil name and location	Parent material	Report number	Depth	Moisture-density data [1]	
				Maximum dry density	Optimum moisture
		S71-Kans-4-	*Inches*	*Pounds per cubic foot*	*Percent*
Port silt loam: 270 feet N and 105 feet E of SW corner of sec. 5, T. 32 S., R. 12 W. (Modal)	Alluvium.	1-1	5-15	113	14
		1-2	15-34	113	14
		1-3	34-60	110	16
Woodward loam: 390 feet E and 75 feet S of NW corner of SW¼ of sec. 7, T. 35 S., R. 12 W. (Modal)	Residuum from soft, fine-grained sandstone and shale.	2-1	0-9	113	14
		2-2	9-20	112	14
		2-3	26-46	117	14
Pond Creek silt loam: 140 feet E and 192 feet N of SW corner of NE¼ of sec. 16, T. 35 S., R. 12 W. (Modal)	Loess and residuum from redbeds.	3-1	6-11	111	14
		3-2	21-32	104	18
		3-3	40-60	109	17
Grant silt loam: 1,410 feet N and 1,225 feet E of center of sec. 12, T. 35 S., R. 11 W. (Modal)	Residuum from redbeds.	4-1	5-13	111	14
		4-2	13-25	111	16
		4-3	34-60	112	13
Vernon clay loam: 90 feet E and 100 feet N of SW corner of SE¼ of sec. 32, T. 33 S., R. 15 W. (Modal)	Residuum from Permian shale.	5-1	0-5	103	17
		5-2	14-40	106	19

[1] Based on AASHTO Designation: T99-57, Method A (*1*), with the following variations: (1) all material is ovendried at 230° F. and crushed in laboratory crusher, and (2) no time is allowed for dispersion of moisture after mixing with the soil material.

[2] Mechanical analysis according to AASHTO Designation: T88-57 (*1*), 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, the minimum time is 1 minute. Results from this procedure may differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is

is affected mainly by ease of working and spreading the soil material, as in preparing a seedbed; natural fertility of the material, or the response of plants when fertilizer is used; 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 can result in the area from which topsoil is taken.

Table 5 shows which soils are probable sources of sand and gravel. A soil rated as a *good* or *fair* source generally has a layer of sand or gravel 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.

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.

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 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 factors that are unfavorable.

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 resistence to water erosion, soil slipping, and soil blowing. A soil suitable for these structures provides outlets for runoff and is not difficult to vegetate.

Irrigation of a soil is affected by such features as slope; susceptibility to stream overflow, to water erosion, or to 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 that restrict movement of water; amount of

test data

Roads (BPR) in accordance with standard procedures of the American Association of State Highway and Transportation (AASHTO)]

Mechanical analysis[2]							Liquid limit	Plasticity index	Classification	
Percentage less than 3 inches 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				
							Percent			
100	99	83	69	39	23	18	27	9	A-4(8)	CL
100	99	78	66	44	27	22	27	10	A-4(8)	CL
100	100	92	82	55	31	23	29	12	A-6(9)	CL
100	99	87	75	40	21	14	28	9	A-4(8)	CL
100	100	93	82	45	23	16	27	8	A-4(8)	CL
100	100	97	92	59	27	18	25	8	A-4(8)	CL
100	100	93	79	43	23	18	26	7	A-4(8)	CL–ML
100	100	92	83	58	40	35	37	16	A-6(10)	CL
100	99	87	74	51	34	29	32	14	A-6(10)	CL
100	100	92	81	38	17	14	26	7	A-4(8)	CL–ML
100	100	92	83	43	23	18	26	6	A-4(8)	CL–ML
100	100	96	87	46	25	20	29	9	A-4(8)	CL
100	99	84	77	58	43	35	34	14	A-6(10)	CL
100	100	98	94	82	63	48	44	21	A-7-6(13)	CL

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

[3] SCS and BPR have agreed to consider that all soils having plasticity indexes within two points of the A-line are to be given a borderline classification.

water held available to plants; and need for drainage or depth to water table or bedrock.

Soil test data

Table 6 contains engineering test data for five of the soil series in Barber County. These tests were made by the State Highway Commission of Kansas to help evaluate the soils for engineering purposes. The engineering classification given is based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods.

Compaction (or moisture-density) data are important in earthwork. If a soil material is compacted at successively higher moisture contents, assuming that the compactive effort remains constant, the density of the compacted material increases until the *optimum moisture content* is reached. After that, density decreases with increase in moisture content. The highest dry density obtained in the compactive test is termed *maximum dry density*. As a rule, maximum strength of earthwork is obtained if the soil is compacted to the maximum dry density.

In tests to determine liquid limit and plastic limit, the effect of water on the consistence of soil material is measured, as has been explained for table 3.

Windbreaks

Most of the trees and shrubs in Barber County are grown in windbreaks on uplands, but eastern redcedar grows well and reproduces on both uplands and bottom lands. Among other trees that grow mainly in the valleys along streams are cottonwood, elm, ash, hackberry, and willow and some scattered chinaberry, oak, and walnut. Although they do not grow extensively on soils of the uplands, trees and shrubs can be grown in windbreaks if special care is taken and the rows properly spaced. Many windbreaks have been planted since 1937 (fig. 16), and many of these are in excellent condition.

A well-planned windbreak provides an effective barrier against wind. It holds soils in place, protects buildings, livestock, orchards, and gardens; and provides food and cover for wildlife. If a windbreak for the farmstead or field is planned, trees and shrubs that are well suited to the soils should be chosen. For example, only Eastern redcedar and pine do well on Tivoli fine

Figure 16.—A windbreak on Attica loamy fine sand.

sand and only if soil blowing is controlled. Also, only Eastern redcedar should be planted on Vernon clay loam. In areas of dryland farming, careful and regular cultivation is necessary to conserve moisture before and after planting and while the trees and shrubs are small. Generally, trees are well suited to loamy soils but less well suited to sandy and clayey soils.

The soils of Barber County have been placed in eight windbreak suitability groups, and many features of the soils, the climate, as well as the trees and shrubs were considered in this placement. Each group has certain soil characteristics and qualities that affect the rate of growth and the chance of survival of trees and shrubs, and each group requires a different kind of management. Among these soil features are effective depth, texture, and permeability of the root zone; soil drainage; depth to the water table; available water capacity; salinity; alkalinity; and highly calcareous layers.

The suitability of the soils in windbreak suitability groups 1 through 8 for specified trees and shrubs is shown in table 7. It is expressed as excellent, good, fair, and poor. Excellent means that the soils are favorable for the establishment, vigorous growth, and reproduction of the specified tree or shrub and that the growth rate is above average. Good means that the soils are suitable for dependable growth and that the growth rate and vigor are about average. Fair means that the soils are severely limited for the tree or shrub specified and that the growth rate is below average. Poor means that the soils are such that little or no growth of the specified tree or shrub can be expected.

Some soils and land types have not been placed in a windbreak suitability group because their use and management for this purpose is very severely limited. Among their limitations are deep sand, steepness, wetness, shallowness to shale or rock, and salinity. Onsite investigation is needed to determine the special management needed. The woodland suitability group for each of the other soils can be found in the "Guide to Mapping Units" at the back of this survey and is listed at the end of each mapping unit description in the section "Descriptions of the Soils."

The windbreak suitability groups are described in the following paragraphs.

WINDBREAK SUITABILITY GROUP 1

This windbreak group consists of moderately deep and deep, nearly level, gently sloping and sloping, well-drained, loamy soils. These soils have moderate to very high available water capacity, and they allow for uniform growth of roots and downward movement of water to a depth of more than 3 feet. The soils of this group have medium or high natural fertility.

WINDBREAK SUITABILITY GROUP 2

This windbreak group consists of shallow and moderately deep, nearly level to moderately steep, well-drained

TABLE 7.—*Trees and shrubs*

[Estimated heights are attained in 20 years. They are not shown if the rating is poor or for American plum or tamarisk. Not suited land, shaly; Tivoli fine sand; and the Shale

Trees and shrubs	Windbreak suitability group—					
	1		2		3	
	Suitability	Height	Suitability	Height	Suitability	Height
		Feet		*Feet*		*Feet*
American plum	Good		Poor		Poor	
Bur oak	Good	17–24	Poor		Poor	
Southern catalpa	Poor		Poor		Poor	
Plains cottonwood	Fair	32–40	Poor		Poor	
Eastern redcedar	Excellent	20–25	Good	12–18	Fair	10–15
Green ash	Good	14–18	Poor		Poor	
Hackberry	Fair	17–21	Poor		Poor	
Honeylocust	Good	18–22	Poor		Poor	
White mulberry	Fair	14–18	Poor		Poor	
Osageorange	Excellent	17–23	Poor		Poor	
Ponderosa pine	Good	20–27	Poor		Poor	
Russian-olive	Fair	15–19	Poor		Poor	
Siberian elm	Good	35–45	Poor		Poor	
Tamarisk	Poor		Poor		Poor	

and somewhat excessively drained loamy soils. These soils have low or very low available water capacity. The growth of roots is limited by layers of shale, rock, or gravel at a depth of 1 to 3 feet. These soils have low natural fertility, and water erosion is a hazard. Moderate steepness is a limitation to the use of equipment.

WINDBREAK SUITABILITY GROUP 3

Vernon clay loam is the only soil in this windbreak group. It is a moderately deep, well-drained, very slowly permeable, clayey soil. It has low available water capacity. This soil has a subsoil of dense clay or layers of clay shale that slow the growth of roots and the downward movement of water. Depth to the water table is more than 6 feet. This soil has low natural fertility, and water erosion is a hazard. Moderate steepness is a limitation to use of equipment.

WINDBREAK SUITABILITY GROUP 4

This windbreak group consists of deep, gently rolling and rolling, well-drained and somewhat excessively drained, sandy soils, and loamy soils that have a sandy surface layer. These soils have rapid or moderately rapid permeability and low or medium available water capacity. Depth to the water table is more than 6 feet. These soils have medium to low natural fertility. Soil blowing is a severe hazard. The use of equipment is somewhat limited in rolling areas.

WINDBREAK SUITABILITY GROUP 5

This windbreak group consists of deep, nearly level to sloping soils that formed in recent alluvium. These soils are on flood plains and are subject to flooding. Except for Clairemont soils, they have loamy and sandy underlying layers. A fluctuating water table is at a depth of 2 to 6 feet. The water table and flood water provide extra water for growth of trees. The flooding hazard and the sand-choked channels are limitations to cultivation and to the use of equipment.

WINDBREAK SUITABILITY GROUP 6

This windbreak group consists of deep, nearly level, well drained to somewhat poorly drained, loamy soils that are affected by salts. These soils are on flood plains and stream terraces. They have moderate or very slow permeability and high available water capacity. The growth of roots is slowed by moderate to high salinity in the root zone. Surface crusting affects the establishment and growth of seedlings. Flooding is a limitation to cultivation and use of equipment.

WINDBREAK SUITABILITY GROUP 7

This windbreak group consists of deep, nearly level, gently sloping and sloping, well-drained, calcareous, loamy soils. These soils have moderate permeability and high available water capacity. They have medium or high natural fertility. The growth of roots is affected by highly calcareous layers in some places.

WINDBREAK SUITABILITY GROUP 8

This windbreak group consists of deep, nearly level, well-drained, loamy soils. They have moderate or high available water capacity and allow uniform growth of roots to a depth of more than 4 feet. These soils are subject to occasional flooding, which supplies moisture for tree growth.

Wildlife[7]

Table 8 gives the suitability ratings, by soil series, for elements of wildlife habitat and kinds of wildlife. These ratings are useful in planning, developing, and managing areas for wildlife. If the properties of the

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

suitable for windbreaks

to windbreaks without special management practices are the Breaks part of Breaks-Clairemont complex; Kanza soils; Rough broken outcrop part of Vernon-Shale outcrop complex]

Windbreak suitability group—Continued									
4		5		6		7		8	
Suitability	Height	Suitability	Height	Suitability	Height	Suitability	Height	Suitability	Height
	Feet		*Feet*		*Feet*		*Feet*		*Feet*
Good	----------	Poor	----------	Poor	----------	Poor	----------	Good	----------
Fair	15–22	Excellent	23–28	Poor	----------	Good	15–20	Good	20–25
Good	20–28	Good	25–35	Poor	----------	Poor	----------	Excellent	25–32
Good	33–42	Excellent	47–53	Poor	----------	Poor	----------	Excellent	45–50
Excellent	18–22	Excellent	20–26	Fair	8–12	Good	22–28	Excellent	22–30
Good	15–23	Good	16–25	Poor	----------	Poor	----------	Good	24–30
Poor	----------	Good	28–34	Poor	----------	Good	15–20	Excellent	24–30
Good	24–30	Good	25–35	Poor	----------	Fair	15–20	Good	26–32
Good	22–26	Good	24–30	Poor	----------	Fair	12–18	Good	24–30
Fair	10–15	Excellent	18–24	Poor	----------	Good	16–22	Excellent	18–24
Good	22–28	Excellent	26–33	Poor	----------	Good	19–25	Good	22–28
Fair	14–17	Good	15–19	Poor	----------	Fair	15–19	Good	18–22
Fair	22–30	Excellent	44–52	Poor	----------	Good	33–42	Excellent	42–48
Poor	----------	Fair	----------	Good	----------	Poor	----------	Poor	----------

TABLE 8.—

Soil series and map symbols	Elements of wildlife habitat			
	Grain and seed crops	Domestic grasses and legumes	Wild herbaceous plants	Hardwood trees
Albion: Ad, Ae	Fair	Good	Fair	Poor
For ratings of Shellabarger part of these units, see that series.				
Alluvial land: As	Poor	Poor	Poor	Very poor
Attica: At	Fair	Good	Good	Very poor
Blanket: Ba, Bb, Bc	Good	Good	Good	Very poor
Breaks: Bf	Very poor	Very poor	Fair	Very poor
For ratings of Clairemont part, see that series.				
Canadian: Ca	Good	Good	Good	Fair
Case: Cc	Fair	Good	Good	Very poor
For ratings of Clark part, see that series.				
Clairemont:				
Cd, Clairemont part of Bf	Good	Good	Fair	Fair
Cf	Poor	Poor	Poor	Fair
Clark: Ck	Fair	Good	Good	Very poor
Farnum: Fa, Fm, Fr, Fu	Good	Good	Good	Very poor
Grant: Ga, Gb, Gc	Good	Good	Good	Very poor
Kanza: Ka	Very poor	Poor	Good	Fair
Kingfisher: Kf, Kv, Kz	Good	Good	Good	Very poor
For ratings of Vernon part of Kv and Kz, see that series.				
Lincoln: Ln	Poor	Poor	Fair	Fair
Mangum: Ma, Mg	Fair	Fair	Good	Good
For ratings of Slickspots part of Mg, see Slickspots.				
Minco: Mn	Good	Good	Good	Very poor
Naron: Na, Nb	Good	Good	Good	Very poor
Ost: Os, Ot	Good	Good	Good	Very poor
Pond Creek: Pa, Pd	Good	Good	Good	Very poor
Port: Ph, Pk	Good	Good	Good	Fair
For ratings of Slickspots part of Pk, see Slickspots.				
Pratt: Ps, Pt	Fair	Good	Good	Very poor
For ratings of Tivoli part of Pt, see that series.				
Quinlan: Qn, Qw	Fair	Fair	Fair	Very poor
For ratings of Woodward part of Qw, see that series.				
Rough broken land, shaly: Rb	Very poor	Very poor	Poor	Very poor
Shellabarger: Sb, Sc	Fair	Good	Good	Very poor
Slickspots	Poor	Poor	Poor	Very poor
Tivoli: Tv	Very poor	Very poor	Fair	Very poor
Vernon:				
Vn, Vr, Vernon part of Kv and Kz	Fair	Good	Fair	Very poor
Vs	Very poor	Very poor	Poor	Very poor
Waldeck: Wa	Fair	Fair	Good	Good
Woodward: Wo, Ws	Fair	Good	Good	Very poor
For ratings of Quinlan part, see that series.				
Yahola: Ya	Good	Good	Good	Good
Zenda: Ze	Good	Good	Fair	Good

soils are known, the soil, water, and plants can be manipulated to produce a suitable habitat and to maintain and improve the wildlife population. Onsite investigation is also needed to determine land use, existing wildlife population, composition of various kinds of cover, and other factors.

Although annihilated in the late 1920's, antelope, or pronghorns, were historically part of the fauna of Barber County. They have been reintroduced in recent years. They were originally released within the Vernon-Kingfisher soil association, but they have since dispersed into the other soil associations.

Bobwhite quail, Rio Grande turkey, and white-tailed deer inhabit the county in generous numbers. They live mainly within the Lincoln-Yahola soil association, where rookeries of the great blue heron are also found.

Wildlife habitat

Elements of wildlife habitat—Continued				Kinds of wildlife		
Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland	Wetland	Range
Poor	Fair	Very poor	Very poor	Fair	Very poor	Good.
Very poor	Fair	Fair	Fair	Very poor	Fair	Poor.
Good	Good	Very poor	Very poor	Fair	Very poor	Good.
Good	Good	Very poor	Very poor	Fair	Very poor	Good.
Very poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
Good	Good	Very poor	Very poor	Good	Very poor	Good.
Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Good	Good	Poor	Very poor	Fair	Very poor	Fair.
Fair	Fair	Very poor	Good	Poor	Poor	Poor.
Good	Good	Very poor	Very poor	Fair	Very poor	Good.
Good	Good	Very poor	Very poor	Fair	Very poor	Good.
Good	Good	Very poor	Very poor	Fair	Very poor	Good.
Fair	Fair	Good	Good	Very poor	Good	Fair.
Good	Good	Very poor	Very poor	Fair	Very poor	Good.
Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Good	Good	Good	Good	Fair	Good	Fair.
Good	Good	Very poor	Very poor	Fair	Very poor	Good.
Good	Good	Very poor	Very poor	Fair	Very poor	Good.
Good	Good	Very poor	Very poor	Fair	Very poor	Good.
Good	Good	Very poor	Very poor	Fair	Very poor	Good.
Good	Good	Very poor	Very poor	Good	Very poor	Good.
Good	Good	Very poor	Very poor	Fair	Very poor	Good.
Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
Good	Good	Very poor	Very poor	Fair	Very poor	Good.
Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
Good	Good	Fair	Poor	Fair	Poor	Good.
Good	Good	Very poor	Very poor	Fair	Very poor	Good.
Good	Good	Poor	Very poor	Good	Very poor	Good.
Good	Good	Poor	Fair	Fair	Poor	Fair.

Among other animals inhabiting this area are beaver, mink, raccoon, and opossum. Although not so common as the white-tailed deer, mule deer are found throughout the county.

The major fishing streams in Barber County are Medicine River, Elm Creek, Salt Fork Arkansas River, Little Sandy Creek, Big Sandy Creek, Turkey Creek, and Mule Creek. Barber County State Lake, which is just north of the city limits of Medicine Lodge, also provides public fishing. Numerous farm ponds, scattered throughout the county, are used for fishing as well as for livestock. Several other privately owned, spring-fed lakes provide excellent fishing, which may be available by membership, by permit, or by payment of a fee. The fish are mainly channel catfish, flathead catfish, large mouth black bass, bluegill, other sunfish, bullhead, and carp.

In table 8, openland wildlife means birds and mammals that inhabit areas where crops, pasture, meadow, and lawns are grown and areas that are overgrown with grasses, herbs, shrubs, and vines. Among these are bobwhite quail, pheasant, meadowlark, field sparrow, killdeer, cottontail rabbit, red fox, and woodchuck.

Wetland wildlife are birds and mammals that inhabit swamps, marshes, or areas of open water. Among them are ducks, geese, herons, shorebirds, rails, kingfishers, muskrats, and beavers.

Range wildlife are birds and mammals that inhabit natural range. Among them are antelope, mule deer, bison, lesser prairie chicken, coyote, badger, jackrabbit, prairie dog, and lark bunting.

Recreation [8]

Barber County is served by two major highways. U.S. Highway 281 transects the county in a north-south direction, and U.S. Highway 160 transects the county in an east-west direction.

Medicine Lodge is the county seat. A pageant is held there every 3 to 5 years commemorating the signing of the 1867 peace treaty between the five Great Plains Indian tribes and the U.S. Government. This pageant is held outdoors in a natural red-rock amphitheater with a stage setting of 400 acres.

Barber County is noted for its rugged scenery west of Medicine Lodge. Rough, broken hills that have mesas and deep canyons stretch out for 19 miles along U.S. Highway 160. Cedar trees contrast with the red soils and colorful native grasses and wild flowers. Antelope have been reintroduced in this area, and occasionally can be seen from the highway.

Other recreation sites include the 55-acre Barber County State Lake; Lake Arrowhead, a 90-acre lake bounded by private homesites; Ninety-Nine Springs Club, Inc., a 25-acre spring-fed lake surrounded by cabin sites; Rainbow Lake, a privately owned area of cabin sites; and West Sand Creek area, site of 12 spring-fed ponds. Wild turkeys are often seen near these areas as well as along the major streams of the county.

Excellent opportunities exist within the county for further recreation development.

Knowledge of soils is necessary in planning, developing, and maintaining areas used for recreation. Table 9 gives the limitations to the use of the soils in Barber County for camp areas, picnic areas, playgrounds, and paths and trails.

In table 9 the degrees of limitations are expressed as slight, moderate, or severe for the specified uses. For all of these degrees of limitations, it is assumed that a good plant cover can be established and maintained. *Slight* means that soil properties are generally favorable and limitations are so minor that they easily can be overcome. *Moderate* means that the limitation can be overcome or modified by planning, by design, or by special maintenance. *Severe* means that costly soil reclamation, special design, or intensive 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 rains but not dusty when dry.

Picnic 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; do not have slopes or stoniness that greatly increase 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 rains 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 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 not 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

In the following pages the factors of soil formation, the current system of soil classification, and the placement of the soil series into higher categories are discussed.

Factors of Soil Formation

Soil is produced by the action of soil-forming processes on materials deposited or altered by geologic forces. The factors that determine the kind of soil that forms at any given point are the physical and mineralogical composition of the parent material; the climate under which the soil material accumulated; the plants and animals in and on the soil; the relief or lay of the land; and the length of time the processes of soil formation have acted on the soil material.

The climate and plants and animals, mainly plants, are the active factors that have a combined effect on soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body of soil having genetically related horizons. The soil layers thus formed are called the soil profile. The effect of climate, plants, and animals on the formation of soil horizons is conditioned by relief. The parent material also affects the kind of soil profile that is formed and in some places may be the dominant factor. For example, Quinlan soils have weakly formed horizons and are shallow to soft, fine-grained sandstone.

The factors of soil genesis are so closely interrelated

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

TABLE 9.—*Interpretations for recreational development*

[Texture refers to texture of the surface layer. For example, "sandy texture" means a "sandy surface layer"]

Soil series and map symbols	Degree of limitation and soil features that affect suitability for—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
Albion: Ad, Ae For Shellabarger part, see that series.	Slight if slope is 2 to 8 percent. Moderate if 8 to 15 percent.	Slight if slope is 2 to 8 percent. Moderate if 8 to 15 percent.	Moderate if slope is 2 to 6 percent. Severe if 6 to 15 percent.	Slight.
Alluvial land, saline: As	Severe: flooding	Severe: flooding	Severe: flooding	Severe: flooding.
Attica: At	Moderate: sandy texture.	Moderate: sandy texture.	Moderate: sandy texture; slope is 2 to 5 percent.	Moderate: sandy texture.
Blanket: Ba, Bb, Bc	Slight	Slight	Slight if slope is less than 2 percent. Moderate if more than 2 percent.	Slight.
Breaks: Bf For Clairemont part, see that series.	Moderate if slope is 8 to 15 percent. Severe if more than 15 percent.	Moderate if slope is 8 to 15 percent. Severe if more than 15 percent.	Severe if slope is more than 6 percent.	Slight if slope is 8 to 15 percent. Moderate if 15 to 25 percent. Severe if more than 25 percent.
Canadian: Ca	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.
Case: Cc For Clark part, see that series.	Moderate: loamy texture.	Moderate: loamy texture.	Moderate: loamy texture; slope is 3 to 6 percent.	Moderate: loamy texture.
Clairemont: Cd Cf	Severe: flooding	Moderate: flooding	Severe: flooding	Moderate: flooding.
Clark: Ck	Moderate: loamy texture.	Moderate: loamy texture.	Moderate: loamy texture.	Moderate: loamy texture.
Farnum: Fa, Fm, Fr, Fu	Slight	Slight	Slight	Slight.
Grant: Ga, Gb, Gc	Slight	Slight	Slight if slope is 0 to 2 percent. Moderate if 2 to 6 percent.	Slight.
Kanza: Ka	Severe: flooding; wetness.	Severe: flooding; wetness.	Severe: flooding; wetness.	Severe: flooding; wetness.
Kingfisher: Kf, Kv, Kz For Vernon part of Kz, see that series.	Slight	Slight	Slight if slope is 0 to 2 percent. Moderate if 2 to 6 percent.	Slight.
Lincoln: Ln	Severe: flooding	Severe: flooding	Severe: flooding	Severe: flooding.
Mangum: Ma, Mg	Severe: flooding and texture.	Severe: flooding and texture.	Severe: flooding and texture.	Severe: flooding and texture.
Minco: Mn	Slight	Slight	Slight	Slight.
Naron: Na, Nb	Slight	Slight	Slight if slope is 0 to 2 percent. Moderate if 2 to 3 percent.	Slight.
Ost: Os, Ot	Moderate: loamy texture.	Moderate: loamy texture.	Moderate: loamy texture.	Moderate: loamy texture.

TABLE 9.—*Interpretations for recreational development*—Continued

Soil series and map symbols	Degree of limitation and soil features that affect suitability for—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
Pond Creek: Pa, Pd	Slight	Slight	Slight if slope is 0 to 2 percent. Moderate if 2 to 3 percent.	Slight.
Port: Ph, Pk	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.
Pratt: Ps, Pt	Moderate: sandy texture.	Moderate: sandy texture.	Moderate: sandy texture; slope is 5 to 6 percent. Severe if 6 to 12 percent.	Moderate: sandy texture.
Quinlan: Qn, Qw For Woodward part of Qw, see that series.	Slight if slope is 0 to 8 percent. Moderate if 8 to 15 percent.	Slight if slope is 0 to 8 percent. Moderate if 8 to 15 percent.	Slight if slope is 0 to 2 percent. Moderate if 2 to 6 percent. Severe if 6 to 15 percent.	Slight.
Rough broken land, shaly: Rb.	Severe if slope is more than 15 percent.	Severe if slope is more than 15 percent.	Severe if slope is more than 6 percent.	Moderate if slope is 15 to 25 percent. Severe if more than 25 percent.
Shellabarger: Sb, Sc	Slight if slope is 2 to 8 percent. Moderate if 8 to 12 percent.	Slight if slope is 2 to 8 percent. Moderate if 8 to 12 percent.	Slight if slope is 0 to 2 percent. Moderate if 2 to 6 percent. Severe if 6 to 12 percent.	Slight.
Tivoli: Tv	Moderate: sandy texture; slope is more than 15 percent. Severe: sandy texture; slope is 15 to 20 percent.	Moderate: sandy texture; slope is more than 15 percent. Severe: sandy texture; slope is 15 to 20 percent.	Severe: slope; sandy texture.	Moderate: sandy texture.
Vernon: Vn, Vr, Vs	Moderate: very slow permeability.	Moderate: loamy texture.	Moderate: very slow permeability; slope is 3 to 6 percent. Severe if slope is 6 to 15 percent.	Moderate: loamy texture.
Waldeck: Wa	Severe: wetness and flooding.	Moderate: wetness and flooding.	Moderate: wetness and flooding.	Moderate: wetness and flooding.
Woodward: Wo, Ws For the Quinlan part, see that series.	Slight if slope is 0 to 8 percent. Moderate if 8 to 12 percent.	Slight if slope is 0 to 8 percent. Moderate if 8 to 12 percent.	Slight if slope is 0 to 2 percent. Moderate if 2 to 6 percent. Severe if 6 to 12 percent.	Slight.
Yahola: Ya	Severe: flooding	Moderate: flooding	Severe: flooding	Slight.
Zenda: Ze	Severe: flooding; wetness.	Moderate: flooding	Moderate: flooding	Moderate: loamy texture; wetness.

in their effect on soil formation that few generalizations can be made of any one, unless conditions are specified for the other four. any of the processes of soil formation are not known.

Parent material

Parent material consists of weathered rocks or partly weathered material in which soils are formed. Weathering of rocks takes place through the processes of freezing and thawing, abrasion and soil blowing, water and glaciers acting on the soil, and chemistry.

In Barber County the soils formed in materials weathered from sediments of Pleistocene and Pliocene age, shale, soft sandstone, and recent alluvium, of Upper Permian age and remnants of sandstone and shale of Cretaceous age.

Among the sediments of Pleistocene and Pliocene age are those of loess caps and old alluvium. These are sediments along the northern county line, on ridgetops in

the western part of the county, and in valley fill along the Medicine River Valley. The Blanket, Attica, Case, Clark, Farnum, Minco, Naron, Ost, Pratt, Shellabarger, and Tivoli soils formed in materials weathered from these sediments. Blanket, Farnum, Naron, Ost, and Shellabarger soils are among those that formed in material weathered from loess and old alluvium. Case and Clark soils formed in material weathered from calcareous, old alluvial sediments, probably the Ogallala Formation. Underlying layers of Ost soils also weathered from calcareous old alluvium. Attica, Pratt, and Tivoli soils formed in coarser textured, wind-reworked, old alluvial material. Minco soils formed in material weathered from more silty, eolian sediment.

The shale, soft sandstone, siltstone, and loess-like sediments of Upper Permian age or the alluvial sediments derived from them are the dominant parent materials in Barber County. These materials occur throughout the southern half, central, western, and northwestern parts of the county. Grant, Kingfisher, Pond Creek, Quinlan, Vernon, and Woodward soils formed in materials weathered from redbeds and the mixed loess and old alluvial sediments derived from them. Grant, Pond Creek, and other soils formed in materials weathered from loess, old alluvium, or deeply weathered bedrock. Kingfisher soils formed in material weathered from thin loess caps and deeply weathered clay shale, mainly the Flowerpot Shale. Quinlan and Woodward soils formed in materials weathered from soft sandstone and siltstone, mainly the Cedar Hills Sandstone and the Salt Plains Siltstone. Some small areas of these soils formed in materials weathered from Whitehorse Sandstone, which occurs along ridges and side slopes in the western part of the county.

Generally, bedrock made up of Cedar Hills Sandstone and Salt Plains Siltstone underlies the Grant, Pond Creek, Quinlan, and Woodward soils that are east of a line from Hardtner to Medicine Lodge.

Vernon soils formed in materials weathered from Dog Creek Shale, which occurs as small areas, and Flowerpot Shale, which occurs as broad areas. These soils are west of a line from Hardtner to Medicine Lodge. Flowerpot Shale, named for Flowerpot Mound, southwest of Medicine Lodge (*7*), is soft, red and gypsiferous. It is the lowermost formation that crops out in the Sun City area. It ranges from 170 to 190 feet in thickness; near Pioneer Mine only the upper 145 feet is exposed. The shale is underlain by Cedar Hills Sandstone, which is not exposed in this area (*7*).

Recent alluvium is the parent material of all soils that formed on the flood plains and stream terraces along the major streams in the county. This material ranges from sand and loamy sand to clay in the slackwater areas. Canadian, Port, and Zenda soils formed in the material on stream terraces. Clairemont, Kanza, Lincoln, Mangum, Waldeck, and Yahola soils formed in the material on flood plains. Canadian, Kanza, and Lincoln soils formed in coarser-textured materials than Clairemont, Port, Waldeck, Yahola, and Zenda soils that formed in loamy materials and Mangum soils that formed in finer-textured material.

Small areas of the Cheyenne Sandstone of the Cretaceous system are in the extreme northwestern part of the county and on some ridgetops southwest of Sun City near the Comanche County line.

Climate

Climate influences both physical and chemical weathering processes as well as the biological forces at work in the parent material. The downward movement of water is a major factor in transforming the parent material into a soil that has distinct horizons. The amount of water that percolates through the soil depends on temperature, type and intensity of precipitation and humidity, relief, and the kind of soil material. Soil-forming processes are most active when the soil is warm and moist. In Barber County these processes are most active during the warmer months. Soil structure is modified by freezing and thawing and by wetting and drying. The freezing and thawing of clay tend to form aggregates in soils. Alternate wetting and drying is active in the subhumid climate of the county.

Climate is an important factor in causing differences in soils over a wide region, but differences in soils as a result of climate in a small area, such as Barber County, are slight.

In Barber County rainfall is sufficient to leach most soils of the uplands. Yearly rainfall is about 3 inches less in the western and northwestern parts of the county than in the eastern part. The amount of rainfall has had little effect on the kind of soils that formed, but it does have some effect on dryland crop production.

Wind velocity in the county is fairly high. The winds have affected soil formation by sorting and moving soil material. For example, the sandy soils that formed near Isabel and along the Medicine River are the result of wind action. Attica, Pratt, and Tivoli soils formed in wind-deposited materials.

Plants and animals

Plants and animals have an important effect on the formation of soils. Some of the major functions of plants and animals in the forming of soils is to furnish, transform, and decompose organic matter, mix the soil materials, use and release nutrients, and help weather rocks.

Many kinds of plants and animals are necessary to soil formation. Plants add organic matter to the soil and thus affect the physical, chemical, and biological processes. For example, organic matter added to the soil when temperature and moisture are optimum is food for organisms. These organisms increase in number, transform chemically vast amounts of soil material, and affect the soil material physically. Plants and animals in and on the soil result in soil that is more permeable to water, promotes leaching, and has improved structure. Burrowing animals, insects, and earthworms mix and move large quantities of soil material and in many places bring fresh mineral materials into the surface horizon.

The soils of Barber County formed chiefly under both tall and midgrasses. These grasses add large amounts of organic matter, and thus over a period of time, the surface layer is darkened and the soil structure is formed.

Relief

Relief affects soil formation through its effect on drainage, runoff, erosion, and soil temperature. Through its effect on soil moisture and soil temperature,

relief also affects the kinds of plants and animals that live on and in the soil. In the more sloping areas where runoff is rapid, the soil material is likely to be washed away before well-defined horizons can be formed. In the nearly level or depressional areas, erosion is slight. In these areas where the soil receives extra water as runoff, it is deep and has well-defined horizons.

Barber County has five main kinds of relief—nearly level, gently sloping, sloping plains; rolling hills; small hilly dunes; moderately steep dissected areas; and steep, rough broken land. The soils generally are well developed in the plains areas of the county. They are less well developed in areas of rolling hills, and are least developed in hilly, dissected, and rough broken areas. Examples of well developed soils are Blanket, Farnum, Grant, Kingfisher, Naron, and Pond Creek soils. Less well developed soils are Albion, Attica, and Pratt soils. Soils that are least developed are Tivoli soils in hill areas and Vernon soils in moderately steep, dissected areas.

Many of the soils are in areas of more than one kind of relief, but some occur only in an area that has one kind of relief. For example, Tivoli soils are only on hilly dunes. Shellabarger soils generally are in nearly level, gently sloping, or sloping plains but may also be in areas of rolling hills.

Time

Time is needed for soils to form from parent materials. Some soils form rapidly and others form slowly. The length of time needed depends largely on the other factors of soil formation. Formation of horizons in a soil is related to time. As water moves downward in the soil, soluble matter and fine particles are leached from the surface layer and deposited in the subsoil. How long this process takes depends chiefly on how long the soil material has been in place, the nature of the soil material, and how much water can penetrate and move downward through the soil. Usually, a long time is required for the formation of distinct horizons.

Some of the soils, such as Tivoli soils, lack horizon development because the soil material in which they formed is highly resistant to weathering. Other soils, such as Port soils, formed in recent alluvium but have had little time to form distinct genetic horizons. Shellabarger soils formed in materials weathered from old alluvium. They have been exposed to soil-forming processes for thousands of years and have distinct horizons. These soils are old or mature soils.

Classification of the Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us 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 (*9*, *11*).

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

In table 10, the soil series of Barber 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 Alfisols, Aridisols, Estisols, Histosols, Inceptisols, Mollisols, Oxidols, Spodosols, Ultisols, and Vertisols. The properties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. The two exceptions, Entisols and Histosols, are in many different climates.

Alfisols are mineral soils that contain horizons of clay accumulation. The surface horizons, among other properties, have light color, high chroma, low organic matter; are too thin to qualify as other horizons; or they are both hard and massive when dry. The base saturation of the lower horizons is moderate to high.

Entisols are mineral soils that recently formed. They have little or no evidence of genetic horizons, and they do not have features that reflect soil mixing caused by shrinking and swelling.

Inceptisols are mineral soils that have weakly expressed genetic horizons. The surface horizons generally have light color but they do not have features that reflect soil mixing caused by shrinking and swelling.

Mollisols are mineral soils that have thick, dark colored, surface horizons containing colloids dominated by bivalent cations. They do not have features that reflect soil mixing caused by shrinking and swelling.

SUBORDER. Each order is subdivided into suborders that are based primarily on those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the order. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging, or soil differences resulting from the climate or vegetation. The names of suborders have two syllables. The last syllable indicates the order. An example is *Aquent* (*Aqu*, meaning water or wet, and *ent*, from Entisol).

GREAT GROUP. Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated; those that have pans that interfere with growth of roots, movement of water, or both; and thick, dark-colored surface horizons. The features used are the self-mulching properties of clay, soil temperature, major differences in chemical

TABLE 10.—*Classification of soil series*

Series	Family	Subgroup	Order
Albion	Coarse-loamy, mixed, thermic	Udic Argiustolls	Mollisols.
Attica	Coarse-loamy, mixed, thermic	Udic Haplustalfs	Alfisols.
Blanket	Fine, mixed, thermic	Pachic Argiustolls	Mollisols.
Canadian	Coarse-loamy, mixed, thermic	Udic Haplustolls	Mollisols.
Case	Fine-loamy, mixed, thermic	Typic Ustochrepts	Inceptisols.
Clairemont	Fine-silty, mixed (calcareous) thermic	Typic Ustifluvents	Entisols.
Clark	Fine-loamy, mixed, thermic	Typic Calciustolls	Mollisols.
Farnum	Fine-loamy, mixed, thermic	Pachic Argiustolls	Mollisols.
Grant	Fine-silty, mixed, thermic	Udic Argiustolls	Mollisols.
Kanza	Mixed, thermic	Mollic Psammaquents	Entisols.
Kingfisher	Fine-silty, mixed, thermic	Udic Argiustolls	Mollisols.
Lincoln	Sandy, mixed, thermic	Typic Ustifluvents	Entisols.
Mangum	Fine, mixed (calcareous) thermic	Vertic Ustifluvents	Entisols.
Minco	Coarse-silty, mixed, thermic	Udic Haplustolls	Mollisols.
Naron	Fine-loamy, mixed, thermic	Udic Argiustolls	Mollisols.
Ost	Fine-loamy, mixed, thermic	Typic Argiustolls	Mollisols.
Pond Creek	Fine-silty, mixed, thermic	Pachic Argiustolls	Mollisols.
Port	Fine-silty, mixed, thermic	Cumulic Haplustolls	Mollisols.
Pratt	Sandy, mixed, thermic	Psammentic Haplustalfs	Alfisols.
Quinlan	Loamy, mixed, thermic, shallow	Typic Ustochrepts	Inceptisols.
Shellabarger	Fine-loamy, mixed, thermic	Udic Argiustolls	Mollisols.
Tivoli	Mixed, thermic	Typic Ustipsamments	Entisols.
Vernon	Fine, mixed, thermic	Typic Ustochrepts	Inceptisols.
Waldeck	Coarse-loamy, mixed, thermic	Fluvaquentic Haplustolls	Mollisols.
Woodward	Coarse-silty, mixed, thermic	Typic Ustochrepts	Inceptisols.
Yahola	Coarse-loamy, mixed (calcareous) thermic	Typic Ustifluvents	Entisols.
Zenda	Fine-loamy, mixed, thermic	Fluvaquentic Haplustolls	Mollisols.

composition (mainly calcium, magnesium, sodium, and potassium), dark-red and dark-brown colors associated with basic rocks, and the like. The names of great groups have three or four syllables and are made by adding a prefix to the name of the suborder. An example is Haplaquents (*Hapl,* meaning simple horizons, *aqu* for wetness or water, and *ent,* from Entisols).

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

FAMILY. Soil families are separated within a subgroup primarily on the basis of properties important to the growth of plants or on the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reactions, soil temperature, permeability, thickness of horizons, and consistence. A family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names for texture, mineralogy, and so on, that are used to differentiate families.

General Facts About the County

Barber County was organized in 1873. It was named in honor of Thomas W. Barber. In the winter of 1871–72, the first settlers in the county established a ranch near the site of Sun City (*5*). During 1872 and 1873 many other settlers came (*13*). In 1873 Medicine Lodge was laid out and was named for the Medicine River which was named by the Indians (*5*). In 1886, the Santa Fe railroad reached Medicine Lodge, and in 1907, a branch line was built to the Pioneer gypsum mine southwest of Sun City (*13*).

Development of irrigation was slow in the county. For example, irrigation with water from a drilled well was begun on a farm in Sharon Valley in 1920 but was discontinued after 1 year. Starting in 1935 a gravity system was established, on Port silt loam, that used water from the Medicine River. In 1937 a sprinkler system, using water from a drilled well, was used to irrigate alfalfa and sorghum. Currently the major source of irrigation water is wells, and water from the Medicine River is not used. Sprinkler and gravity systems of irrigation are used.

According to the U.S. Census of Agriculture, in 1969 there were 618 farms in Barber County. The average size of a farm was 1,167 acres. About 87 percent of the farms harvested dryland crops and only 2 percent of the farms harvested irrigated crops. About 23 percent of the farms harvesting dryland crops were smaller than 260 acres.

Of the 618 farm operators, 204 were full owners; 243 were part owners; and 171 were tenants. The tenants commonly rent land on a crop-share basis. The landlord usually gets one-third of the crop.

Most of the farm machinery is powered by internal combustion engines. Some stationary installations are powered by electric motors. Crops are harvested by combines. The machinery used for cultivating, planting, and some harvesting is owned by the operator, but the combine is generally not owned by the farmer. Farm labor is adequate locally for planting and tillage opera-

tions. At harvest time, additional labor commonly is required and is furnished by custom operators.

Crops—Winter wheat and sorghum make up more than 90 percent of the total acreage of cultivated crops harvested in the county. Nearly all the cultivated crops are dryland and are grown year after year. Less than 10 percent of the cultivated acreage is fallow land in preparation for winter wheat each year.

In the 1970–71 crop year, according to the Kansas State Board of Agriculture (*6*), winter wheat was harvested from 102,000 acres. Sorghum harvested for grain was 18,500 acres; sorghum for forage and silage was harvested from 14,800 acres; corn from 590 acres; and oats, barley and rye from 9,010 acres. Alfalfa was harvested from 8,300 acres, and all hay harvested accounted for 11,100 acres.

According to the December, 1969, Conservation Needs Inventory, 255,203 acres are used for crops, and 445,468 acres are used for range. Naturally wooded, narrow drainageways and other land areas, such as farmsteads, account for 9,043 acres. The remaining 23,726 acres is federal non-crops, urban, and built–up land, and small water areas. On the basis of these figures, 61 percent of the county is used for grassland; 35 percent is used for crops; 3 percent is used for such purposes as roads, railroads, towns and airports as well as small areas of water; and 1 percent is used for wooded drainageways, and farmsteads, and other purposes.

Large ranches of the feeder-stocker or cow-calf type are in Barber County. On some ranches the two types of operations are combined. In addition, many operators pasture wheat in winter to help maintain a livestock operation. In 1970, according to the Kansas State Board of Agriculture, 79,800 cattle, other than milk cows, were reported in the county. Also reported were 1,200 milk cows, 1,500 sheep, 4,600 hogs, and 8,000 chickens.

Resources

In the following paragraphs some of the more important resources in Barber County are discussed.

Gypsum–Gypsum is an important resource of the county. In 1889 a gypsum mill was started near Medicine Lodge. During the growth of this industry, three plants were destroyed. One was destroyed by flood, one by tornado in 1907, and one by fire in 1916 (*13*). The same company that purchased the facilities in 1926 continues to operate the mine and the plant.

The gypsum mined near Sun City is obtained from the Medicine Lodge member, Blaine formation, Nippewalla group, in the upper part of the Kansas Permian section of rocks (*7*). Thickness of the deposit ranges from 10 to 30 feet, and the maximum thickness is exposed in the (Pioneer) mine, (*7*). The quality of this gypsum is superior. Among the many products made from it are Keene's cement, several kinds of plaster, and portland cement retarder.

Water.—Most of Barber County lacks a suitable ground-water supply. Wells, ponds, springs, and a few continuously running streams are the principal sources of water in the county. Water wells are an uncertain source of water in most upland areas, except in the northeastern corner, in the vicinity of Isabel, and along the northern border of the county. Good water wells are also in Elm Creek Valley, Medicine River Valley, and in old alluvium in a nearly level upland area between Medicine Lodge and Sharon. Good springs also are along the upper tributaries of Elm Creek and along Turkey Creek. The Salt Fork Arkansas River Valley furnishes a sufficient quantity of water from wells, but water quality in several places is questionable for use by livestock and for irrigation. More than 3,000 ponds have been constructed in the county for livestock water. Several farm houses have cisterns for home use, and a small number haul water from the city of Medicine Lodge.

Oil and gas.—Major oilfields and gasfields are scattered throughout the county, except in the southeastern part near Kiowa and in the northeastern part near Isabel. These fields have been developed over the years, and new discoveries continue. For example, during 1919, the first oil well was drilled in the western part of the county but without success. In March 1927 the first gasfield was discovered 12 miles southwest of Medicine Lodge. In 1934 the oilfield near section 29, T. 31 S., R. 14 W., was discovered (*5*). And oil has been discovered 9 miles south of Medicine Lodge.

Cheyenne sandstone.—Cheyenne Sandstone in the northwestern corner and western edge of the county is suitable for glass making and for foundry sand. Large quantities are available. Some of the deposits in Barber County are in section 7, 8, 15, 17 and 31, T. 30 S., R. 15 W., and section 10, T. 31 S., R., 15 W. The Cheyenne Sandstone is the oldest formation of the Cretaceous System in Kansas (*8*).

Physiography, Relief, and Drainage

The southeastern corner of Barber County is in the Wellington Lowland minor division of the Arkansas River Lowland section of the Central Lowlands physiographic province of the United States (*8*). The extreme northern part of the county is in the High Plains section of the Great Plains province. Most of the county is in the Red Hills minor division of the Dissected High Plains section of the Great Plains province (*8*). In the Red Hills minor division are soils that formed in materials weathered from red beds of Permean age.

In the rougher areas of these redbeds, several cycles of geologic erosion may be observed. These cycles have produced layers of sediment that are veneered with the debris of gypsum rock derived from steep valley sidewalls (*4*). The layers of sediment range from a trace to more than 20 feet in thickness (*4*). Little or no soil has formed on the thinner layers of sediment, but Vernon and Kingfisher soils commonly formed on the thicker layers.

The Medicine River and its tributaries drain most of the county. The Medicine River crosses the county from the northwestern corner to the southeastern corner and makes a slight loop toward the northeast at Medicine Lodge. At this point it is joined by Elm Creek that drains most of the northeastern part of the county. Hackberry Creek, Driftwood Creek, and Little Mule Creek flow southward from the county and drain the southcentral part between the Medicine River and the Salt Fork Arkansas River drainage area. The Salt Fork Arkansas River and its tributaries drain the south-

western corner of the county. Drainage in the county is to the south and east.

The uplands in the county make up about 90 percent of the acreage, and the flood plains and stream terraces make up about 10 percent.

The lowest point in the county is in the southeastern part at an elevation of about 1,260 feet above sea level. The highest point is in the western part of the county at an elevation of about 2,031 feet. This difference in relief is about 771 feet.

Climate[9]

The subhumid continental climate of Barber County is characterized by hot summers, cool to cold winters, large daily and annual temperature variations, considerable sunshine, and moderate to low humidity. Most of the rain falls late in spring and early in summer. Much of the precipitation in Kansas is caused by the collision of warm, moist air from the Gulf of Mexico with cooler air from the north and northwest (*3*). The flow of moist air from the Gulf is more frequent over eastern Kansas than over western Kansas. Annual precipitation in Barber County averages 25 inches.

Table 11 shows temperature and precipitation data, and table 12 shows probabilities of specified low temperatures in spring and fall.

Deficient precipitation is the principal factor limiting the production of agricultural crops in the area. Most of the rainfall occurs during the growing season and this tends to minimize the detrimental effect of the generally inadequate precipitation. More than three-fourths of the annual total falls during the 7-month period, April through October. This distribution, which coincides closely with the freeze-free period, favors the growth of crops and grasses. Winters are dry; precipitation in each month during the period December through February averages less than 1 inch. Rainfall increases markedly during spring, reaching a peak of more than 3½ inches in May and June. After early summer, precipitation declines gradually until it reaches an average of only ½ inch in January.

One of the outstanding features of the climate is the large variability in precipitation from month to month, from season to season, and from year to year. Since 1891 the annual precipitation at Medicine Lodge has ranged from 11.25 inches in 1954 to 42.51 inches in 1923. Periods of dry weather occur at irregular intervals; droughts were very serious in the 1930's and again in the period 1952 to 1956.

Snowfall is light, averaging about 12 inches per year. Heaviest snows usually occur in February or March. As much as 19 inches of snow have been recorded in a month, but more than 12 inches of snow in 30 days is rare. Snowfall remains on the ground only a short time.

There are four distinct seasons and a rapid transition from the cold weather of winter to warm weather of other seasons. The mean monthly temperature is 47° F. in March compared with 58° F. in April. The change is even more noticeable between October, 60½° F., and November, 46½°. Temperature extremes at Medicine Lodge have ranged from 22° below zero to 118° above.

[9] By MERLE J. BROWN, climatologist for Kansas, National Weather Service, U. S. Department of Commerce, Manhattan.

TABLE 11.—*Temperature and precipitation*

[Based on data from Medicine Lodge]

Month	Temperature				Precipitation				
	Average daily maximum[1]	Average daily minimum[1]	Two years in 10 will have about 4 days with—		Average total[1]	One year in 10 will have—		Days with snow cover of 1 inch or more	Average depth of snow on days with snow cover
			Maximum temperature equal to or higher than[2]—	Minimum temperature equal to or lower than[2]—		Less than[1]	More than[1]		
	°F	°F	°F	°F	Inches	Inches	Inches	Number	Inches
January	46.3	20.6	67	5	0.50	0.01	1.29	4	3
February	51.8	24.2	72	9	.87	.08	1.83	2	2
March	61.1	32.2	80	15	1.35	.14	2.79	1	2
April	71.8	43.9	88	31	2.28	.76	4.37	0	0
May	79.9	54.1	94	41	4.01	1.37	7.95	0	0
June	89.5	63.5	102	54	3.61	1.05	7.85	0	0
July	95.2	67.7	106	60	2.85	.74	5.63	0	0
August	94.6	66.4	107	58	2.87	.96	6.68	0	0
September	86.3	58.2	101	44	2.71	.37	5.56	0	0
October	74.9	45.8	91	33	2.14	.30	4.56	0	0
November	60.2	32.3	76	18	1.15	.01	2.94	([3])	2
December	48.4	23.3	68	11	.78	.01	1.89	3	2
Year	71.6	44.4	[4]108	[5]−4	25.12	17.03	34.11	10	2

[1] For the period 1898 to 1970.

[2] For the period 1931 to 1960.

[3] Less than half a day.

[4] Average annual highest temperature.

[5] Average annual lowest temperature.

TABLE 12.—*Probabilities of specified low temperatures in spring and fall*

Probability	Dates for given probability and temperature—				
	16° F or lower	20° F or lower	24° F or lower	28° F or lower	32° F or lower
Spring:					
1 year in 10 later than	March 26	April 1	April 8	April 19	April 30
2 years in 10 later than	March 20	March 26	April 3	April 14	April 25
5 years in 10 later than	March 8	March 16	March 25	April 4	April 15
Fall:					
1 year in 10 earlier than	November 15	November 9	October 30	October 21	October 13
2 years in 10 earlier than	November 21	November 14	November 3	October 26	October 17
5 years in 10 earlier than	December 3	November 25	November 13	November 4	October 27

Daily and annual temperature variations are large, because of the land-controlled climate and the dry atmospheric air. The dry air allows rapid warming during periods of sunshine and marked cooling at night. It is not unusual for the daily range to exceed 30°, and diurnal ranges of more than 40° occur at times. Annual extremes of temperature nearly always range from less than 10° to more than 100°. Monthly mean temperatures are about 34° in midwinter, increasing to 81½° in July.

Barber County is in the area of Kansas that has the longest growing season. The freeze-free period averages 6½ months or 195 days and normally extends from mid-April to late October (*2*).

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 storm systems in spring or with thunderstorms in the warmer half of the year. A combination of moderate to strong winds, dry weather, and low humidity may cause a reduction in crop yields in some growing seasons. During such periods, the potential evapotranspiration is quite high and crop plants are unable to obtain enough water to maintain a satisfactory rate of growth.

Tornadoes, hailstorms, or both are reported at times, but these storms are local in extent, of short duration, and produce damage in variable and spotted patterns.

Sunshine is abundant. The percentage of possible sunshine averages 80 in July and averages about 70 for the year.

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Glossary

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

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

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

Base saturation. The degree to which material that has base-exchange properties is saturated with exchangeable cations other than hydrogen, expressed as a percentage of the cation-exchange capacity.

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

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

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

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are——

Loose.—Noncoherent 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.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.
Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.
Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.
Well-drained soils are nearly free from mottling and are commonly of intermediate texture.
Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and mottling in the lower B and the C horizons.
Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.
Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.
Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

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.

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.

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.

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

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.

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 or 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.

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.

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 grain 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.

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."

Thin layer. Suitable soil material is not thick enough for use as borrow material or topsoil.

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.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

☆U.S. GOVERNMENT PRINTING OFFICE: 1977-225-472/31

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. In referring to a capability unit, range site, or windbreak suitability group, read the introduction to the section it is in for general information about its management. Other information is given in tables as follows:

Acreage and extent, table 1, page 10.
Predicted yields, table 2, page 34.
Engineering uses of the soils, tables 3, 4, 5, and 6, pages 42 through 59.
Windbreaks, table 7, pages 60 and 61.
Wildlife, table 8, pages 62 and 63.
Recreational development, table 9, pages 65 and 66.

Map symbol	Mapping unit	Page	Capability unit	Range site		Windbreak suitability group
			Symbol	Name	Page	Number
Ad	Albion-Shellabarger sandy loams, 2 to 4 percent slopes	11	IIIe-2	Sandy	38	--
	Albion	--	------	----------	--	2
	Shellabarger	--	------	----------	--	1
Ae	Albion and Shellabarger soils, 4 to 15 percent slopes	11	VIe-1	Sandy	38	--
	Albion	--	------	----------	--	2
	Shellabarger	--	------	----------	--	1
As	Alluvial land, saline	11	VIs-1	Saline Lowland	38	6
At	Attica loamy fine sand, 1 to 5 percent slopes	12	IIIe-4	Sands	38	4
Ba	Blanket silt loam, 0 to 1 percent slopes	13	IIc-2	Loamy Upland	37	1
Bb	Blanket silt loam, 1 to 3 percent slopes	13	IIe-4	Loamy Upland	37	1
Bc	Blanket silty clay loam, 1 to 3 percent slopes, eroded	13	IIIe-6	Loamy Upland	37	1
Bf	Breaks-Clairemont complex	13	VIe-4	----------	--	--
	Breaks	--	------	Red Shales	37	--
	Clairemont	--	------	Loamy Lowland	36	5
Ca	Canadian fine sandy loam	14	IIe-6	Sandy Terraces	39	8
Cc	Case-Clark clay loams, 2 to 6 percent slopes	14	IVe-5	Limy Upland	36	7
Cd	Clairemont silt loam	15	IIw-1	Loamy Lowland	36	5
Cf	Clairemont soils, channeled	15	VIw-1	Loamy Lowland	36	5
Ck	Clark clay loam, 0 to 2 percent slopes	16	IIIe-5	Limy Upland	36	7
Fa	Farnum fine sandy loam, 0 to 1 percent slopes	16	IIe-5	Sandy	38	1
Fm	Farnum loam, 0 to 1 percent slopes	16	IIc-1	Loamy Upland	37	1
Fr	Farnum loam, 1 to 3 percent slopes	17	IIe-1	Loamy Upland	37	1
Fu	Farnum clay loam, 1 to 3 percent slopes, eroded	17	IIe-2	Loamy Upland	37	1
Ga	Grant silt loam, 0 to 1 percent slopes	17	IIc-1	Loamy Upland	37	1
Gb	Grant silt loam, 1 to 3 percent slopes	18	IIe-1	Loamy Upland	37	1
Gc	Grant silt loam, 3 to 6 percent slopes	18	IIIe-1	Loamy Upland	37	1
Ka	Kanza soils	18	Vw-1	Subirrigated	39	--
Kf	Kingfisher silt loam, 1 to 3 percent slopes	19	IIe-2	Loamy Upland	37	1
Kv	Kingfisher-Vernon complex, 1 to 3 percent slopes	19	IIIe-7	----------	--	--
	Kingfisher	--	------	Loamy Upland	37	1
	Vernon	--	------	Red Clay Prairie	37	3
Kz	Kingfisher-Vernon complex, 3 to 6 percent slopes	19	IVe-2	----------	--	--
	Kingfisher	--	------	Loamy Upland	37	1
	Vernon	--	------	Red Clay Prairie	37	3
Ln	Lincoln soils	20	Vw-2	Sandy Lowland	39	5
Ma	Mangum clay	20	IIIw-1	Clay Lowland	35	5
Mg	Mangum-Slickspots complex	20	IVs-1	----------	--	--
	Mangum	--	------	Clay Lowland	35	5
	Slickspots	--	------	Saline Lowland	38	6
Mn	Minco silt loam, 0 to 2 percent slopes	21	IIe-1	Loamy Upland	37	1
Na	Naron fine sandy loam, 0 to 1 percent slopes	22	IIe-5	Sandy	38	1
Nb	Naron fine sandy loam, 1 to 3 percent slopes	22	IIe-3	Sandy	38	1

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit	Range site		Windbreak suitability group
			Symbol	Name	Page	Number
Os	Ost clay loam, 0 to 1 percent slopes	22	IIc-3	Loamy Upland	37	1
Ot	Ost clay loam, 1 to 3 percent slopes	23	IIe-2	Loamy Upland	37	1
Pa	Pond Creek silt loam, 0 to 1 percent slopes	23	IIc-1	Loamy Upland	37	1
Pd	Pond Creek silt loam, 1 to 3 percent slopes	23	IIe-1	Loamy Upland	37	1
Ph	Port silt loam	24	I-1	Loamy Terrace	36	8
Pk	Port-Slickspots complex	24	IVs-2	----------	--	--
	Port	--	------	Loamy Terrace	36	8
	Slickspots	--	------	Saline Lowland	38	6
Ps	Pratt loamy fine sand, 5 to 10 percent slopes	24	IVe-4	Sands	38	4
Pt	Pratt-Tivoli loamy fine sands, 5 to 15 percent slopes	25	VIe-5	Sands	38	4
Qn	Quinlan loam, 1 to 3 percent slopes	25	IIIe-3	Shallow Prairie	39	2
Qw	Quinlan-Woodward complex, 5 to 15 percent slopes	25	VIe-3	----------	--	--
	Quinlan	--	------	Shallow Prairie	39	2
	Woodward	--	------	Loamy Upland	37	1
Rb	Rough broken land, shaly	25	VIIs-1	Red Shales	37	--
Sb	Shellabarger sandy loam, 3 to 6 percent slopes	26	IIIe-2	Sandy	38	1
Sc	Shellabarger sandy loam, 3 to 6 percent slopes, eroded	26	IVe-3	Sandy	38	1
Tv	Tivoli fine sand, 5 to 20 percent slopes	27	VIIe-1	Choppy Sands	35	--
Vn	Vernon clay loam, 3 to 5 percent slopes	27	IVe-2	Red Clay Prairie	37	3
Vr	Vernon clay loam, 5 to 15 percent slopes	28	VIe-2	Red Clay Prairie	37	3
Vs	Vernon-Shale outcrop complex	28	VIIs-2	----------	--	--
	Vernon	--	------	Red Clay Prairie	37	3
	Shale outcrop	--	------	Eroded Red Clay	36	--
Wa	Waldeck sandy loam	28	IIIw-2	Subirrigated	39	5
Wo	Woodward-Quinlan loams, 0 to 3 percent slopes	29	IIIe-3	----------	--	--
	Woodward	--	------	Loamy Upland	37	1
	Quinlan	--	------	Shallow Prairie	39	2
Ws	Woodward-Quinlan loams, 3 to 6 percent slopes	29	IVe-1	----------	--	--
	Woodward	--	------	Loamy Upland	37	1
	Quinlan	--	------	Shallow Prairie	39	2
Ya	Yahola sandy loam	30	IIw-2	Subirrigated	39	5
Ze	Zenda clay loam	30	IIw-3	Subirrigated	39	5

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