Issued June 1971

SOIL SURVEY

Phillips County, Colorado

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

Major fieldwork for this soil survey was done in the period 1962–64. Soil names and descriptions were approved in 1966. Unless otherwise indicated, statements in this publication refer to conditions in the county in 1964. This survey was made cooperatively by the Soil Conservation Service and the Colorado Agricultural Experiment Station. It is part of the technical assistance furnished to the Haxtun Soil Conservation District.

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, USDA, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

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

Locating Soils

All the soils of Phillips County are shown on the detailed map at the back of this survey. 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 windbreak 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 and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the range sites and windbreak groups.

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

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

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

Community planners and others can read about soil properties that affect the choice of sites for nonindustrial buildings and for recreation areas in the section "Use of Soils for Recreation."

Engineers and builders can find, under "Engineering Uses of 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 Soils."

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

Cover: **Channel terraces on Rago and Kuma loams.**

U.S. GOVERNMENT PRINTING OFFICE: 1971

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

CONTENTS

Issued June 1971

SOIL SURVEY OF PHILLIPS COUNTY, COLORADO

BY JOHN I. BRUBACHER, ALAN E. AMEN, LOUIS A. FLETCHER, EVERETT E. GEIB, AND TOM R. MOORE, SOIL CONSERVATION SERVICE

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

PHILLIPS COUNTY is on the High Plains in the northeastern part of Colorado (fig. 1). The county is about 32 miles from east to west and about 21 miles from north to south. It has a total land area of 680 square miles, or 435,200 acres. Holyoke, the county seat, is near the center of the county.

The soils are mostly nearly level to gently sloping and have a general slope of less than 1 percent to the southeast. The soils in the sandhills are nearly level to steep. Surface drainage is slow, and all streams in the county flow intermittently. The main drainageways in the county are Patent Creek, Wildhorse Creek, Sandy Creek, and Frenchman Creek. Patent Creek terminates in the sandhills. Sandy and Wildhorse Creeks drain into Frenchman Creek, which in turn flows into the Republican River in Hitchcock County, Nebr.

In 1960 the official estimate of the population for Phillips County was 4,440. Holyoke had a population of 1,555; Haxtun, 990; and Paoli, 81. Amherst is an unincorporated village within the county.

In 1964 approximately 6,400 acres was irrigated, and the rest was range and dryfarmed cropland. Small grains, sorghums, alfalfa, and corn are the most important crops. Sugar beets, as well as the major crops, are grown in irrigated areas. Grass is abundant in the sandhills and is used for grazing.

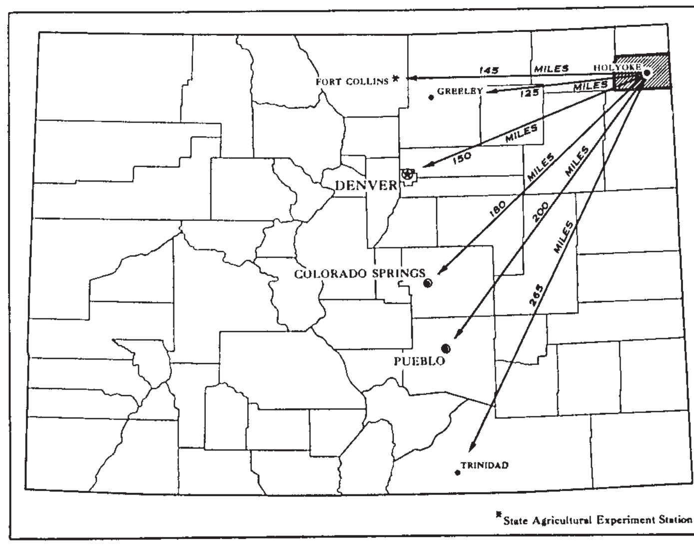

Figure 1.—**Location of Phillips County in Colorado.**

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Phillips County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. As they traveled over the county, 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.

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. Haxtun and Wages, 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 soil 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, Haxtun loamy sand, 0 to 3 percent slopes, is one of several phases within the Haxtun series.

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

Some mapping units are made up of soils of different series, or of different phases within one series. Three such kinds of mapping units are shown on the soil map of Phillips County: soil complexes, soil associations, and undifferentiated groups.

A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Bayard-Canyon complex, 3 to 5 percent slopes, is an example.

A soil association is made up of adjacent soils that occur as areas large enough to be shown individually on the soil map but are shown as one unit because the time and effort of delineating them separately cannot be justified. There is a considerable degree of uniformity in pattern and relative extent of the dominant soils, but the soils may differ greatly one from another. The name of an association consists of the names of the dominant soils, joined by a hyphen. Platner-Eckley association, 3 to 5 percent slopes, is an example.

An undifferentiated soil group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. The name of an undifferentiated group consists of the names of the dominant soils, joined by "and." Chappell and Dix sandy loams, 0 to 3 percent slopes, is an example.

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

The soil scientists set up trial groups of soils on the basis of yield and practice tables and other data they have collected. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. Then they adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map in this survey shows the soil associations in Phillips County (fig. 2). 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 asociation 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 farming or other land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect management.

The three soil associations in Phillips County are described in the following pages.

1. Rago-Platner-Kuma Association

Nearly level to gently sloping soils that have a loam surface layer and clay loam to clay subsoil

This soil association, the most extensive one in the county, consists of broad, nearly level to gently sloping uplands cut by a few shallow drainageways (fig. 3). Small potholes and playas are numerous throughout the association. Because slopes generally are less than 1 percent, runoff is slow. The only areas that have slopes of more than 3 percent are along the intermittent streams and playa lakes. This association extends from the southwestern part of the county through the center and into the eastern and northeastern parts. It is called hardland by farmers and ranchers.

This association covers about 310,000 acres, or nearly 72 percent of the county. About 42 percent is made up of Rago soils, 26 percent of Platner soils, 18 percent of Kuma soils, and 14 percent of minor soils. Playas and small potholes cover less than 1 percent.

The Rago soils typically have a grayish-brown loam surface layer. Their subsoil is dark grayish-brown loam in the upper part. The middle part of the subsoil is clay loam and silty clay loam that is nearly black, especially when moist. Between depths of 23 and 26 inches, the subsoil is lighter in color and contains visible lime in the form of threadlike filaments and small white concretions. The underlying material is very pale-brown loam and silt loam that is highly calcareous.

Platner soils have a grayish-brown loam surface layer. The upper part of the subsoil is dark grayish-brown clay, but the lower part is dark grayish-brown clay loam. The next layer is very pale brown loam that contains visible lime in the form of threadlike filaments and white concretions between depths of 17 and 24 inches. Below this the material is lighter in color, gravelly, and less clayey.

Kuma soils have a slightly less clayey subsoil than the Rago soils but in other respects are similar to those soils. The Rago and Kuma soils are closely intermingled.

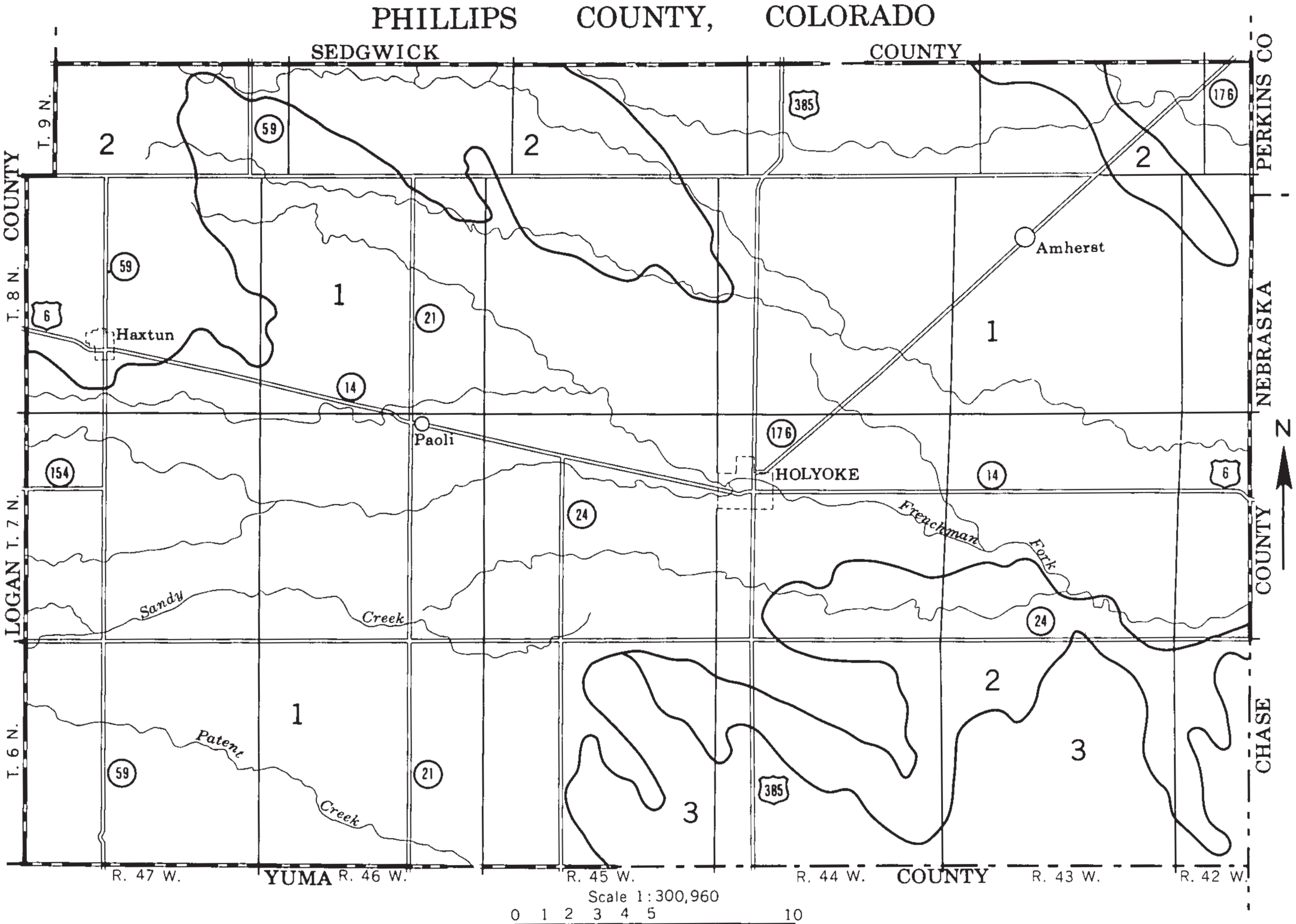

Figure 2.—**General Soil Map, Phillips County, Colorado.**

1. **Rago-Platner-Kuma association: Nearly level to gently sloping soils that have a loam surface layer and clay loam to clay subsoil.**
2. **Haxtun-Julesburg association: Nearly level to gently sloping soils that have a sandy loam or loamy sand surface layer and sandy loam to clay loam subsoil.**
3. **Valentine association: Rolling to hilly soils that are fine sand throughout the profile.**

Minor soils in this association are in the Wages, Eckley, Dix, Campus, Weld, Dawes, Richfield, and Pleasant series. The Wages, Eckley, and Dix soils occur along intermittent streams. The Wages and Eckley soils are on side slopes, and the Dix soils are on terraces. The Campus, Weld, and Dawes soils are in windblown material that was deposited on old land surfaces south of Haxtun and in the northwestern part of the county. The Richfield soils occur on uplands and are nearly level to gently sloping. Most areas are near Amherst in the northeastern part of the county. The Pleasant soils are nearly level to gently sloping and occur on the alluvial fans of major intermittent streams.

The soils in this association are well suited to cultivated crops and are used mostly for winter wheat, though barley and sorghums also are grown. Most farmers use summer fallow. A few small areas that are not cultivated are in grass, mostly blue grama and western wheatgrass, and are grazed. The soils in this association are well suited to irrigation. By the time the survey was completed, nearly 10,000 acres was irrigated.

The major hazards to cultivation are fluctuations in precipitation from year to year and hailstorms. The hazard of water erosion is slight, but stubble-mulch tillage and crop residue should be used to protect these soils from soil blowing. On a few of the more sloping areas, terraces are used for conserving water and reducing erosion.

2. Haxtun-Julesburg Association

Nearly level to gently sloping soils that have a sandy loam or loamy sand surface layer and sandy loam to clay loam subsoil

This association is in nearly level to gently sloping upland areas. It is in three widely separated tracts and is

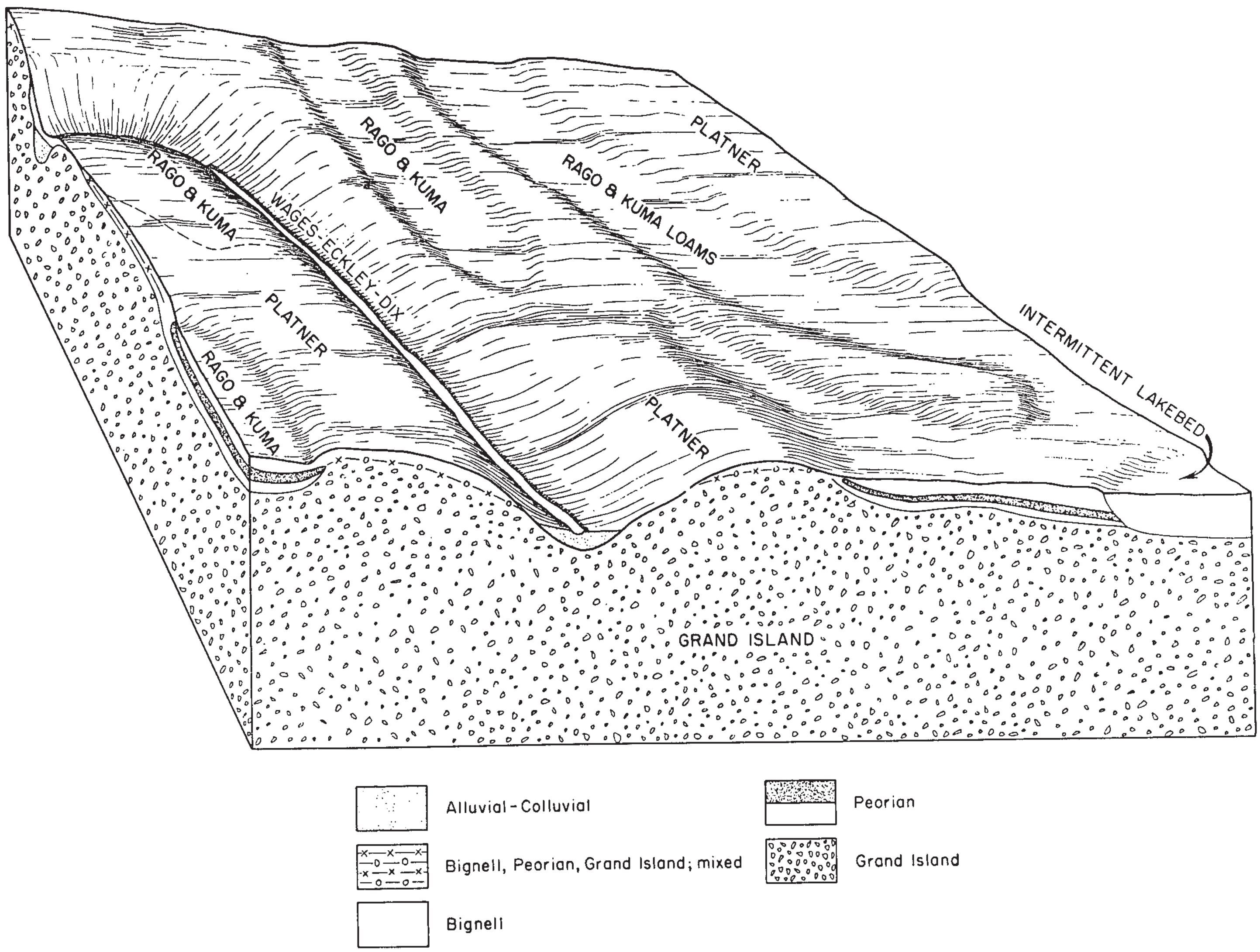

Figure 3.—**Typical landscape of the Rago-Platner-Kuma association showing the major soils and the minor Wages, Eckley, and Dix soils.**

called sandy land by farmers and ranchers. The largest is in the northwestern part of the county; the next largest is southeast of Holyoke; and the smallest is in the northeastern part of the country. The soils in this association absorb water rapidly, and there is little or no runoff.

This association makes up about 85,000 acres, or 19 percent of the county. About 70 percent is made up of Haxtun soils, 15 percent of Julesburg soils, and 15 percent of minor soils.

The Haxtun soils are deep. They typically have a grayish-brown loamy sand surface layer. Their subsoil is dark grayish-brown sandy loam in the upper part, dark grayish-brown clay loam in the middle, and light brownish-gray loam in the lower part. At a depth of about 33 inches, the subsoil is underlain by limy material that is lighter colored and less clayey than the layers above.

The Julesburg soils also are deep, but their surface layer is grayish-brown loamy sand over dark grayish-brown loamy sand. The upper part of the subsoil is dark grayish-brown sandy loam, but the lower part and the substratum consist of pale-brown loamy sand.

Minor soils in this association are the Ascalon and Valentine. These soils generally are nearly level or gently sloping, though some areas are strongly sloping or rolling.

The major soils in this association are well suited to cultivated crops, and most of the acreage is in small grains, sorghums, and corn. Most farmers use summer fallow. A few small areas are grazed. Some fields in this association are irrigated with water from deep wells. Irrigated crops grow well.

Variations in precipitation from year to year and damaging hailstorms are the main hazards in cultivated fields. Soil blowing is also a hazard. Wind stripcropping, use of crop residue, and stubble mulching are practices needed for controlling soil blowing. These practices are also effective in conserving moisture.

3. Valentine Association

Rolling to hilly soils that are fine sand throughout the profile

This association is in the rolling and hilly sandhills in the southeastern part of the county, bordering Yuma County. It is called the sandhills by farmers and ranchers. In some places the topography is dunelike. Also, there are a few blowouts about a half acre to 5 acres in size.

The association covers about 40,000 acres, or 9 percent of the county. About 85 percent is made up of Valentine soils, and 15 percent of Haxtun soils.

Valentine soils generally are rolling to hilly. In native pasture, these soils have a thin surface layer of grayish-brown fine sand. Below it is a transitional layer of brown fine sand. The next layer is pale-brown sand, which extends to a depth of more than 48 inches.

Haxtun soils are nearly level to gently sloping and occur in narrow valleys. They have a grayish-brown loamy sand surface layer. The upper part of the subsoil is dark grayish-brown sandy loam; the middle part is dark grayish-brown clay loam; and the lower part is light brownish-gray loam. Between depths of 33 and 50 inches, the material is silt loam or loam that is very strongly calcareous.

Nearly all of this association remains in native grasses and is used for grazing. The native vegetation consists of tall grasses, mainly sandreed, sand bluestem, needle-and-thread, and little bluestem. Because the Valentine soils are so sandy and so susceptible to erosion, they are not suited to cultivated crops.

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

Soil	Acreage	Percent
Anselmo loamy fine sand, marly substratum variant, 0 to 3 percent slopes	1, 080	0. 2
Ascalon sandy loam, 0 to 3 percent slopes	8, 200	1. 9
Ascalon sandy loam, 3 to 5 percent slopes	11, 040	2. 5
Ascalon sandy loam, 5 to 9 percent slopes	1, 480	. 3
Bayard-Canyon complex, 3 to 5 percent slopes	440	. 1
Canyon complex, 3 to 9 percent slopes	520	. 1
Chappell and Dix sandy loams, 0 to 3 percent slopes	2, 380	. 5
Dawes loam	3, 520	. 8
Dunday fine sand	720	. 2
Haxtun loamy sand, 0 to 3 percent slopes	37, 974	8. 7
Haxtun loamy sand, 3 to 5 percent slopes	4, 980	1. 1
Haxtun sandy loam, 0 to 3 percent slopes	17, 350	4. 0
Julesburg loamy sand, 0 to 3 percent slopes	2, 780	. 6
Julesburg loamy sand, 3 to 5 percent slopes	3, 520	. 8
Platner loam, 0 to 3 percent slopes	65, 800	15. 2
Platner loam, 3 to 5 percent slopes	17, 990	4. 1
Platner-Eckley association, 3 to 5 percent slopes	680	. 2
Pleasant loam	3, 200	. 7
Rago and Kuma loams	167, 368	38. 5
Richfield loam, 0 to 3 percent slopes	20, 895	4. 8
Richfield loam, 3 to 5 percent slopes	1, 680	. 4
Valentine fine sand, rolling	39, 343	9. 1
Valentine fine sand, hilly	4, 680	1. 1
Wages-Campus-Weld loams, 0 to 3 percent slopes	2, 080	. 5
Wages-Campus-Weld loams, 3 to 5 percent slopes	6, 380	1. 5
Wages-Eckley-Dix complex, 5 to 25 percent slopes	9, 120	2. 1
Total	435, 200	100. 0

Descriptions of the Soils

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

The procedure is first to describe the soil series, and then the mapping units in the series. Thus, to get full information on any one mapping unit, it is necessary to read the description of that unit and also the description of the series to which it belongs. The description of a soil series mentions features that apply to all the soils in a series. Differences among the soils of one series are pointed out in the descriptions of the individual soils or are indicated in the soil name.

An essential part of each soil series is the description of the soil profile. A soil profile is the sequence of layers beginning at the surface and continuing downward to depths beyond which roots of most plants do not penetrate. Each soil series contains both a brief nontechnical and a detailed technical description of the soil profile. The nontechnical description is useful to most readers. The detailed technical description is included for soil scientists, engineers, and others who need to make thorough and precise studies of soils. Unless otherwise stated, the description of each soil profile is for a dry soil. Some of the terms used to describe the soils are defined in the Glossary at the back of this survey. Others are defined in the "Soil Survey Manual" (*11*).[1]

[1] Italic numbers in parentheses refer to Literature Cited, p. 51.

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

Anselmo Series, Marly Substratum Variant

The Anselmo series, marly substratum variant, is made up of well-drained, sandy soils that overlie a deposit of salty marllike material at a depth of 30 to 40 inches. These nearly level soils are adjacent to and within the sandhills.

In a typical profile the plow layer is dark grayish-brown loamy fine sand about 8 inches thick. The subsoil, about 12 inches thick, consists of dark grayish-brown fine sandy loam that is slightly hard when dry and very friable when moist. The underlying material is light brownish-gray fine sandy loam, which rests on white, salty marllike material. This marllike material contains very few roots, though it is friable and absorbs water well.

The Anselmo soils absorb water rapidly. Practically all the precipitation that falls on them is readily absorbed.

Available water holding capacity is low, and natural fertility is moderate to low.

The native vegetation includes needle-and-thread, little bluestem, big bluestem, sandreed, and switchgrass. Sand sage and yucca are also common in some areas. Anselmo soils are best suited to pasture and meadow of native hay. In dryfarmed fields the main crops grown are corn and sorghums. Because the salty layer is directly under the subsoil, alfalfa does not grow well.

Typical profile of Anselmo loamy fine sand, marly substratum variant, 0 to 3 percent slopes, in a field of alfalfa (1,400 feet east and 300 feet south of the center of section 19, T. 6 N., R. 42 W.):

Ap—0 to 8 inches, dark grayish-brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; weak to moderate, fine, granular structure; soft when dry, very friable when moist; pH 7.6; noncalcareous; clear, smooth boundary.

B2—8 to 20 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure that breaks to moderate, fine, granular; slightly hard when dry, very friable when moist; pH 7.6; noncalcareous; clear, wavy boundary.

C1ca—20 to 32 inches, light brownish-gray (2.5Y 6/2) fine sandy loam, grayish brown (2.5Y 5/2) when moist; weak, coarse, prismatic structure that breaks to weak, coarse, subangular blocky; hard when dry, very friable when moist; pH 8.4; strongly calcareous; some visible lime; clear, wavy boundary.

IIC2ca—32 to 52 inches, white (5Y 8/2) heavy loam, light olive gray (5Y 6/2) when moist; weak to moderate, medium, prismatic structure that breaks to weak to moderate subangular blocky; very hard when dry, friable when moist; pH 8.6; very strongly calcareous; strong accumulation of lime that is salty and marllike.

In Phillips County the Anselmo soils show little range in color or texture. The A horizon ranges from 5 to 10 inches in thickness, and the B horizon ranges from 8 to 20 inches in thickness.

The Anselmo soils are associated with the Haxtun, Valentine, and Julesburg soils. Anselmo soils have a salty, marly layer but lack a buried soil in the subsoil like that in the Haxtun soils and are less clayey. The Anselmo soils have a thicker darker surface layer than the Valentine soils and have a less blocky subsoil than in the Julesburg soils.

Anselmo loamy fine sand, marly substratum variant, 0 to 3 percent slopes (AnB) occupies swales and broad valleys in the sandhills in the southeastern part of the county.

Included with this soil in mapping were small areas of Haxtun, Julesburg, and Valentine soils.

Although much of this marly substratum variant is cropped to corn, sorghums, and wheat, it is only marginal as cropland, and tilth and fertility are difficult to maintain. Soil blowing is the greatest hazard. The loamy sand surface layer blows readily if not protected by vegetative cover. In dryfarmed areas, stubble-mulch tillage and stripcropping are helpful in reducing soil blowing. Stubble mulching or crop residue provides the necessary cover during winter and early in spring. Small irrigated areas of this soil also need protection from soil blowing. Because only a few roots extend into the marly layer, irrigated crops on this soil require light irrigations at frequent intervals.

Where left in native grass, this soil supports a good cover of mid and tall grasses and the hazard of erosion is slight. In some fields stands of native grass are thick enough to be cut for hay in years when moisture is favorable. Capability units IVe-4 (dryland) and IIIe-6 (irrigated); Sandy Plains range site; windbreak suitability group 2.

Ascalon Series

The Ascalon series consists of deep, friable, well-drained soils that are nearly level to strongly sloping. These soils formed in moderately coarse textured, wind-deposited material. They are chiefly in the southeastern part of the county, generally on ridges that extend southeastward.

In a typical profile the plow layer is sandy loam about 10 inches thick. It is grayish brown in the upper 5 inches and dark grayish brown in the lower part. This layer is easily worked.

The subsoil is about 17 inches of noncalcareous sandy clay loam. This layer is slightly hard when dry and friable when moist. It is dark grayish brown in the upper 9 inches and grayish brown streaked with brown in the lower part.

The substratum is strongly calcareous, very pale brown sandy loam that has been reworked by wind and water.

Runoff is slow because the sandy loam surface layer absorbs water rapidly. Internal drainage is good. These soils have moderate natural fertility and moderate available water holding capacity.

Almost all the acreage is cultivated. In fields of native grass, most of the plant cover is side-oats grama, little bluestem, and needle-and-thread.

Typical profile of Ascalon sandy loam, 0 to 3 percent slopes, in a field of winter wheat (600 feet east and 110 feet north of the southwest corner of section 27, T. 7 N., R. 43 W.):

Ap1—0 to 5 inches, grayish-brown (10YR 5/2) light sandy loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; soft when dry, very friable when moist; pH 6.8; clear, smooth boundary.

Ap2—5 to 10 inches, dark grayish-brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, subangular blocky structure that breaks to moderate, fine, granular; hard when dry, very friable when moist; few seams of material that is very dark brown (10YR 2/2) when moist; pH 7.0; noncalcareous; clear, smooth boundary.

B2t—10 to 19 inches, dark grayish-brown (10YR 4/2) sandy clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, prismatic structure that breaks to moderate, medium, subangular blocky; slightly hard when dry, friable when moist; thin, patchy clay films, chiefly on vertical faces of peds; pH 7.2; noncalcareous; clear, smooth boundary.

B3—19 to 27 inches, grayish-brown (10YR 5/2) light sandy clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, prismatic structure that breaks to moderate, medium, subangular blocky; few, very thin, patchy clay films on vertical faces of peds; streaks of material that is brown (10YR 5/3) when dry and dark brown (10YR 4/3) when moist; pH 7.4; noncalcareous; clear, wavy boundary.

C1ca—27 to 44 inches, very pale brown (10YR 8/3) light sandy loam, pale brown (10YR 6/3) when moist; weak, very coarse, prismatic structure; hard when dry, very friable when moist; moderate accumulation of lime visible as threads, fine coatings, and soft concretions; pH 8.6; strongly calcareous; gradual, wavy boundary.

C2—44 to 60 inches, very pale brown (10YR 7/3) sand, brown (10YR 5/3) when moist; massive (structureless) to very weak, coarse, prismatic structure; loose when dry or moist; little visible lime; pH 8.6; weakly to strongly calcareous.

The A horizon ranges from 5 to 15 inches in thickness. In some transitional areas, the A horizon is loamy sand and the B horizon is clay loam. The B horizon ranges from 10 to 25 inches in thickness. Depth to the calcareous material normally is 27 inches, but it ranges from 15 to 35 inches.

Ascalon soils lack the clay or clay loam subsoil and the underlying gravelly material that are common in Platner soils. The subsoil of the Ascalon soils is more compact and more clayey than that of Julesburg soils, which do not have the layer of accumulated lime.

Ascalon sandy loam, 0 to 3 percent slopes (AsB) is mainly in the southeastern part of the county, but there are some small areas northeast of Amherst, northeast of Holyoke, and north of Haxtun. The areas are irregular in shape, generally range from 10 to 40 acres in size, and extend southeastward. The profile of this soil is the one described as typical for the series.

Included with this soil in mapping were some small, eroded spots that appear as white areas. Also included in the sags, or flat spots, were a few small areas of Haxtun soils.

Almost all of this soil is cultivated, mainly to winter wheat, winter barley, and sorghums. Some areas are irrigated. Dryfarming practices suitable for protecting this soil against erosion are stubble mulching, wind stripcropping, and emergency tillage. These practices also are effective in conserving moisture. In irrigated areas, working manure or crop residue into the soil helps to keep it fertile and in good tilth. Irrigated areas need to be leveled so that water spreads uniformly. Irrigated crops respond well to applications of fertilizer.

A few areas are still in grass and are used for grazing. In these areas overgrazing should be avoided because the soil is susceptible to blowing. Eroded areas can be easily reseeded. Capability units IIe–1 (dryland) and IIe–3 (irrigated); Sandy Plains range site; windbreak suitability group 1.

Ascalon sandy loam, 3 to 5 percent slopes (AsC) occupies convex ridges that trend to the southeast. This is the most extensive Ascalon soil in the county. Most of it lies southeast of Holyoke.

Because this soil takes in water readily, surface runoff is slow. Soil blowing is the main hazard.

Included with this soil in mapping were a few small gravelly spots and spots where limestone crops out. These areas are shown on the soil map by symbol. Also included were severely eroded areas in which all the surface layer and most of the subsoil have been removed by erosion. These areas are less than half an acre in size.

This soil is suited to cultivated crops or to grass. Almost all of it is cultivated. Stubble mulching and proper management of crop residue generally are effective in controlling erosion. Emergency tillage and wind stripcropping also are effective.

Where the soil is still in grass, proper range use can be obtained by fencing the areas and by providing well-spaced watering points and salt blocks. It is essential to permit grazing only at the suitable season and by the proper number of animals. Eroded areas can be easily reseeded, but grazing should be deferred until the grasses are established. Capability unit IIIe–2 (dryland); Sandy Plains range site; windbreak suitability group 1.

Ascalon sandy loam, 5 to 9 percent slopes (AsD) occupies ridges or side slopes that trend southeastward. The soil areas are primarily in the southeastern part of the county, though a few areas are north of Haxtun and northeast of Amherst.

374-140—71——2

This soil takes in water rapidly and releases it readily to plants, but its capacity to hold water is moderate. This soil is susceptible to severe erosion.

Included with this soil in mapping were severely eroded areas where the original surface layer and subsoil material are gone. These spots are less than an acre in size and are white.

This soil is suited to range and to limited cultivation, preferably of close-growing crops. Stubble-mulch tillage, wind stripcropping, and working crop residue into the soil are generally effective in controlling erosion. Also, emergency tillage may be necessary in windy periods to prevent soil blowing.

Among the grasses that grow well on rangeland are blue grama, little bluestem, switchgrass, side-oats grama, and sand bluestem. The rangeland can be reseeded if the soil is moist and has a good cover of plant litter. Overgrazing is best avoided by stocking the range at a proper rate and by placing fences, salt blocks, and watering points where animals are forced to graze the entire area. Capability unit IVe–2 (dryland); Sandy Plains range site; windbreak suitability group 1.

Bayard Series

The Bayard series consists of deep sandy loams that are well drained. These soils formed in a mixture of material weathered from limestone and deposits of reworked sands.

In a typical profile the surface layer is dark grayish-brown sandy loam about 6 inches thick. The next layer is about 10 inches thick and consists of dark-brown sandy loam that contains some small fragments of caliche.

The underlying material, to a depth of 60 inches, is strongly calcareous, light brownish-gray sandy loam overlying very strongly calcareous, dark-gray sandy loam. This material contains much visible lime.

The Bayard soils have rapid permeability and slow runoff. Because these soils are sandy, they have moderate to low available water holding capacity and moderate natural fertility. Bayard soils are susceptible to soil blowing unless protected.

The native vegetation consists of little bluestem, needle-and-thread, and side-oats grama. Bayard soils are best suited to grasses, and most of the acreage is still in grass. Winter wheat and sorghums are grown in a few cultivated areas.

Typical profile of a Bayard sandy loam in native grass (930 feet north and 135 feet east of the southwest corner of section 19, T. 9 N., R. 47 W.):

A11—0 to 3 inches, dark grayish-brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, crumb structure; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

A12—3 to 6 inches, dark grayish-brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 4/2) when moist; weak, coarse, subangular blocky structure that breaks to weak, fine, granular; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

AC—6 to 16 inches, dark-brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) when moist; weak, coarse, prismatic structure that breaks to weak, coarse, subangular blocky; slightly hard when dry, very friable when moist; noncalcareous to weakly calcareous; some coarse sand and small fragments of caliche; gradual, smooth boundary.

C1ca—16 to 23 inches, light brownish-gray (10YR 6/2) sandy loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure that breaks to weak, coarse, subangular blocky; slightly hard when dry, very friable when moist; strongly calcareous; some coarse sand and small fragments of caliche; clear, wavy boundary.

IIC2ca—23 to 60 inches, dark-gray (10YR 4/1) sandy loam, very dark gray (10YR 3/1) when moist; very weak, coarse, prismatic structure that breaks to very weak, coarse, subangular blocky; hard when dry, very friable when moist; very strongly calcareous; below a depth of 29 inches is dark grayish-brown or dark-gray sandy loam that is massive (structureless) and very strongly calcareous.

The A1 horizon of Bayard soils is 3 to 10 inches thick. It is sandy loam in most places, but in a few areas it is loamy sand. The AC horizon ranges from 5 to 15 inches in thickness.

Bayard soils are limy, but Julesburg soils are not. Also, Bayard soils are not so well developed as the Julesburg soils.

Bayard-Canyon complex, 3 to 5 percent slopes (BcC) occupies high, old land surface areas in the extreme northwestern corner of the county. The two kinds of soils are so closely intermingled that it is not practical to map them separately. Bayard soils occupy the tops and side slopes of high old land surfaces. The slopes on the tops are 0 to 3 percent, and the side slopes are 3 to 5 percent. Canyon soils also are on the side slopes, where the limestone shelf crops out. Canyon soils contain fragments of hard limestone that are generally flat, about 2 to 3 inches thick, and as much as 12 inches in diameter.

Bayard soils make up about 75 percent of the complex, and Canyon soils, about 20 percent. Each kind of soil has a profile similar to the one described as typical for its series. The rest of the complex consists of small areas of Haxtun and Julesburg soils, generally less than 1 acre in size, that are in sags or on smoother side slopes.

The major soils in this complex have slow runoff, mainly because they are sandy and absorb water rapidly. These soils are well drained but are low in available water holding capacity.

Almost all the acreage is native grasses and is used for pasture, which is the most suitable use. These soils can be reseeded easily, but the stones are hazards to farm machinery. Unless protected by plant cover, the soils erode easily. Capability unit VIe-1 (dryland); Bayard soils are in Sandy Plains range site and windbreak suitability group 2; Canyon soils are in Limestone Breaks range site and windbreak suitability group 3.

Campus Series

The Campus series consists of moderately deep, well-drained, loamy soils that are underlain by weathered limestone and partly consolidated beds of lime-cemented alluvium. These soils are nearly level to moderately sloping and occur in the western and northeastern parts of the county. In Phillips County the Campus soils were mapped only in complexes with Wages and Weld soils.

In a typical profile the plow layer is grayish-brown, strongly calcareous gravelly sandy loam about 6 inches thick. Gravel, fragments of limestone, and chips of caliche make up about 30 percent of this layer.

The next layer is about 4 inches of light brownish-gray loam that is hard when dry and friable when moist. It is underlain by light-gray loam about 7 inches thick. This layer is 10 to 15 percent gravel and chips and contains much visible lime. Below this, and extending to a depth of 30 inches, the material is lighter in color, more sandy, and more limy as depth increases. The next layer is partly consolidated white sandy loam that is lime cemented. It contains cracks and seams through which some moisture and a few roots can penetrate.

Campus soils absorb water well and have moderate available water holding capacity.

Typical profile of a Campus gravelly sandy loam in a wheatfield (500 feet south and 530 feet east of the northwest corner of section 29, T. 7 N., R. 46 W.):

Ap—0 to 6 inches, grayish-brown (10YR 5/2) gravelly sandy loam, very dark brown (10YR 2/2) when moist; moderate, fine, granular structure; slightly hard when dry, very friable when moist; 30 percent gravel, fragments of limestone, and chips of caliche; pH 8.4; strongly calcareous; clear, smooth boundary.

AC—6 to 10 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) when moist; weak, medium, prismatic structure that breaks to weak, medium, subangular blocky; hard when dry, friable when moist; 10 to 15 percent gravel and chips; rock fragments on one side of pit; pH 8.4; strongly calcareous; clear, smooth boundary.

C1ca—10 to 17 inches, light-gray (10YR 7/2) loam, brown (10YR 5/3) when moist; weak, coarse, prismatic structure that breaks to weak, coarse, subangular blocky; hard when dry, friable when moist; 10 to 15 percent gravel and chips; weak to moderate accumulation of lime that has lime visible as specks and common, medium-sized, soft concretions; pH 8.4; very strongly calcareous.

C2ca—17 to 30 inches, white (10YR 8/1) loam, very pale brown (10YR 7/3) when moist; massive (structureless); hard when dry, friable when moist; 10 to 15 percent gravel; strong accumulation of lime in marllike material; pH 8.6; very strongly calcareous; gradual, wavy boundary.

R—30 to 40 inches +, partly consolidated, lime-cemented, white (10YR 8/2) heavy sandy loam that is 10 to 15 percent gravel; cracks and seams through which some moisture and a few roots penetrate.

The A1 horizon ranges from loam to gravelly sandy loam in texture and from 6 to 15 inches in thickness. In content of gravel, the C horizon ranges from 5 to 15 percent. Depth to the R horizon ranges from 20 to 40 inches.

Campus soils lack the B2t horizon of the Wages and Weld soils, which have more clay below the A horizon.

Canyon Series

The Canyon series consists of shallow, loamy soils that are excessively drained and developed on material weathered from limestone (fig. 4). These soils are moderately sloping to strongly sloping and occur on ridges or side slopes, mainly in the southwestern part of the county.

In a typical profile the surface layer is strongly calcareous, grayish-brown gravelly loam about 5 inches thick. Fine gravel and fragments of caliche make up 30 to 40 percent of this layer, by volume. The layer is easily worked.

The next layer consists of grayish-brown gravelly loam that is slightly hard when dry and very friable when moist. It is about 4 inches thick.

Underlying this is very pale brown, very strongly calcareous gravelly loam that contains some pieces of weathered limestone and rests on strongly cemented caliche.

The Canyon soils are well drained, but the caliche layer keeps water from penetrating deep into the soil. These soils have low available water holding capacity and are low in natural fertility.

These soils are not suited to crops and are cultivated only where they are in small areas within large areas of better soils. They are better suited as range. The native vegetation consists of thin stands of grasses, such as blue grama, side-oats grama, western wheatgrass, and needle-and-thread.

Typical profile of a Canyon gravelly loam in native grass (2,110 feet north of southeast corner of section 17, T. 7 N., R. 47 W.):

A1—0 to 5 inches, grayish-brown (10YR 5/2) gravelly loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; strongly calcareous; streaks of weak-red (2.5YR 4/2) material when crushed; many roots; about 30 to 40 percent is fine gravel and fragments of caliche; clear, smooth boundary.

AC—5 to 9 inches, grayish-brown (10YR 5/2) gravelly loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, subangular blocky structure that breaks to weak, medium, subangular blocky; slightly hard when dry, very friable when moist; very strongly calcareous; about 30 to 40 percent is fine gravel and fragments of caliche; clear, smooth boundary.

Cca—9 to 15 inches, very pale brown (10YR 8/3) gravelly loam, very pale brown (10YR 7/3) when moist; massive (structureless); hard when dry, friable when moist; streaks of gray (10YR 5/1) material; about 20 to 30 percent is calcium carbonate; very strongly calcareous; irregular, abrupt boundary.

R—15 inches +, white (10YR 8/1), strongly cemented caliche, light gray (10YR 7/2) when moist; very strongly calcareous; brown gravelly sandy loam in fractures in caliche.

The A horizon ranges from 4 to 8 inches in thickness and from gravelly loam to gravelly fine sandy loam in texture. The AC and Cca horizons range from loam to gravelly loam and are as much as 10 to 50 percent gravel and fragments of caliche. Depth to the R horizon ranges from 4 to 20 inches.

Canyon soils are associated with the Wages soils but are more shallow.

Canyon complex, 3 to 9 percent slopes (CcD) occupies narrow, ribbonlike areas that extend southeastward. These areas generally range from 10 to 15 acres in size. The surface layer is gravelly loam and gravelly fine sandy loam.

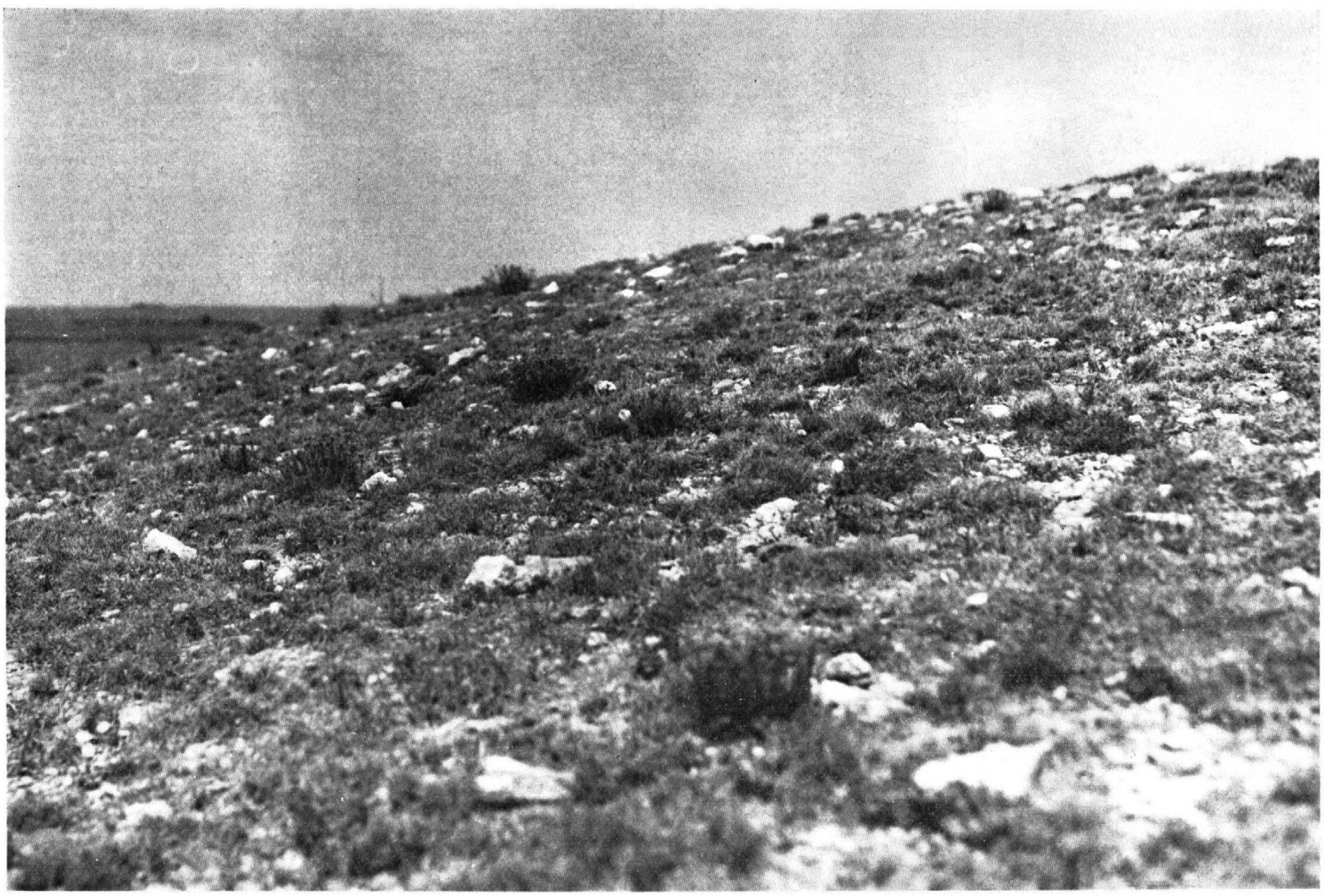

Figure 4.—A strongly sloping area of Canyon soil where limestone rocks are on the surface.

Small areas of Wages soils were included in mapping. They are generally on side slopes.

The acreage of these soils is about equally divided between grassland and cropland. Although cultivated crops are not suited, many small areas within fields of better soils are cultivated because they are easier to farm through than to farm around. Because these soils are shallow and sloping to strongly sloping, they are susceptible to severe erosion.

Where these soils are still in grass, the erosion hazard is slight and only proper grazing management is needed. Capability unit VIIs–1 (dryland); Limestone Breaks range site; windbreak suitability group 3.

Chappell Series

The Chappell series consists of nearly level to gently sloping sandy loams that are on terraces along intermittent streams. These soils are moderately deep over sand and gravel. They are well drained or somewhat excessively drained.

In a typical profile the surface layer is grayish-brown sandy loam. It is soft, easily worked, and about 5 inches thick. In most places gravel is scattered on the surface.

The subsoil, about 14 inches thick, is sandy loam that is grayish brown in the upper part and dark grayish-brown in the lower part. About 10 to 15 percent of this layer is fine gravel.

Below the subsoil, at a depth of about 19 inches, is dark grayish-brown sandy loam. This is underlain by brown gravelly coarse sand. About 40 to 50 percent of the material is fine gravel that restricts the growth of plant roots.

Chappell soils are well drained or somewhat excessively drained. They have moderate to rapid permeability and slow runoff. These soils have moderately low available water holding capacity and are moderate to low in fertility. Chappell soils are susceptible to both soil blowing and water erosion and are flooded periodically.

The native vegetation consists of western wheatgrass, blue grama, little bluestem, sandreed, side-oats grama, needle-and-thread, and similar grasses. Almost all of the acreage is cultivated, mainly to sorghums, winter wheat, and barley.

Typical profile of a Chappell sandy loam in a cultivated wheatfield (530 feet east, 75 feet south of the northwest corner of section 1, T. 7 N., R. 47 W.):

A1—0 to 5 inches, grayish-brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

B2—5 to 11 inches, grayish-brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure that breaks to weak, medium, subangular blocky; slightly hard when dry, friable when moist; noncalcareous; very thin clay bridges between sand grains; clear, smooth boundary.

B3—11 to 19 inches, dark grayish-brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) when moist: weak, coarse, prismatic structure that breaks to weak, coarse, subangular blocky; slightly hard when dry, friable when moist; noncalcareous; clear, smooth boundary.

C1—19 to 36 inches, dark grayish-brown (10YR 6/2) sandy loam, dark brown (10YR 4/3) when moist; streaks of material from B3 horizon, very dark grayish brown (10YR 3/2) when moist; weak, very coarse, prismatic structure that breaks to weak, coarse, prismatic; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

IIC2—36 to 60 inches, brown (10YR 5/3) gravelly coarse sand; single grain (structureless); loose when dry or moist; noncalcareous.

In thickness, the A horizon ranges from 4 to 8 inches and the B horizon from 5 to 10 inches. Depth to the coarse-textured IIC horizon ranges from 20 to 40 inches.

Chappell soils are deeper to sand and gravel than the Dix soils.

Chappell and Dix sandy loams, 0 to 3 percent slopes (CdB) are moderately deep and shallow soils along intermittent streams. These soils are on terraces in areas of oxbows. The areas are generally crescent shaped and range from about 8 to 30 acres in size.

About 65 percent of the acreage is Chappell sandy loam, and about 30 percent is Dix gravelly loam. Each kind of soil has a profile similar to the one described as typical for its series.

Included in mapping were small areas of Rago and Kuma soils that are in old, depressional, loam-filled channels.

Chappell and Dix sandy loams take in water rapidly and release it readily to plants, but available water holding capacity is low and the soils are droughty. Runoff is slow.

These soils are suited to grass or limited cultivation of close-growing harvested crops, but they are susceptible to blowing. The Dix soil is frequently flooded. In dryfarmed fields, stubble-mulch tillage and wind stripcropping are helpful in reducing erosion. In the irrigated fields, the size of the irrigating stream should be small enough to prevent the soil from washing. Leveling is needed in irrigated fields so that water spreads uniformly.

Grasses grow well on these sandy soils. Reseeding the range is a good practice if the soil is moist and well covered with litter and if grazing is deferred until the grass is well established. After the grass is established, fences, water, and salt should be located so that livestock graze the entire range. Overgrazing should be avoided. Capability units IVe–4 (dryland) and IIIe–7 (irrigated); Sandy Plains range site; windbreak suitability group 2.

Dawes Series

The Dawes series consists of moderately well drained, loamy soils. These soils formed in a windblown deposit on the uplands and are mostly in the southwestern part of the county. Slopes range from 0 to 3 percent.

In a typical profile the plow layer is grayish-brown loam about 5 inches thick. It is underlain by a leached layer, about 2 inches thick, that consists of light brownish-gray very fine sandy loam.

The subsoil, about 8 inches thick, is dark grayish-brown clay and is very hard when dry and firm when moist. The lower 3 inches of this layer contains some calcium carbonate.

The underlying material, to a depth of 27 inches, is very pale brown loam and sandy loam that contains fine fragments of caliche in the lower part. This layer rests on hard, cobbly and gravelly limestone material.

These soils absorb water slowly and have medium runoff. They are easily worked and normally have high available water holding capacity.

The native vesgetation consists of blue grama, buffalograss, western wheatgrass, and similar grasses. Almost all the acreage is cultivated.

Typical profile of Dawes loam in a wheatfield (2,355 feet west, 105 feet south of the northeast corner of section 27, T. 7 N., R. 47 W.):

Ap—0 to 5 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; hard when dry, friable when moist; noncalcareous; some visible coarse sand; abrupt, smooth boundary.

A2—5 to 7 inches, light brownish-gray (10YR 6/2) very fine sandy loam, dark grayish brown (10YR 4/2) when moist; moderate, coarse, subangular blocky structure; hard when dry, friable when moist; noncalcareous; graying evident on all ped surfaces; abrupt, smooth boundary.

B2t—7 to 15 inches, dark grayish-brown (10YR 4/2) clay, very dark brown (10YR 2/2) when moist; strong, medium, prismatic structure that breaks to strong, medium and fine, angular blocky; very hard when dry, firm when moist; noncalcareous in upper part; lower 3 inches is weakly calcareous; thick, continuous clay films; pH 8.3; clear, gradual boundary.

C1ca—15 to 24 inches, very pale brown (10YR 8/3) loam, pale brown (10YR 6/3) when moist; weak, coarse, prismatic structure that breaks to weak, coarse, subangular blocky; hard when dry, firm when moist; streaks and seams of calcium carbonate; very strongly calcareous; fragments of caliche in the lower 5 inches; pH 9.4; gradual boundary.

C2—24 to 27 inches, very pale brown (10YR 7/3) sandy loam, brown (10YR 5/3) when moist; massive (structureless); slightly hard when dry, very friable when moist; strongly calcareous; coarse sand and fine fragments of caliche: clear, wavy boundary.

IIC3—27 inches +, white (10YR 8/2), hard, cobbly and gravelly limestone material, light gray (10YR 7/2) when moist.

In thickness, the A1 horizon ranges from 5 to 8 inches, the leached A2 horizon from 1 to 3 inches, and the B2t horizon from 5 to 9 inches. The B2t horizon ranges from heavy clay loam to clay. Lime has been leached to a depth of 15 to 22 inches. Depth to the gravelly IIC horizon is 20 to 40 inches.

Dawes soils have a darker subsoil than Weld soils but lack the thick, dark buried subsoil that occurs in the Rago soils.

Dawes loam (0 to 3 percent slopes) (Da) occupies old, high land surfaces south of Haxtun. This soil is moderately deep and is in areas that trend southeastward and are generally 80 to 100 acres in size.

Included with this soil in mapping were small areas of Rago and Kuma loams and of Wages and Weld soils. The Rago and Kuma loams are in depressional areas. Wages soils are near limestone materials, and Weld soils are in small, convex areas having slopes of about 3 percent.

Dawes loam is well suited to cultivated crops, mainly sorghums, winter wheat, and barley. It is also suited to native grass.

Although this soil takes in water slowly, the available water holding capacity is high. In dryfarmed fields, stubble-mulch tillage is generally adequate for controlling erosion. In some irrigated areas leveling is needed so that water spreads uniformly. Leveling also helps control erosion. Other practices needed to reduce erosion are managing irrigation water and working crop residue into the soil. Plowpans can form easily if this soil is tilled when wet.

Blue grama, western wheatgrass, buffalograss, and similar grasses grow well on this soil. Reseeding generally is not difficult where this soil is used as range, but grasses should not be grazed until they are well established. Then, proper range use can be obtained by limiting the number of livestock, by grazing at the right season, and by locating fences, water, and salt so that animals graze the entire area. Capability units IIIs-2 (dryland) and IIIs-3 (irrigated); Loamy Plains range site; windbreak suitability group 1.

Dix Series

The Dix series consists of gravelly, excessively drained soils that are nearly level to sloping and occur on terraces along intermittent streams. These soils developed in waterlaid, loose sand and gravel.

In a typical profile the plow layer is noncalcareous, dark grayish-brown sandy loam about 7 inches thick. It is free of lime.

The subsoil, about 11 inches thick, consists of dark grayish-brown coarse sandy loam that is also free of lime. Fine gravel makes up about 10 to 15 percent of this layer.

The underlying material is brown gravelly coarse sand that is free of lime, loose, and somewhat stratified.

These soils have rapid permeability and slow runoff. The water holding capacity and natural fertility are low. Because these soils are periodically flooded, they are susceptible to severe erosion.

The native vegetation consists of sedges, western wheatgrass, blue grama, side-oats grama, needle-and-thread, and sandreed grasses. Almost all of the acreage is cultivated, mainly to winter wheat or sorghums.

In Phillips County the Dix soils were not mapped separately. They were mapped only with the Chappell soils in an undifferentiated unit and with the Wages and Eckley soils in a complex.

Typical profile of Dix sandy loam in an alfalfa field (1,320 feet north and 80 feet east of the southwest corner of section 29, T. 7 N., R. 47 W.):

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) sandy loam, very dark brown (10YR 2/2) when moist; upper 3 inches generally has weak, thick, platy structure, and below that is weak, coarse, subangular blocky structure that breaks to moderate, fine, granular; slightly hard when dry, very friable when moist; 5 to 10 percent is fine gravel; pH 6.4; noncalcareous; clear, smooth boundary.

B2—7 to 18 inches, dark grayish-brown (10YR 4/2) coarse sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure that breaks to weak, coarse, subangular blocky; hard when dry, very friable when moist; thin clay bridges between grains; 10 to 15 percent is fine gravel; pH 7.2; noncalcareous; clear, wavy boundary.

IIC1—18 to 42 inches, brown (10YR 5/3) gravelly coarse sand, dark grayish brown (10YR 4/2) when moist; weak, very coarse, prismatic structure that breaks to weak, coarse, prismatic; hard when dry, very friable when moist; 30 to 50 percent is gravel; more gravel in lower part than in upper part; pH 7.2; noncalcareous; gradual, wavy boundary.

IIC2—42 to 60 inches, pale-brown (10YR 6/3) sand and gravel; brown (10YR 5/3) when moist; single grain (structureless); loose when dry and moist; noncalcareous.

The A horizon ranges from 4 to 8 inches in thickness and in some depressional areas is loam instead of sandy loam. The B2 horizon ranges from 7 to 15 inches in thickness. Gravel and coarse sand occur at a depth of 10 to 20 inches. Lime has been leached to a depth of 30 inches.

Dix soils are similar to Chappell, which do not have coarse sand and gravel at a depth of 10 to 20 inches. The subsoil of the Dix soils is less compact and clayey than that occurring in the Eckley soils.

Dunday Series

The Dunday series consists of deep, sandy, excessively drained soils that formed in wind-deposited sand. These soils are nearly level. Most areas are in valleys that extend into areas of Valentine soils.

In a typical profile the surface layer is grayish-brown fine sand. It is about 12 inches thick, free of lime, and porous. The next layer, about 13 inches thick, is brown loamy sand.

Underlying this is pale-brown loamy coarse sand that extends to a depth of 40 inches. Below this depth is pale-brown medium sand that is free of lime and is very friable when moist.

These soils are very rapidly permeable and have slow runoff. Natural fertility and available water holding capacity are low.

Most of the acreage is still in native grass, for which these soils are well suited. Only a few acres are cultivated.

Typical profile of Dunday fine sand in native grassland (2,110 feet east and 85 feet south of the northeast corner of section 4, T. 8 N., R. 47 W.):

A1—0 to 12 inches, grayish-brown (10YR 5/2) fine sand, very dark grayish brown (10YR 3/2) when moist; weak, medium, granular structure; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

C1—12 to 25 inches, brown (10YR 5/3) loamy sand, dark brown (10YR 4/3) when moist; weak, coarse, prismatic structure that breaks to weak, medium and coarse, subangular blocky; slightly hard when dry, very friable when moist; noncalcareous; clear, smooth boundary.

C2—25 to 40 inches, pale-brown (10YR 6/3) loamy coarse sand, dark brown (10YR 4/3) when moist; weak, coarse, prismatic structure that breaks to weak, medium and coarse, subangular blocky; slightly hard when dry, very friable when moist; noncalcareous; clear, smooth boundary.

C3—40 to 60 inches, pale-brown (10YR 6/3) medium sand, dark brown (10YR 4/3) when moist; massive (structureless) but breaks to single grain; soft when dry, very friable when moist; noncalcareous.

The Dunday soils are fairly uniform in Phillips County, but the A horizon ranges from about 6 to 15 inches in thickness. In some areas Dunday soils are underlain by clay loam materials at depths of 40 inches or more.

Dunday soils have a thicker surface layer than that of Valentine soils, and it is slightly less sandy. The subsoil of Dunday soils is sandier and less compact than that of Julesburg soils.

Dunday fine sand (0 to 3 percent slopes) (Du) occupies broad, undulating flats and valleys mainly in the northwestern part of the county. The areas mapped border or extend into areas of Valentine soils. In general, areas of this Dunday soil are more than 40 acres in size and are irregular in shape.

Included in mapping were a few areas of Haxtun loamy sand, 0 to 3 percent slopes.

Soil blowing is a severe hazard in cultivated fields unless this soil is protected by grass, growing crops, or stubble mulch. Only irrigated areas are suitable for cultivation, and in these areas cultivation should be limited. For protection against erosion, all crop residue should be left on the surface or worked into the soil. Capability units VIe–2 (dryland) and IVs–1 (irrigated); Deep Sand range site; windbreak suitability group 2.

Eckley Series

The Eckley series consists of well-drained soils that formed in gravelly material deposited by water. Most areas of Eckley soils occur on side slopes along Frenchman Creek, Patent Creek, and other intermittent streams. These soils are strongly sloping to steep.

In a typical profile the surface layer is grayish-brown gravelly loam about 4 inches thick. It is free of lime.

The subsoil, about 6 inches thick, consists of dark-brown gravelly sandy clay loam and also is free of lime.

Below the subsoil is light-brown sand and gravel that was deposited by water and grades to pale-yellow coarse sand. This layer is generally free of lime and loose, but it has few plant roots. In some places cobblestones are evident.

These soils have moderate to rapid permeability and medium or slow runoff. The available water holding capacity and natural fertility are low.

These soils generally are not susceptible to washing or blowing, because almost all the acreage is in native grass. Only a few areas are cultivated. These soils are well suited as range.

In Phillips County Eckley soils were mapped only in a soil association with the Platner soils and in a complex with Wages and Dix soils.

Typical profile of an Eckley gravelly loam in native grass (270 feet south and 2,585 feet west of the northeast corner of section 17, T. 7 N., R. 47 W.):

A1—0 to 4 inches, grayish-brown (10YR 5/2) gravelly loam, very dark grayish brown (10YR 3/2) when moist; weak, fine granular structure; soft when dry, very friable when moist; noncalcareous; about 35 percent is fine and coarse gravel; clear, smooth boundary.

B2t—4 to 10 inches, dark-brown (10YR 4/3) gravelly sandy clay loam, dark brown (10YR 3/3) when moist; weak to moderate, coarse, prismatic structure that breaks to weak to moderate, medium, subangular blocky; very hard when dry, very friable when moist; noncalcareous; very thin, nearly continuous clay bridges between peds; bridges stained with very dark grayish brown (10YR 3/2) when moist; gradual, wavy boundary.

IIC1—10 to 35 inches, light-brown (7.5YR 6/4) coarse sand and gravel, brown (7.5YR 5/4) when moist; massive (structureless); very hard when dry, very friable when moist; noncalcareous; clear, wavy boundary.

IIC2—35 inches +, pale-yellow (2.5Y 7/4) gravelly coarse sand, light olive brown (2.5Y 5/4) when moist; moderate, coarse, prismatic structure that breaks to massive (structureless); very hard when dry, loose when moist; strongly calcareous.

The A horizon ranges from 4 to 8 inches in thickness and is loam or gravelly loam in some places. The B2t horizon ranges from 6 to 12 inches in thickness and is gravelly loam or gravelly sandy clay loam. In some places the underlying material contains some calcium carbonate. Depth to the underlying gravel and coarse sand ranges from 10 to 20 inches.

In contrast to Wages soils, Eckley soils do not have a layer of accumulated lime, have a coarser textured subsoil, and have sand and gravel at a depth of 10 to 20 inches. The subsoil of Eckley soils is more clayey than that of Dix soils.

Haxtun Series

The Haxtun series consists of deep, well-drained loamy sands and sandy loams of the uplands (fig. 5). These soils are nearly level to moderately sloping and are mostly in the north-central and northwestern parts of the county.

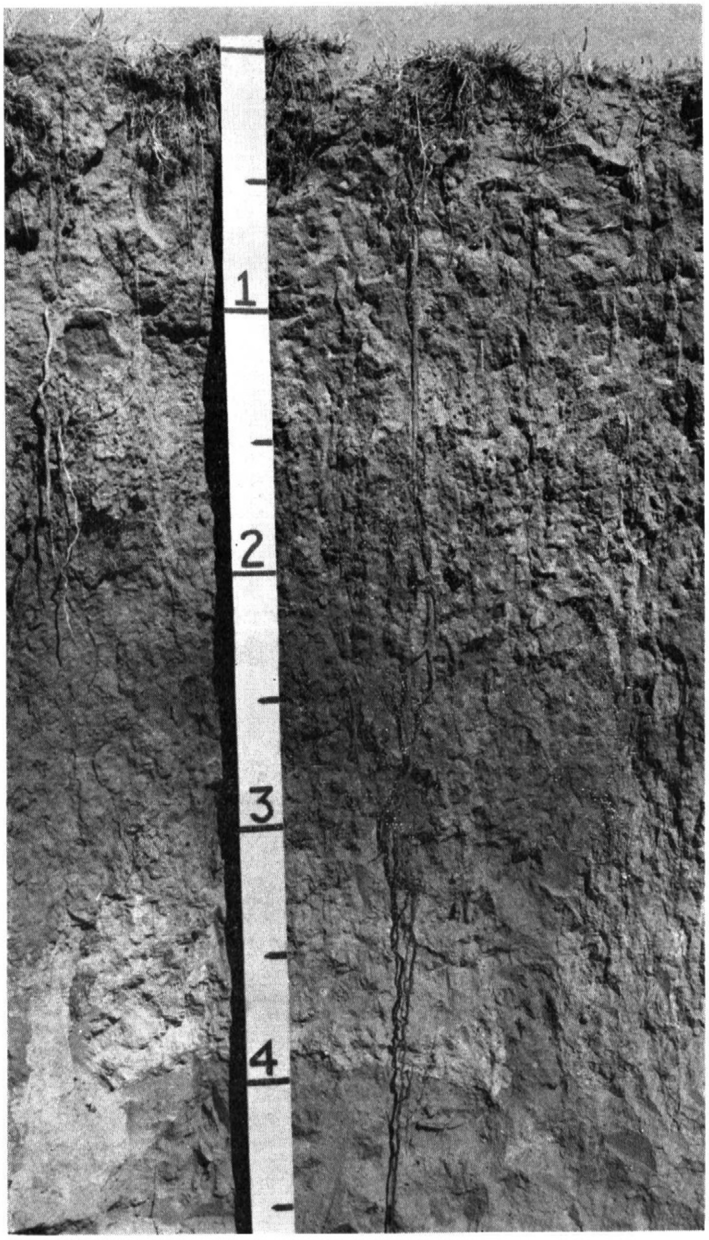

Figure 5.—**Profile of a Haxtun loamy sand.**

Extending into the sandhills of the southeastern part is a considerable acreage in broad swale or valley areas.

In a typical profile the surface layer is grayish-brown loamy sand about 9 inches thick. It is easily worked. The next layer is grayish-brown sandy loam about 3 inches thick.

The subsoil is about 21 inches thick. The upper part is dark grayish-brown sandy loam. The middle part, which is the upper part of an older, buried soil, is dark grayish-brown clay loam about 7 inches thick. The lower part of the subsoil is light brownish-gray loam, also about 7 inches thick. The subsoil is hard when dry and friable or very friable when moist. The underlying material is loamy and rich in lime.

These soils take in water rapidly to very rapidly and have rapid internal drainage. Available water holding capacity is high in the subsoil. Because the surface layer has rapid permeability, there is little runoff. Natural fertility is moderate to high, but these soils are subject to soil blowing unless they are protected by growing crops or crop residue.

Almost all the acreage of Haxtun soils is cultivated. Sorghums, winter wheat, barley, and corn are grown in many areas. The few fields still in native blue grama, needle-and-thread, and western wheatgrass are grazed.

Typical profile of a Haxtun loamy sand, in a field of winter wheat (600 feet south and 300 feet west of the northeast corner of section 10, T. 8 N., R. 45 W.):

Ap—0 to 9 inches, grayish-brown (10YR 5/2) very light loamy sand, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

AB—9 to 12 inches, grayish-brown (10YR 5/2) sandy loam, very dark brown (10YR 2/2) when moist; weak, coarse, subangular blocky structure; slightly hard when dry, very friable when moist; noncalcareous; clear, smooth boundary.

B2t—12 to 19 inches, dark grayish-brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, prismatic structure that breaks to moderate, medium, subangular blocky; hard when dry, very friable when moist; thin, patchy clay films on both vertical and horizontal faces of peds; noncalcareous; clear, smooth boundary.

IIB2tb—19 to 26 inches, dark grayish-brown (10YR 4/2) clay loam, very dark brown (10YR 2/2) when moist; strong, medium, prismatic structure that breaks to moderate to strong, fine, subangular blocky; hard when dry, friable when moist; moderate, continuous clay films on both vertical and horizontal faces of peds; streaks of very dark grayish brown (10YR 3/2) when moist, in this horizon; noncalcareous; clear, smooth boundary.

IIB3tb—26 to 33 inches, light brownish-gray (10YR 6/2) heavy loam, dark grayish brown (10YR 4/2) when moist; weak to moderate, medium, prismatic structure that breaks to weak to moderate, medium, subangular blocky; hard when dry, friable when moist; thin, patchy clay films on both vertical and horizontal faces of peds; streaks of very dark grayish brown (10YR 3/2); noncalcareous; gradual, smooth boundary.

IIC1cab—33 to 50 inches, white (10YR 8/2) silt loam or loam, pale brown (10YR 6/3) when moist; massive (structureless); slightly hard when dry, very friable when moist; moderate accumulation of visible lime, chiefly in finely divided forms; very strongly calcareous; gradual, smooth boundary.

IIIC2ca—50 to 60 inches, light-gray (10YR 7/2) sandy loam, dark grayish brown (10YR 4/2) when moist; massive (structureless); slightly hard when dry, very friable when moist; strongly calcareous but visible lime is less than in horizon above; few soft concretions of lime.

The A horizon ranges from 6 to 15 inches in thickness and from sandy loam to loamy sand in texture. The B2t horizon ranges from 5 to 15 inches in thickness and from clay loam to sandy clay loam in texture. Depth to the buried soil ranges from 12 to 24 inches.

Haxtun soils are closely associated with the Julesburg soils. The subsoil in Haxtun soils is more clayey than that in Julesburg soils, which do not have a distinct, dark buried layer. Also, the Haxtun soils have a distinct lime zone, which is lacking or very weak in the Julesburg soils.

Haxtun loamy sand, 0 to 3 percent slopes (HtB) is in broad areas in the north-central, northwestern, and southeastern parts of the county. The areas of this soil are irregular in shape, and they range from 5 to nearly 700 acres in size. The smaller areas extend southeastward.

Included with this soil in mapping were small areas of Ascalon sandy loam that generally are gently sloping. Also included were areas of gently sloping Valentine fine sand and Julesburg loamy sand. Small areas of sloping Haxtun soil, less than 5 acres in size, also occur on convex hills or ridges.

This nearly level Haxtun soil absorbs water rapidly and has moderate available water holding capacity. Soil blowing is likely unless the soil is protected, but there is little or no runoff.

This soil is suitable for dryfarming, irrigation farming, or range. In the dryfarmed fields, stubble-mulch tillage, use of crop residue, and wind stripcropping are helpful in controlling soil blowing. Because the surface layer is low in organic-matter content and available nitrogen, additions of fertilizer are required. In years of normal precipitation, crops respond well if nitrogen fertilizer is added. Sprinkler irrigation generally works best on this sandy soil because it requires light, frequent irrigations for good results.

Grasses grow well on this soil if the surface is moist and well covered with litter that forms a mulch before seeding. Grasses should be well established before they are grazed. Then, proper range use can be obtained if fences, water, and salt are well distributed and grasses are grazed by the right number of livestock at the proper season. Capability units IIIe-3 (dryland) and IIIe-6 (irrigated); Sandy Plains range site; windbreak suitability group 2.

Haxtun loamy sand, 3 to 5 percent slopes (HtC) occurs in areas that are mostly in the northwestern part of Phillips County. This soil is similar to Haxtun loamy sand, 0 to 3 percent slopes, but it is more sloping and occupies narrow ridges or side slopes that trend southeastward.

Included with this soil in mapping were small areas of Ascalon and Julesburg soils that are moderately sloping. A few limestone outcrops are in the northwestern part of the county. These spots are shown on the soil map by symbol.

This Haxtun soil is suitable for grazing and for limited cultivation. Small grain, corn, and sorghums are suitable crops; almost all of the acreage is cultivated.

Soil blowing is the main hazard. In the dryfarmed fields, stubble-mulch tillage or use of crop residue and wind stripcropping generally are helpful in controlling erosion. Close-growing crops hold the topsoil in place better than row crops. In irrigated fields sprinkler irrigation is probably best, but the water should be applied at frequent intervals. Because the sandy surface layer is low in organic-matter content, crops respond well to nitrogen fertilizer in moist years.

Areas that remain in grass should be protected from overgrazing because the surface layer eventually erodes after plant cover is lost. Eroded areas can be easily reseeded if the soil is moist and has a good cover of litter. Then, deferred grazing is required until the grasses are well established. A way to aid in obtaining proper range use is by spacing fences, watering points, and salt so that the range is more evenly grazed. Grazing should be allowed only during the proper season so that the grasses recover and make seed. Capability units IVe-3 (dryland) and IVe-5 (irrigated); Sandy Plains range site; windbreak suitability group 2.

Haxtun sandy loam, 0 to 3 percent slopes (HxB) occupies areas in the north-central, northwestern, and southeastern parts of the county. Except for having a sandy loam surface layer, the profile of this soil is similar to the one described as typical for the series.

Included with this soil, where sandy lands and hardlands merge, were small areas of Rago and Kuma soils.

This Haxtun soil is suited to grass or to dryfarmed and irrigated crops. The practice of following small grain or sorghums with summer fallow provides a suitable cropping sequence. Row crops grow well if the soil is irrigated. The surface layer is rapidly permeable, and the clay loam subsoil stores water well. The surface layer, however, is low in organic-matter content, and this soil responds well to additions of nitrogen fertilizer in years when precipitation is normal.

Almost all the acreage is cultivated. In dryfarmed fields working crop residue into the soil, stubble-mulch tillage, and wind stripcropping generally protect against soil blowing. In irrigated fields working crop residue into the soil and leveling that allows the water to spread uniformly are helpful in controlling erosion and maintaining fertility. Careful management of irrigation water is required. Irrigated pasture or hay plants grow well in this soil.

Grazing rangeland at the right season for a specified period insures an adequate grass cover for controlling erosion. A good way to force cattle to graze the entire range more evenly is by fencing separate areas and by providing well-placed watering points and salt blocks. Capability units IIe-1 (dryland) and IIe-3 (irrigated); Sandy Plains range site; windbreak suitability group 1.

Julesburg Series

The Julesburg series consists of deep, nearly level or gently sloping, sandy soils that are well drained. These soils are chiefly in the northwestern and southeastern parts of the county. They normally occupy flats or narrow, ridgelike areas that trend to the southeast. They are between or adjacent to areas of Valentine or Haxtun soils.

In a typical profile Julesburg soils have a loamy sand plow layer about 11 inches thick. It is grayish brown in the upper part and dark grayish brown in the lower part. The plow layer is free of lime and easily worked.

The subsoil is about 17 inches thick. It consists of dark grayish-brown sandy loam in the upper part and pale-brown loamy sand in the lower part. The subsoil is soft when dry and very friable when moist.

The underlying material is pale-brown loamy sand. It has been reworked locally by wind and water and, in some places, is slightly limy below a depth of 4 feet.

Because surface drainage channels are lacking or poorly established, these soils have very little runoff. Internal drainage is rapid, available water holding capacity is low, and fertility is moderate.

The native vegetation is mainly sandreed, needle-and-thread, and grama grasses. Cacti, yucca, and sages also grow well, especially where the soils have been overgrazed. About 50 percent of the acreage is farmed, mainly to winter wheat. The rest is used for pasture and hay. In addition to winter wheat, some corn, sorghums, dryfarmed alfalfa, and sweetclover are also grown.

Typical profile of Julesburg loamy sand, 0 to 3 percent slopes, in a cornfield (530 feet east and 2,530 feet north of the southwest corner of section 18, T. 6 N., R. 42 W.):

Ap1—0 to 5 inches, grayish-brown (10YR 5/2) loamy sand, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure to single grain (structureless); soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

Ap2—5 to 11 inches, dark grayish-brown (10YR 4/2) loamy sand, very dark brown (10YR 2/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

B2t—11 to 19 inches, dark grayish-brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure that breaks to weak, coarse, subangular blocky; soft when dry, very friable when moist; noncalcareous; thin, continuous clay films; clear, smooth boundary.

B3—19 to 28 inches, pale-brown (10YR 6/3) loamy sand, dark brown (10YR 4/3) when moist; massive (structureless) but breaks to weak, coarse, prismatic; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

C—28 to 60 inches, pale-brown (10YR 6/3) loamy sand, dark brown (10YR 4/3) when moist; massive (structureless); soft when dry, very friable when moist; noncalcareous.

The A horizon and the B2t horizon each range from 6 to 12 inches in thickness. Depth to lime ranges from 50 to 60 inches.

Julesburg soils have a higher content of organic matter and contain more silt and clay than the Valentine soils. Also, the surface layer in Julesburg soils is thicker than that in Valentine soils. Julesburg soils lack the dark, buried layer that occurs in the Haxtun soils.

Julesburg loamy sand, 0 to 3 percent slopes (JuB) mainly occupies areas in the northwestern and southeastern parts of the county, though some small areas are northeast of Amherst. Areas are irregular in shape but are generally about 40 acres in size. They lie in a southeast direction. The profile of this soil is the one described as typical for the Julesburg series.

Included with this soil in mapping were small areas of nearly level Haxtun loamy sand.

This soil is suitable for cultivation; either dryfarmed or irrigated crops and grass can be grown. Cropland and grassland make up about equal parts of the acreage. Soil blowing is the main hazard. In dryfarmed fields wind stripcropping, stubble mulching, and working crop residue into the soil help to protect against erosion and to maintain fertility and tilth. Close-growing crops should be grown in the cropping sequence much of the time. In irrigated areas the best way to keep the soil from eroding is by growing cover crops or green-manure crops and by carefully managing crop residue and irrigation water. Sprinkler irrigations that are light and frequent can be used. Irrigated pasture or hay plants also grow well on this soil. Capability unit IIIe–3 (dryland) and IIIe–6 (irrigated); Sandy Plains range site; windbreak suitability group 2.

Julesburg loamy sand, 3 to 5 percent slopes (JuC) occupies ridges and side slopes that trend southeastward. The areas are mostly in the northwestern and southeastern parts of the county. Except that the surface layer and subsoil are normally thinner, this soil has a profile similar to that described as typical for the series.

Included with this soil in mapping were small areas of Valentine and Haxtun soils. These areas of Haxtun soil are moderately sloping and less than about 8 acres in size.

This Julesburg soil is suited to a limited number of cultivated crops or to grass. The acreage is about equally divided between crops and grass.

In dryfarmed fields working crop residue into the soil, wind stripcropping, and stubble-mulch tillage are necessary to reduce the severe soil blowing. The surface layer erodes severely unless it is protected. A suitable cropping sequence is small grain or sorghums followed by summer fallow. Also suited is alfalfa. In irrigated fields small grains, corn, alfalfa and similar crops are suitable. Irrigated pasture or hay plants also grow well. Irrigations should be light and frequent and, where practical, crop residue should be worked into the soil. Cover crops can be grown successfully to protect the soil against erosion.

Areas that are still in grass should not be overgrazed, for this soil is subject to erosion. Grassland can be reseeded if the soil is moist and well covered with litter. Grazing should be deferred until grasses are well established, even though deferments for as much as two growing seasons are sometimes necessary. Proper range use is obtained by placing fences, water, and salt so that livestock graze the entire range. Capability units IVe–3 (dryland) and IVe–5 (irrigated); Sandy Plains range site; windbreak suitability group 2.

Kuma Series

The Kuma series consists of deep, well-drained, loamy soils that are nearly level to gently sloping. These soils formed in wind-deposited material, mostly in the central and northeastern parts of the county.

In a typical profile the plow layer is noncalcareous, grayish-brown loam about 5 inches thick. It is easy to till. The next layer, also grayish-brown loam, is about 3 inches thick, and it is soft when dry.

The subsoil, about 29 inches thick, is slightly hard, grayish-brown loam in the upper part and is dark-gray clay loam in the middle part. The lower part is slightly hard, light brownish-gray clay loam.

The underlying material is pale-brown loam that is very strongly calcareous.

These soils have moderate to slow permeability and medium runoff. The available water holding capacity and natural fertility are high.

Kuma soils are well suited to winter wheat, winter barley, and sorghums. They are also suited to native grass, but nearly all of the acreage is cultivated.

In Phillips County the Kuma soils were mapped only with the Rago soils in an undifferentiated group.

Typical profile of a Kuma loam in a field of winter wheat (1,585 feet north and 50 feet west of the southeast corner of section 36, T. 9 N., R. 44 W.):

Ap1—0 to 5 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

AB—5 to 8 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, thick, platy structure that breaks to weak, medium, subangular blocky; soft when dry, very friable when moist; noncalcareous; abrupt, smooth boundary.

B21t—8 to 16 inches, grayish-brown (10YR 5/2) heavy loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, prismatic structure that breaks to moderate, medium, subangular blocky; slightly hard when dry, friable when moist; thin, continuous clay films on vertical and horizontal faces of peds; noncalcareous; clear, smooth boundary.

B22tb—16 to 29 inches, dark-gray (10YR 4/1) clay loam, black (10YR 2/1) when moist; strong, medium and fine, prismatic structure that breaks to strong, fine, angular blocky; slightly hard when dry, firm when moist; thick, continuous clay films on vertical and horizontal faces of peds; noncalcareous; clear, smooth boundary.

B3b—29 to 37 inches, light brownish-gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, prismatic structure that breaks to moderate, medium, subangular blocky; slightly hard when dry, friable when moist; noncalcareous; thin, patchy clay films; many krotovinas filled with material from above, very dark grayish brown (10YR 3/2) when moist; clear, smooth boundary.

Cca—37 to 60 inches, pale-brown (10YR 6/3) loam, dark brown (10YR 4/3) when moist; weak, medium and thick, prismatic structure that breaks to weak, medium and coarse, subangular blocky; soft when dry, very friable when moist; very strongly calcareous; a layer of very fine sandy loam, dark brown (10YR 4/3) when moist, is at a depth of 46 to 60 inches; many krotovinas; gradual boundary.

In thickness, the A horizon ranges from 5 to 10 inches and the B21t horizon ranges from 6 to 15 inches. Depth to the top of the buried soil ranges from 12 to 18 inches. In some areas gravelly material underlies these soils at a depth of only 40 inches.

Kuma soils have less clay in their subsoil than Rago or Richfield soils. Kuma soils are deeper to the limy substratum than are Richfield soils and have weaker structure throughout.

Platner Series

The Platner series consists of deep, well-drained, loamy soils that are nearly level to moderately sloping. These soils are extensive in the hardlands in the southwestern part of the county. A few areas are also along the banks of small intermittent drainageways. These soils formed in a thin silty deposit of windblown material that has been mixed to some extent with the underlying sand and gravel.

In a typical profile the plow layer is grayish-brown loam about 5 inches thick. Fine gravel makes up about 5 percent of this layer. Clean sand grains are evident in the lower inch of this layer.

The subsoil is about 12 inches thick. The upper part, about 7 inches thick, is dark grayish-brown clay that is very hard when dry and firm when moist. The lower part is dark grayish-brown clay loam that is very hard when dry and friable when moist.

The underlying material is very pale brown, very strongly calcareous loam that is more sandy and limy as depth increases.

These soils have high natural fertility and available water holding capacity. They are well suited to dryland cultivation under normal management, but soil blowing and water erosion are hazards in cultivated areas. Plowpans form easily in these soils if they are tilled when wet.

Almost all the acreage is dryfarmed, mainly to winter wheat, barley, oats, and sorghums. In a few undisturbed, generally small areas, the native vegetation is mainly grama grasses.

Typical profile of Platner loam, 0 to 3 percent slopes, in a field of winter wheat (1,890 feet east and 200 feet north of the southwest corner of section 16, T. 7 N., R. 46 W.):

Ap—0 to 5 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; bleached sand grains and specks of light brownish gray (10YR 6/2) are evident in a layer 1 or 2 inches thick; 5 percent fine gravel; pH 6.4; noncalcareous; abrupt, smooth boundary.

B2t—5 to 12 inches, dark grayish-brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) when moist; strong, medium and fine, prismatic structure that breaks to strong, medium, angular blocky; very hard when dry, firm when moist; moderate, continuous clay films on vertical and horizontal ped faces; some bleached sand grains on tops of prisms; pH 7.2; noncalcareous; clear, smooth boundary.

B3—12 to 17 inches, dark grayish-brown (10YR 4/2) light clay loam, dark grayish brown (10YR 4/2) when moist; weak to moderate, medium, prismatic structure that breaks to weak to medium subangular blocky; very hard when dry, friable when moist; thin, patchy clay films on vertical and horizontal ped faces; streaks of very dark grayish brown (10YR 3/2) when moist, and brown (10YR 4/3) when moist, on some vertical ped faces; pH 7.6; noncalcareous; clear, smooth boundary.

C1ca—17 to 24 inches, very pale brown (10YR 8/3) loam, pale brown (10YR 6/3) when moist; weak, coarse, prismatic structure that breaks to weak, coarse, subangular blocky; hard when dry, friable when moist; strong accumulation of visible finely divided lime; pH 9.0; very strongly calcareous; clear, smooth boundary.

IIC2ca—24 to 48 inches, light yellowish-brown (10YR 6/4) fine sandy clay loam, yellowish brown (10YR 5/4) when moist; massive (structureless); hard when dry, very friable when moist; 40 to 50 percent fine gravel; moderate accumulation of lime in which visible lime occurs in finely divided forms, as coatings on the pebbles, and as common, medium-sized soft concretions; lower 14 inches slightly more sandy and contains more lime than upper part of horizon; pH 9.0; very strongly calcareous; clear, wavy boundary.

IIC3—48 to 60 inches, pinkish-white (7.5YR 8/2) very fine sandy clay loam, pink (7.5YR 7/4) when moist; massive (structureless); very hard when dry, friable when moist; strong accumulation of lime in marllike material; pH 9.0; very strongly calcareous.

The A horizon has little range in color or texture. In most areas it shows bleaching or clean sand grains on the structure faces in the lower inch, but the sand grains are normally mixed with the plow layer in cultivated areas. The A horizon ranges from 4 to 7 inches in thickness. The B horizon ranges from 5 to 12 inches in thickness and from dark grayish brown to dark brown in color. It is heavy clay loam or clay. Depth to lime ranges from 10 to 20 inches.

Platner soils developed in a thinner deposit of loess than the Rago soils, and they lack the dark, buried layer that occurs in the Rago soils. The subsoil of Platner soils is more clayey and more strongly developed than that of Ascalon soils.

Platner loam, 0 to 3 percent slopes (PaB) mainly occupies convex areas that are irregular in shape and are elongated in a southeast-northwest direction. This soil is also on side slopes along intermittent drainageways. Its profile is the one described as typical for the series.

Included with this soil in mapping were small areas of nearly level Rago soils in slightly depressional areas. Also included were a few small spots of gravel or caliche outcrops, which are shown on the soil map by a symbol.

Nearly all of this soil is cultivated. Soil blowing and water erosion are only slight in dryfarmed areas that are managed well, but plowpans form easily if this soil is tilled when wet. Suitable dryfarming practices are use of stubble mulch and crop residue. Where irrigated, this soil can be leveled so that water spreads uniformly and is not wasted. In irrigated areas, crop residue should be worked into the soil so as to maintain tilth and reduce erosion. Grass can be seeded and irrigated and then used for hay or pasture.

If this soil is used as range, a good way to avoid overgrazing is by fencing separate areas and by providing well-placed watering points and salt blocks. Reseeding overgrazed or eroded areas is a good practice, but grazing should be deferred until the grass is well established. Capability units IIc–1 (dryland) and IIe–2 (irrigated); Loamy Plains range site; windbreak suitability group 1.

Platner loam, 3 to 5 percent slopes (PaC) mainly occupies ridges and convex hills, but many areas border intermittent drainageways. The profile of this soil is similar to the one described as typical for the series, except that it contains more gravel and is more shallow to lime.

Included with this soil in mapping were small outcrops of gravel and of caliche. These spots are shown on the soil map by symbols. Also included were small spots of Eckley and Ascalon soils.

This Platner soil is suited to cultivated crops, and nearly all of it is cultivated. Plowpans may form if this soil is tilled when wet; however, both irrigated and dryfarmed crops common in the county are grown. Also suited is grass on range, pasture, and hayland. In dryfarmed fields stubble-mulch tillage and working crop residue into the soil give protection against erosion and help to maintain fertility. In the dryfarmed fields, terracing is needed for controlling water erosion and conserving moisture. Irrigated areas need to be leveled so that water spreads uniformly and is not wasted. In these areas, crop residue should be worked into the soil. Irrigated pasture or hay plants grow well on this soil.

Blue grama, western wheatgrass, and similar grasses grow well on rangeland. Proper range use can be obtained if fences, water, and salt are located so that livestock graze the entire range evenly. This soil can be reseeded easily if it is moist and well covered with plant litter. Capability units IIIe–1 (dryland) and IIIe–4 (irrigated); Loamy Plains range site; windbreak suitability group 1.

Platner-Eckley association, 3 to 5 percent slopes (PeC) occupies long, narrow convex ridges or round convex hills that trend to the southeast. The ridges are irregular in shape and range from about 8 to 40 acres in size. The hills are generally round and cover 8 to 15 acres. Platner soils are on the slopes, and Eckley soils are on ridge crests and tops of hills. The two kinds of soils are so closely associated that it is not practical to map them separately. Most areas of this association are east of Holyoke, though a few areas are southwest of Holyoke near the western edge of the sandhills.

About 60 percent of this association is Platner soils, and the rest is Eckley soils. Each kind of soil has a profile similar to the one described for its series.

Because the Eckley soils are shallow to sand and gravel, this association is not suitable for cultivation. Some areas are cultivated, but it is advisable to reseed the cultivated fields with native grasses, such as blue grama, western wheatgrass, side-oats grama, and little bluestem. Grasses can be established quickly if they are seeded when the soil is moist and has an adequate cover of plant litter. Grazing should be allowed only during the proper season and then be deferred so that the grasses recover before dormancy in winter. The best way to obtain proper range use is by fencing the areas and by spacing salting blocks and watering points so that the animals graze the range evenly. Capability unit VIe–3 (dryland); Platner soils are in Loamy Plains range site and windbreak suitability group 1; Eckley soils are in Gravel Breaks range site and windbreak suitability group 3.

Pleasant Series

The Pleasant series consists of deep, well-drained, loamy soils. These soils are nearly level and occur where intermittent streams are blocked by the sandhills in the loamy uplands. Nearly all of the acreage is south and southwest of Holyoke where loamy soils border the sandhills.

In a typical profile the surface layer is soft, gray loam about 5 inches thick. It is easily worked.

The subsoil is about 47 inches thick. In the upper part it is gray silty clay loam that is hard when dry and in the middle part is grayish silty clay or clay. At a depth of about 30 inches, the subsoil is an older, buried soil that consists of extremely hard, dark-gray clay and hard, pale-brown silty clay loam or silt loam. The underlying material is pale-brown gravelly loamy sand. These soils are noncalcareous throughout.

Cultivation is limited by occasional ponding. Permeability of the surface layer is moderate, but downward movement of water through the subsoil is slow. These soils have high available water holding capacity and natural fertility.

The native vegetation consists of blue grama, western wheatgrass, and buffalograss. Snakeweed is the main weed in overgrazed areas. About 80 percent of the acreage is cultivated. Winter wheat, winter barley, and sorghums are the main crops.

Typical profile of Pleasant loam in a pasture of native grass (1,055 feet east, 25 feet south of the northwest corner of section 4, T. 6 N., R. 45 W.):

A1—0 to 5 inches, gray (10YR 5/1) loam, very dark brown (10YR 2/2) when moist; strong, very fine, granular structure; soft when dry, very friable when moist; noncalcareous; pH 7.2; clear, smooth boundary.

B1—5 to 9 inches, gray (10YR 5/1) silty clay loam, very dark brown (10YR 2/2) when moist; moderate, medium, prismatic structure that breaks to moderate, medium, subangular blocky; hard when dry, very friable when moist; noncalcareous; pH 7.2; thin, patchy clay films; gradual, smooth boundary.

B21t—9 to 19 inches, gray (10YR 5/1) silty clay, very dark brown (10YR 2/2) when moist; strong, fine, prismatic structure that breaks to strong, fine, angular blocky; very hard when dry, firm when moist; noncalcareous; pH 7.3; thick, continuous clay films; clear, smooth boundary.

B22t—19 to 30 inches, grayish-brown (10YR 5/2) clay, very dark grayish brown (10YR 3/2) when moist; strong, fine, prismatic structure that breaks to strong, fine, angular blocky; very hard when dry, firm when moist; noncalcareous; pH 7.4; thick, continuous clay films; the lower 5 inches of the layer has slightly weaker structure than the upper part; clear, smooth boundary.

B23tb—30 to 40 inches, dark-gray (10YR 4/1) clay, very dark brown (10YR 2/2) when moist; strong, fine, prismatic structure that breaks to strong, fine, angular blocky; extremely hard when dry, very firm when moist; noncalcareous; pH 7.6; thin, continuous clay films; clear, wavy boundary.

B3b—40 to 52 inches, pale-brown (10YR 6/3) silty clay loam and silt loam, brown (10YR 5/3) when moist; structure is moderate, fine, angular blocky and moderate, medium, subangular blocky; hard when dry, very friable when moist; noncalcareous; pH 7.8; thin, patchy clay films; clear, wavy boundary.

IICb—52 to 60 inches, pale-brown (10YR 6/3) gravelly loamy sand, grayish brown (10YR 5/2) when moist; massive to single grain (structureless); slightly hard when dry, very friable when moist; noncalcareous; pH 7.8.

The A horizon ranges from 4 to 8 inches in thickness. The B2t horizon ranges from heavy silty clay loam to clay. When the soil is moist, very dark grayish-brown or darker colors extend to a depth of 20 to 50 inches. In most areas free lime has been leached to a depth of 60 inches, but a few areas are calcareous at a depth of 40 inches.

Pleasant soils have a more uniform color in the subsoil than have Rago soils. Also, Pleasant soils lack the distinct layer of accumulated lime that occurs in Rago soils.

Pleasant loam (0 to 3 percent slopes) (Ps) occupies the acreage in the south-central part of the county at the west and northwest edges of the sandhills.

Included with this soil in mapping were areas of Rago and Kuma loams. Also included were playas and a few areas having a surface layer of light clay loam.

Pleasant loam is deep and takes water slowly, but it does not release water readily to plants. Runoff is slow.

This soil is suitable for cultivation, and about half the acreage is cultivated. In dryfarmed areas, crops and grass for pasture or range are suited. Also suited are irrigated crops, pasture, or hay.

This soil periodically is flooded after heavy rains. If the soil is tilled when wet, plowpans tend to form in the upper part of the subsoil. Periodic chiseling when the soil is dry breaks up the plowpan. Stubble mulching or use of crop residue generally helps to reduce erosion in dryfarmed areas. Although the soil is nearly level, irrigated fields require leveling so that water spreads uniformly. Practices for controlling soil blowing and for maintaining fertility are careful management of irrigation water and working crop residue into the soil.

Blue grama, buffalograss, and western wheatgrass grow vigorously on this soil. In cultivated or overgrazed areas, reseeding is desirable if the soil is moist and covered with litter. All grazing should be deferred until the grass forms a good root system. Overgrazing can be avoided if salt, watering points, and fences are located so that animals graze the entire range. Capability units IIIs–1 (dryland) and IIe–2 (irrigated); Clayey Plains range site; windbreak suitability group 1.

Rago Series

The Rago series consists of deep, well-drained, loamy soils. These soils occur on uplands and are nearly level or gently sloping. They occupy broad, flat areas and are extensive throughout the county.

In a typical profile the plow layer is grayish-brown loam about 5 inches thick (fig. 6). It is easily worked.

The subsoil is about 21 inches thick. The upper part is dark grayish-brown, slightly hard loam and hard clay loam. The middle part is dark-gray, hard silty clay loam, and the lower part is pale-brown, slightly hard silty clay loam that is strongly calcareous and contains visible lime.

The underlying material is very pale brown loam and silt loam that is very strongly calcareous and contains visible lime.

Surface runoff is medium, because these soils are not more than gently sloping and have a moderately permeable surface layer. They have a high capacity to hold water and are high in natural fertility.

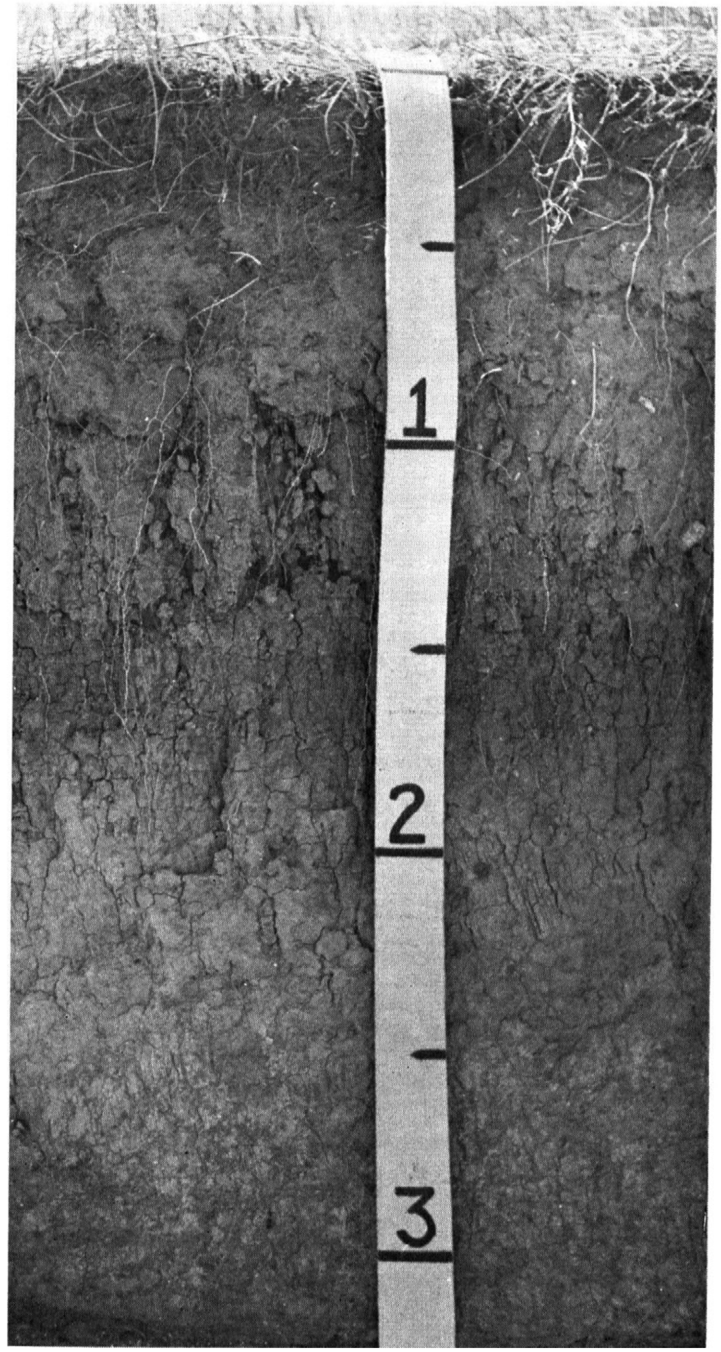

Figure 6.—Profile of Rago loam.

Except for a few small areas, the Rago soils are dryfarmed. Winter wheat, barley, and sorghums are the main crops. Some oats are grown in a few areas. The native vegetation consists mainly of western wheatgrass and blue grama grasses.

Typical profile of Rago loam in a field of wheat stubble (295 feet west and 84 feet north of southeast corner of section 36, T. 8 N., R. 43 W.):

Ap—0 to 5 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, thin to very thick, platy structure that breaks to weak, fine granular; hard when dry, friable when moist; noncalcareous; abrupt, smooth boundary.

B1—5 to 9 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate, coarse, subangular blocky structure that breaks to moderate, medium, subangular; slightly hard when dry, firm when moist; noncalcareous; about 2 percent fine gravel; clear, smooth boundary.

B21t—9 to 14 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, prismatic structure that breaks to moderate, fine, subangular blocky; hard when dry, friable when moist; noncalcareous; very thin, patchy clay films; clear, smooth boundary.

B22tb—14 to 23 inches, dark-gray (10YR 4/1) silty clay loam, very dark brown (10YR 2/2) when moist; strong, medium, prismatic structure that breaks to strong, fine, subangular blocky; hard when dry, firm when moist; noncalcareous; thick, nearly continuous clay films; gradual, smooth boundary.

B3cab—23 to 26 inches, pale-brown (10YR 6/3) silty clay loam, dark brown (10YR 4/3) when moist; moderate, medium, prismatic structure that breaks to moderate, medium, subangular blocky; slightly hard when dry, friable when moist; strongly calcareous; visible lime along cleavage lines; about 5 percent of the horizon is very dark grayish brown (10YR 3/2) when moist; clear, wavy boundary.

C1ca—26 to 43 inches, very pale brown (10YR 8/3) loam, pale brown (10YR 6/3) when moist; moderate, medium, prismatic structure that breaks to moderate, medium, subangular blocky; slightly hard when dry, very friable when moist; very strongly calcareous; lime prominent, but lower part of horizon contains less lime than upper part; about 2 percent fine gravel; clear, wavy boundary.

C2—43 to 60 inches, very pale brown (10YR 8/3) silt loam, very pale brown (10YR 7/3) when moist; massive (structureless); hard when dry, friable when moist; very strongly calcareous.

The A horizon ranges from 5 to 8 inches in thickness, and the B2t horizon ranges from 10 to 20 inches in thickness. When moist the B22tb horizon is black to very dark brown. Depth to lime ranges from 22 to 38 inches. In some areas a gravel bed underlies the loess at a depth of 40 inches or more.

Rago soils are associated with the Kuma and Richfield soils. In contrast to Richfield soils, Rago soils have a black to dark-brown layer in the subsoil and are deeper to the limy substratum. Rago soils have a more clayey B2t horizon than the Kuma soils.

Rago and Kuma loams (0 to 3 percent slopes) (Ra) are in broad areas of the uplands. These soils are so similar that it is not practical to map them separately. This mapping unit is the most extensive one in Phillips County. Areas generally extend in a southeast direction and range from 40 to 400 acres in size. About 70 percent of the unit is Rago soil, and 30 percent is Kuma soil, but some fields are all Rago soil, and others are all Kuma soil.

Included in mapping were small areas of Platner, Richfield, and Dawes soils. The Platner soil is in the western part of the county, the Richfield soil is in the eastern part, and the Dawes soil is in both the central and western parts. Also included were areas of a soil that is similar to Rago loam, except that gravelly material is at a depth of about 24 inches. Many small intermittent lakes or potholes are within mapped areas and are shown on the soil map by a symbol.

Rago and Kuma loams absorb water at a moderate to slow rate, and runoff causes erosion during some storms. These soils have high available moisture capacity.

Almost all the acreage is cultivated. The soils in this group are well suited to winter wheat, barley, sorghums, and corn that are dryfarmed. They also are suited to many kinds of irrigated crops. In dryfarmed fields, the practice of following small grain or sorghum with summer fallow helps in maintaining soil moisture and fertility. Stubble mulching and working crop residue into the soil are practices needed for controlling erosion.

In irrigated fields the soils can be leveled so that the water spreads uniformly. The crops respond well if fertilizer is added. Working crop residue into the soil helps to control erosion and to maintain fertility and tilth. Blue grama, western wheatgrass, and similar grasses grow well where these soils are used as range. Capability units IIc–1 (dryland) and IIe–2 (irrigated); Loamy Plains range site; windbreak suitability group 1.

Richfield Series

The Richfield series consists of deep, well-drained, loamy soils of the uplands. These soils occur mainly in the northeastern part of the county and are nearly level to moderately sloping.

In a typical profile the surface layer is grayish-brown loam about 6 inches thick. It is easily worked.

The subsoil, about 14 inches thick, is noncalcareous. It is grayish-brown, hard clay loam in the upper part, slightly hard, dark grayish-brown clay loam in the middle part, and slightly hard, light brownish-gray loam in the lower part.

Underlying the subsoil is very pale brown loam or very fine sandy loam that was deposited by wind and then reworked locally by wind and water. The underlying material is very strongly calcareous or strongly calcareous. It contains much accumulated lime.

Runoff is medium where slopes are nearly level, but it is rapid where they are gently sloping or moderately sloping. The available water holding capacity and natural fertility are high.

Most of the acreage of Richfield soils is cultivated. These soils are suited to winter wheat and sorghums. The native vegetation consists mostly of western wheatgrass and blue grama, but some buffalograss grows in depressional areas where more clay has accumulated in the subsoil. Snakeweed is a common perennial weed where the native grasses have been overgrazed.

Typical profile of Richfield loam, 0 to 3 percent slopes, in a cultivated wheatfield (530 feet east, 2,540 feet north of the southwest corner of section 23, T. 9 N., R. 43 W.):

Ap—0 to 6 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

B1—6 to 10 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure that breaks to weak, coarse, subangular blocky; hard when dry, firm when moist; very thin, patchy clay films on vertical and horizontal faces of peds; noncalcareous; clear, smooth boundary.

B2t—10 to 15 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, prismatic structure that breaks to moderate, medium and fine, subangular blocky; slightly hard when dry, firm when moist; thick, continuous clay films on vertical and horizontal faces of peds; noncalcareous; clear, smooth boundary.

B3—15 to 20 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) when moist; weak to moderate, medium, prismatic structure that breaks to weak to moderate, medium, subangular blocky; slightly hard when dry, very friable when moist; very thin, patchy clay films on vertical and horizontal faces of peds; noncalcareous; clear, smooth boundary.

C1ca—20 to 33 inches, very pale brown (10YR 8/3) loam, pale brown (10YR 6/3) when moist; weak to moderate, coarse, prismatic structure that breaks to weak to moderate, coarse, subangular blocky; soft when dry, very friable when moist; moderate accumulation of visible, finely divided lime; very strongly calcareous; krotovinas; clear, wavy boundary.

C2ca—33 to 53 inches, very pale brown (10YR 7]3) very fine sandy loam, brown (10 YR 5/3) when moist; massive (structureless) to weak, very coarse, prismatic structure; soft when dry, very friable when moist; weak to moderate lime accumulation; strongly calcareous; clear, wavy boundary.

IIC3ca—53 to 60 inches, very pale brown (10YR 7/3) sandy loam that grades to reddish-brown gravel bed of Grand Island formation; brown (10YR 5/3) when moist; massive (structureless); soft when dry, very friable when moist; strongly calcareous.

The A1 horizon ranges from 3 to 7 inches in thickness and from loam to very fine sandy loam in texture. The B2t horizon ranges from 5 to 10 inches in thickness and from clay loam to clay in texture.

The Richfield soils are associated with the Platner and Rago soils. Richfield soils have less clay in the subsoil than Platner soils and formed in windblown silty material instead of gravelly material. The subsoil of the Richfield soils is thinner than that of the Rago soils, which have a distinct buried layer.

Richfield loam, 0 to 3 percent slopes (RcB) occupies irregularly shaped areas in the northeastern corner of the county. The areas generally range from 8 to 100 acres in size. Within areas of this soil are many intermittent lakebeds, ½ acre to 5 acres in size, and a few larger than 5 acres. This soil has the profile described as typical for the series.

Included with this soil in mapping were small areas of Rago and Kuma loams and of Weld and Dawes soils. The Dawes soils are mostly in the western part of the country, but Weld and Rago soils are in the northeastern part.

This Richfield soil takes in water slowly, but it has high water holding capacity and natural fertility. It is suited to both irrigated and dryfarmed crops and grass on pasture or range and irrigated hay plants. Almost all the acreage is cultivated.

Special care is required in tillage because a plowpan forms easily if the soil is tilled when it is too moist. Chiseling, however, can be used to break up the plowpan when the soil is nearly dry. Stubble-mulch tillage and working crop residue into the soil are practices suitable for controlling erosion. In dryfarmed fields, a suitable cropping system is winter wheat or barley followed by a period of summer fallow. Such cropping helps to maintain soil fertility and tilth. In irrigated fields this soil can be leveled so that water spreads uniformly. Practices also helpful are careful management of irrigation water and keeping crop residue on the surface or working it into the soil. Crops respond well when fertilizer is added in irrigated areas. Small grains, row crops, alfalfa, and grass grow well in these areas. Capability units IIc–1 (dryland) and IIe–2 (irrigated); Loamy Plains range site; windbreak suitability group 1.

Richfield loam, 3 to 5 percent slopes (RcC) occupies convex ridges that trend to the southeast in the northeastern part of the county. The areas are generally long and narrow. The surface layer is about 3 to 5 inches thick and is slightly thinner than the one described as typical for the series.

Included with this soil in mapping were convex areas of Platner soils, generally less than 8 acres in size.

This Richfield soil takes in water slowly, and it is capable of holding a large amount available for plants. It has high natural fertility.

This soil is suited to both irrigated and dryfarmed crops, and almost all the acreage is cultivated. It also is suited to irrigated pasture and hay plants and to grass on pasture or range. Winter wheat, barley, and sorghums are grown in dryfarmed fields. Grown in a few irrigated areas are sorghums, small grains, and alfalfa. If this soil is not protected, it is susceptible to erosion.

The main management concerns are conserving the soil and maintaining tilth and fertility. Among the practices needed are stubble-mulch tillage and working crop residue into the soil. In irrigated fields the soil can be leveled so that water spreads uniformly. Terracing is needed to conserve the soil and the water falling on this soil. In irrigated areas crops respond to applications of fertilizer. Chiseling helps break up plowpans if they form in these areas.

On rangeland a good way to avoid overgrazing is by providing well-placed watering points and salt blocks and by fencing. This soil can be reseeded if the surface is moist and covered with litter. Capability units IIIe–1 (dryland) and IIIe–4 (irrigated); Loamy Plains range site; windbreak suitability group 1.

Valentine Series

The Valentine series consists of deep, excessively drained soils of the upland sandhills. These soils are rolling or hilly and occur mostly in the southeastern part of the county.

In a typical profile the surface layer is grayish-brown fine sand about 4 inches thick (fig. 7). Beneath this, and extending to a depth of 12 inches, is brown fine sand that is very friable to loose when moist and very soft when dry.

The underlying material consists of windblown, pale-brown fine sand that is free of lime to a depth of about 60 inches.

The Valentine soils have low available moisture holding capacity. Because the porous surface layer absorbs moisture rapidly, there is little runoff and water erosion is not significant. Soil blowing is the main hazard, especially in areas that have been overgrazed. The vegetation needs to be protected from overgrazing.

Practically all the acreage of Valentine soils is native range, for which these soils are well suited. The native vegetation consists mainly of sandreed, sand bluestem, needle-and-thread, sand dropseed, and switchgrass. Also occurring are sagebrush, yucca, and some weeds.

Typical profile of Valentine fine sand in native grass pasture (500 feet west and 100 feet south of the northeast corner of section 24, T. 9 N., R. 46 W.):

A1—0 to 4 inches, grayish-brown (10YR 5/2) fine sand, very dark grayish brown (10YR 3/2) when moist; very weak, fine, granular structure that breaks to single grain (structureless); soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

AC—4 to 12 inches, brown (10YR 5/3) fine sand, dark brown (10YR 4/3) when moist; very weak, coarse, prismatic

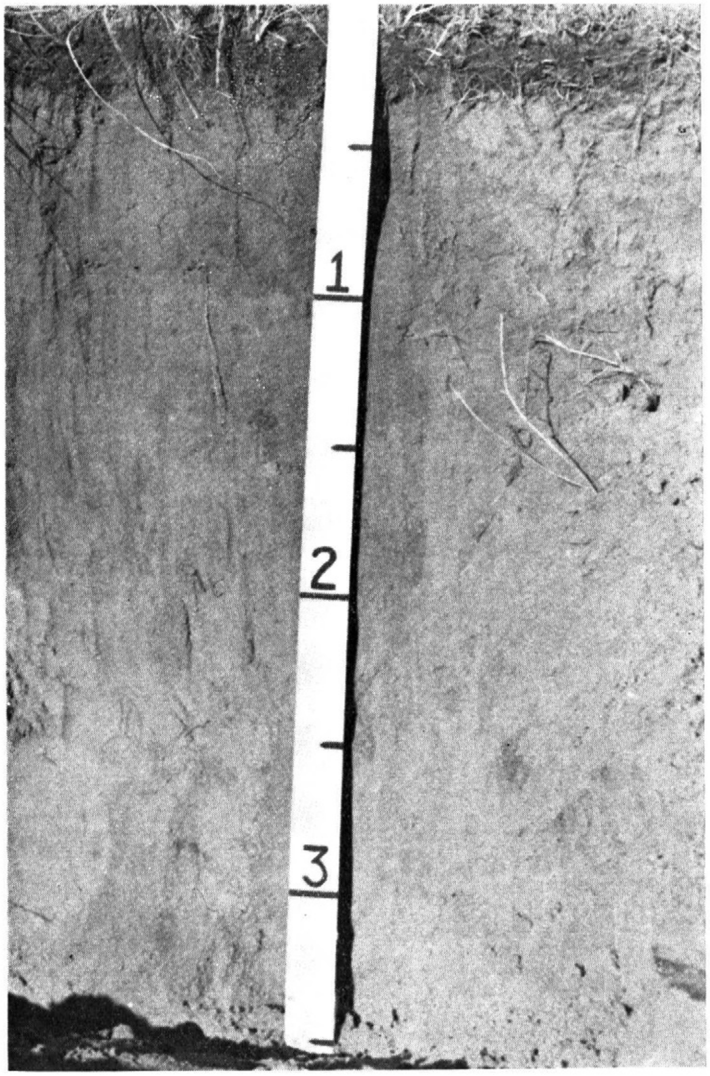

Figure 7.—**Profile of Valentine sand showing the thin surface layer**

structure that breaks to single grain (structureless); very soft when dry, very friable to loose when moist; gradual, smooth boundary.

C—12 to 48 inches +, pale-brown (10YR 6/3) fine sand, dark brown (10YR 4/3) when moist; single grain (structureless); loose when dry and moist; noncalcareous.

The A horizon ranges from 0 to 6 inches in thickness. The thickest surface layers are in the least sloping areas.

The Valentine soils are associated with the Julesburg soils. Valentine soils have a thinner surface layer than the Julesburg soils and less clay in the underlying layer. Valentine soils are less well developed throughout the profile than the Julesburg soils and have less thickness of dark soil material.

Valentine fine sand, rolling (VaD) occupies most of the sandhills that are southeast of Holyoke. This soil is associated with Haxtun soils in some small areas in the north-central and northwestern parts of the county. Slopes are moderate to steep. The profile of this soil is similar to the one described as typical for the series.

Included with this soil in mapping were a few small blowouts ½ acre to 5 acres in size. These areas are shown on the soil map by a symbol.

This Valentine soil is extremely droughty in dry years, mainly because it is excessively drained and low in available water holding capacity. This soil has very rapid permeability.

Growing in most areas are sandreed, sand bluestem, switchgrass, needle-and-thread, and other native mid and tall grasses. This soil is well suited to these plants, but grazing should be limited because of susceptibility to severe blowing. This soil can be reseeded with adapted species of native grasses, but the steep slopes make management difficult. A few small areas are cultivated, mainly for the purpose of squaring larger fields of other soils and making them easier to cultivate. Capability unit VIe-2 (dryland); Deep Sand range site; windbreak suitability group 4.

Valentine fine sand, hilly (VaE) occupies dunelike areas that have steep, abrupt slopes on the leeward side. This soil is in the south-central and southeastern parts of the county. The surface layer of this soil is severely eroded, is very dark grayish brown, and is as much as 2 inches thick.

This soil is suited to native grasses, but extreme limitations are needed to prevent overgrazing. Even though the plant cover generally is increasing, many areas are nearly bare. Revegetation is extremely difficult, though it can be done through careful management of grass in blowouts and of annuals and yucca. This soil is droughty because it is very rapidly permeable, excessively drained, and low in available water holding capacity. Capability unit VIIe-1 (dryland); Choppy Sand range site; windbreak suitability group 4.

Wages Series

The Wages series consists of deep, well-drained, loamy soils that are gently sloping to steep. These soils occupy the side slopes of intermittent streams (fig. 8), and most areas are along Frenchman and Patent Creeks. Wages soils formed in a reddish-brown gravelly deposit. The upper part of the soil has been mixed with some windblown silty material.

In a typical profile the surface layer is grayish-brown loam about 5 inches thick. The subsoil is about 11 inches thick. In the upper part it is dark grayish-brown, slightly hard clay loam that is about 5 percent fine gravel. The lower part is limy, light brownish-gray clay loam that is about 5 to 10 percent fine gravel.

At a depth of 16 to 24 inches is very strongly calcareous, light brownish-gray loam. Below this is light-brown gravelly sandy loam that is free of lime.

Wages soils are moderately to slowly permeable and are well drained. Because they have a thin loam surface layer over a slowly permeable clay loam subsoil and are gently sloping to steep, surface runoff is medium to rapid. Because their subsoil is somewhat gravelly, they have moderate available water holding capacity. Wages soils are moderate in natural fertility.

Along side slopes of intermittent streams are a few areas of Wages soils that are still in native grass, mainly western wheatgrass and blue grama. Grasses are better suited than row crops, and only a few acres are cultivated. These soils can be seeded to grass.

Figure 8.—Landscape of the Wages-Eckley-Dix complex.

Typical profile of a Wages loam in pasture of native grass (1,850 feet west, 225 feet south of the northeast corner of section 17, T. 7 N., R. 47 W.) :

A—0 to 5 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; noncalcareous; pH 7.4; clear, smooth boundary.

B2t—5 to 14 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, prismatic structure that breaks to moderate, medium, subangular blocky; slightly hard when dry, friable when moist; noncalcareous; pH 7.6; very thin, nearly continuous clay films; 5 percent fine gravel; clear, smooth boundary.

B3ca—14 to 16 inches, light brownish-gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, prismatic structure that breaks to weak, medium, subangular blocky; slightly hard when dry, friable when moist; strongly calcareous; pH 8.0; 5 percent fine gravel; clear, smooth boundary.

C1ca—16 to 24 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) when moist; massive (structureless) to weak, coarse, subangular blocky structure; hard when dry, friable when moist; very strongly calcareous; pH 8.2; krotovinas of very dark grayish brown (10YR 3/2) when moist; 5 to 10 percent fine gravel; gradual boundary.

IIC2—24 to 60 inches, light-brown (7.5YR 6/4) gravelly sandy loam, dark brown (7.5YR 4/4) when moist; massive (structureless); soft when dry, very friable when moist; noncalcareous; pH 8.2.

The A horizon ranges from 3 to 7 inches in thickness, and it is loam or gravelly loam. In many areas the surface is covered with pebbles as much as about 3 inches in diameter.

The B2t horizon is 6 to 15 inches thick, and it is more compact and darker in the upper part than in the lower. Depth to layers of accumulated lime ranges from 9 to 20 inches, and depth to the underlying gravelly material is 20 to 40 inches.

Wages soils have a less clayey subsoil than occurs in Richfield or Platner soils. Wages soils have more gravel but are less sandy than Ascalon soils.

Wages-Campus-Weld loams, 0 to 3 percent slopes (WcB) are in a broad area near the northeastern corner of the county. These soils are so closely associated that it is not practical to map them separately. About 50 percent of the complex is Wages soil, 25 percent is Campus soil, and 15 percent is Weld soil. Wages and Campus soils are on the side slopes, and Weld soil is on the convex ridgetops. Each kind of soil has a profile similar to the one described as typical for its series.

Included with these soils were small areas of Richfield soil that make up about 10 percent of the area mapped. The included areas are closely associated with Campus soil, generally on knobs, or in sags where the soil material has been reworked considerably and a thin mantle of loess deposited.

The soils in this complex take in water well and have moderate to high available water holding capacity. Chiseling can be used to break up plowpans that form if the soils are tilled when wet. In a few spots, flat fragments of limestone as much as 3 to 12 inches in diameter cover the surface.

These soils are suitable for cultivation or as rangeland. Nearly all of the acreage is cultivated. In dryfarmed fields winter small grains, sorghums, and similar crops grow well. Erosion can be controlled if stubble-mulch tillage is used and these soils are summer fallowed after crops are harvested. In some fields emergency tillage is needed for reducing soil blowing. In addition to small grains and sorghums, alfalfa, corn, and sugar beets are suited in irrigated areas. In these areas crop residue and manure should be worked into the soil. Irrigated crops respond if fertilizer is applied.

On rangeland blue grama, western wheatgrass, little bluestem, and buffalograss grow well. These native grasses can be reseeded if the soil is moist and well covered with litter. Proper range use can be obtained by locating fences, water, and salt so that animals graze the entire area. Capability units IIIs–2 (dryland) and IIe–2 (irrigated); Loamy Plains range site; windbreak suitability group 1.

Wages-Campus-Weld loams, 3 to 5 percent slopes (WcC) occur mostly in the western part of the county. They occupy old, high land surfaces that have been covered with windblown silt. These areas generally occupy convex ridges that trend southeastward. Some areas of Wages and Campus soils are on side slopes adjacent to nearly level areas of Dawes loam, but the Weld soil does not occur in these areas.

Wages soil makes up about 50 percent of the complex; Campus soil, 25 percent; and Weld soil, 15 percent. Wages and Campus soils are on the slopes, and the Weld soil is on the narrow, convex ridgetops. These soils are so closely associated that it is not practical to map them separately. Each kind of soil has a profile similar to the one described for its series.

Included in mapping were small areas of Platner soils that occupy the toe slopes of the ridges. Also included were a few small spots of Canyon soils near spots where limestone crops out. The limestone is a hazard to farm machinery. Also occurring were a few small areas having slopes of 5 to 9 percent.

These soils take in water moderately well. Their available water holding capacity is moderate to high. Because slopes are gentle, runoff is considerable during heavy rains, which causes small rills to form. Plowpans tend to form in the soils if they are tilled when wet.

Soils in this complex are suitable for limited cultivation or as rangeland. Nearly all the acreage is cultivated. A suitable practice in dryfarmed fields is stubble-mulch tillage for controlling erosion and maintaining tilth and fertility. Tilth and fertility are also maintained by working crop residue into the soil, emergency tillage, and constructing terraces on the longer slopes. These practices also conserve moisture. In the irrigated areas, crops respond to applications of fertilizer.

On rangeland grasses grow well if fences, water, and salt are properly placed so that livestock graze the entire range. Seedlings emerge quickly if the range is reseeded when the soil is moist and has a good cover of litter. Then, grazing should be deferred until the young plants are well established. Capability units IVe–1 (dryland) and IIIe–5 (irrigated); Loamy Plains range site; windbreak suitability group 1.

Wages-Eckley-Dix complex, 5 to 25 percent slopes (WeE) occupies areas along intermittent drainageways, principally Frenchman and Patent Creeks. These soils are so intermingled that it is not practical to map them separately.

Included with these soils in mapping were nearly level to moderately sloping soils on stream terraces and channel bottoms. The channel bottoms are shown on the soil map by a symbol for drainage. Also included were small areas where the soil is shallow over gravel and calcareous throughout.

About 60 percent of this complex is Wages soils, 18 percent is Eckley soils, and 12 percent is Dix soils. Each kind of soil has the profile described as typical for its series. The rest of the complex consists of areas of Platner and Ascalon soils. In hardland or sandy land areas, the Ascalon soils occur on the south banks of the streams and Platner soils are at the upper edges of side slopes.

These soils take water at a moderate to rapid rate. Where they are shallow, their capacity to hold water is limited. If rains are heavy, runoff is considerable and causes rill erosion. Also, extra water from runoff frequently concentrates and floods the Dix soils. Erosion control dams could be built to control this water.

The complex is not suitable for cultivation, mainly because it is erodible, shallow, and sloping to steep. The areas should be seeded with native grasses. In the more accessible areas, overgrazing is prevented by placing water, fences, and salt so that the livestock graze the entire range. Although reseeding may be difficult in some eroded or overgrazed areas, seeds germinate quickly if the soil is moist and covered with litter. Young plants should not be grazed until they are well established. Capability unit VIe–3 (dryland); Wages soils are in Loamy Plains range site and windbreak suitability group 1; Eckley soils are in Gravel Breaks range site and windbreak suitability group 3; and Dix soils are in Gravel Breaks range site and windbreak suitability group 2.

Weld Series

The Weld series consists of deep, well-drained, loamy soils that are nearly level to gently sloping. These soils are in the western and extreme northeastern parts of the county (fig. 9). They formed in loamy eolian, or loessal, materials. In a typical profile the surface layer is about 6 inches thick. It is grayish-brown loam in the upper part and dark grayish-brown loam in the lower part.

The subsoil is about 10 inches thick and noncalcareous. The upper part is very hard, dark grayish-brown clay, and the lower part is hard, dark grayish-brown very fine sandy loam.

The underlying material is very pale brown loamy material that contains many fragments of limestone as much as 1 inch in diameter.

Because the surface layer of the Weld soils is a thin deposit of loam overlying a very slowly permeable subsoil, runoff is rapid on moderately sloping areas. Hard-

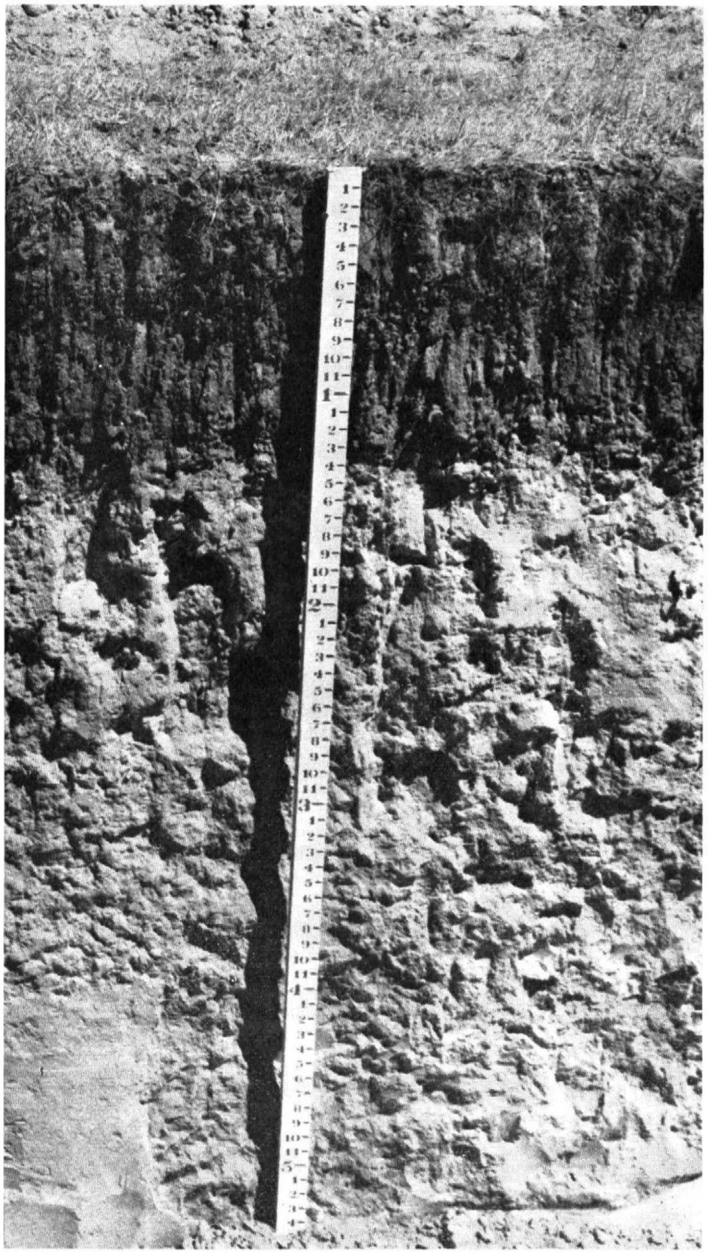

Figure 9.—Profile of Weld loam.

pans form easily if these soils are tilled when wet. The available water holding capacity is high. Erosion can be controlled by stubble-mulch tillage or management of crop residue.

Almost all the acreage is used for winter wheat, barley, and sorghums. Only a few small areas are still in blue grama, western wheatgrass, and some buffalograss.

In Phillips County Weld soils are mapped only in complexes with Wages and Campus soils.

Typical profile of Weld loam in a wheatfield (790 feet south and 1,055 feet east of the northwest corner of section 29, T. 7 N., R. 46 W.):

Ap—0 to 4 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

A2—4 to 6 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, platy structure that breaks to weak, medium, granular; soft when dry, very friable when moist; noncalcareous; evident graying; abrupt, smooth boundary.

B2t—6 to 12 inches, dark grayish-brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) when moist; mainly strong, medium, prismatic structure that breaks to strong, fine, angular and subangular blocky, but some strong, medium, columnar structure; very hard when dry, friable when moist; thick, continuous clay films on all ped faces; noncalcareous; clear, smooth boundary.

B3—12 to 16 inches, dark grayish-brown (10YR 4/2) very fine sandy loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, prismatic structure that breaks to moderate, medium, subangular blocky; hard when dry, friable when moist; thin, patchy clay films; noncalcareous; clear, smooth boundary.

C1ca—16 to 30 inches, very pale brown (10YR 7/3) loam, brown (10YR 5/3) when moist; upper part of horizon weak, medium, prismatic structure that breaks to weak, medium, subangular blocky; slightly hard when dry, very friable when moist; many krotovinas; lower part of the horizon is slightly lighter colored than upper part; is massive (structureless) and contains many fragments of limestone ½ to 1 inch in diameter; very strongly calcareous; clear, smooth boundary.

IIC2ca—30 inches +, very pale brown (10YR 7/4) fine sandy loam, yellowish brown (10YR 5/4) when moist; massive (structureless); soft when dry, very friable when moist; very strongly calcareous.

The A1 horizon ranges from 3 to 5 inches in thickness. The A2 horizon is more than 2 inches thick in only a few places, and it is barely visible in many places. The B2t horizon ranges from 5 to 10 inches in thickness and from heavy clay loam to clay in texture. Depth to the layer of accumulated lime ranges from 8 to 20 inches. Depth to the underlying loess ranges from 30 inches to more than 6 feet.

Weld soils have more clay in their subsoil than Richfield soils and also have a leached layer (A2 horizon) that is lacking in Richfield soils. Weld soils formed in uniform windblown material, whereas Platner soils formed in mixed silty and gravelly material.

Use and Management of Soils

The soils of Phillips County are used mainly for dryfarming and to less extent for irrigation and native grass range. This section discusses the management of soils for these purposes and gives predicted yields of the principal crops. Also, this section explains the capability classification of the soils in the county and discusses uses of the soils as range, as sites for windbreaks, as wildlife habitat and recreational areas, and for building roads, farm ponds, and other engineering structures.

Use and Management of Soils as Cropland [2]

This subsection describes the management generally followed on dryfarmed and irrigated soils in the county and the yields to be expected on both kinds of soil. It also briefly explains the system of capability classification used by the Soil Conservation Service and lists the capability units represented in the county. Those who wish to know

[2] CHARLES H. ALLEN, work unit conservationist, Soil Conservation Service, assisted in preparing this subsection.

the capability classification of a particular soil can refer to the "Guide to Mapping Units" at the back of this publication. Those who desire detailed information about the management of a soil can turn to the section "Descriptions of the Soils."

Management of dryfarmed soils

Most of the cropland in Phillips County is dryfarmed, mainly to winter wheat, corn, grain sorghum, forage sorghum, and millet (fig. 10). Minor crops are barley, oats, rye, alfalfa, and safflower.

The average annual precipitation in Phillips County is about 18 inches, but it ranges from 12 inches in some years to 26 inches in others. Because climate is semiarid and winds are high in spring, proper management of the soils is necessary for maintaining good crop growth. Normally, moisture is not sufficient for continuous cropping, but by alternating fallow and crops on most of the dryfarmed soils enough moisture is retained for good crop growth.

In dryfarmed fields good management provides those practices that control soil blowing and water erosion, make effective use of limited rainfall, prevent deterioration in soil structure, and maintain the supply of organic matter.

Figure 10.—Top: **Sorghum on stripcropped Haxtun loamy sand.** *Bottom:* **Winter wheat that shows well-developed heads and uniform growth. The wheat is ready for harvesting. The soils are Rago and Kuma loams.**

Among these practices are contour farming, terracing (fig. 11), stripcropping, subsoiling and chiseling, the use of a fallow period to enable the soil to conserve moisture, and proper use of crop residue, as in stubble mulching. Where feasible, grassed waterways can be constructed to reduce erosion. Emergency tillage may be necessary during spring on fields that are not sufficiently protected by growing crops or crop residue.

Management of irrigated soils

According to the 1964 Census of Agriculture, irrigated land in Phillips County amounted to 6,400 acres. The irrigation water is from deep wells. It is pumped to the surface and used in gravity or sprinkler systems to irrigate the soils. The main crops grown under irrigation are sugar beets, corn, alfalfa, beans, and small grains. Potatoes are also grown.

Good management of irrigated soils includes practices that control soil blowing and water erosion, that prevent deterioration in soil structure, and that maintain the content of organic matter in the soil. Among the practices needed is land leveling, which should be used on nearly level to gently sloping Dawes, Platner, Pleasant, Rago, Kuma, Richfield, Wages, Campus, Weld, Ascalon, and Haxtun loamy soils. On these soils chiseling and subsoiling also can be used. Cover crops and green-manure crops can be planted on nearly level to moderately sloping Haxtun loamy sand and Julesburg and Dunday soils. Other practices that benefit most irrigated soils in the county are managing irrigation water and crop residue, rotating grasses and legumes in the cropping sequence, emergency tillage, minimum tillage, stubble mulching, and planting or renovating pasture and hayland. These practices can be applied singly or in combination, depending on the kind of soil.

Predicted yields

Yields predicted for the principal nonirrigated crops in Phillips County are given in table 2, and the yields predicted for the main irrigated crops are given in table 3. These are averages for a period of years, not yields for any particular year. The predictions are based on yield records published in Colorado Agricultural Statistics (7) and on information obtained from farmers, personnel of the Soil Conservation Service, the county agricultural agent, and the Phillips County Agricultural Stabilization and Conservation Service.

In making these predictions, losses from hail, drought, or other damaging factors were taken into account and only the years when crops were seeded were considered. Nonirrigated soils, as a rule, are seeded to crops every second year and are left fallow in the alternate years. Only the soils generally used for crops are included in tables 2 and 3.

The yields shown in columns A are those that can be expected under a common level of management. Those shown in columns B are the yields that can be expected under a high level of management.

Crop yields depend chiefly on the tilth and fertility of the soils and on a sufficient supply of moisture at planting time and throughout the growing season. Consistent high yields on any soil indicate that the soil has been managed well. Fertility has been kept at a high level, tilth has

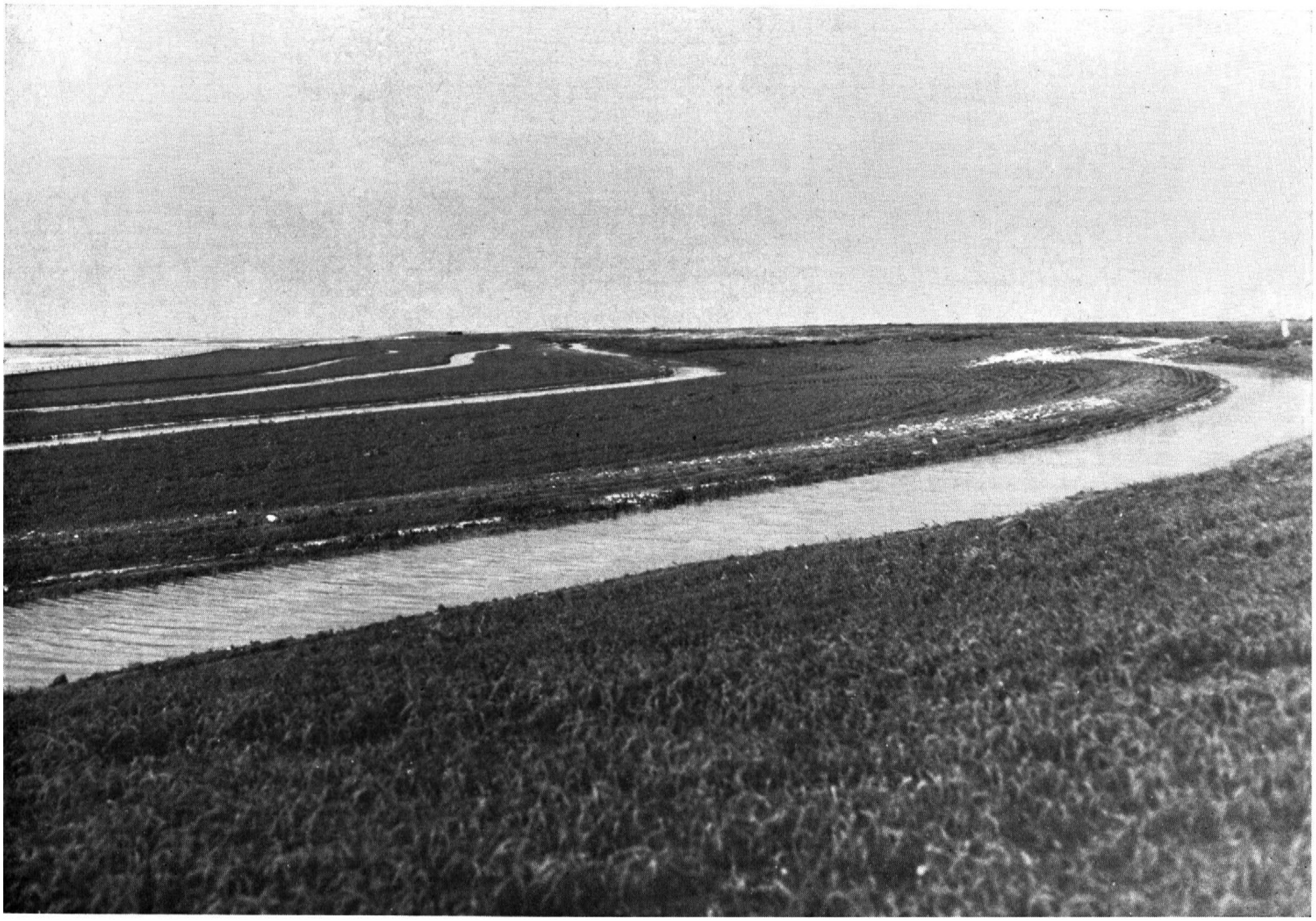

Figure 11.—Channel-type terraces in an area of Wages-Campus-Weld loams where slopes are 6 percent.

been maintained, and practices have been used that conserve water from rain and snow. Consistent low yields indicate that the soil has not been managed well. Erosion has damaged the soil, and this damage has lowered fertility or has made the surface layer hard and cloddy.

The practices used under a high level of management (columns B) are (1) contour tillage, crop residue management, and the like to control erosion and conserve water; (2) a suitable cropping system; (3) tillage to the proper depth, at the right time, and with suitable implements so as to control weeds and to use crop residue efficiently; (4) suitable crop varieties are chosen; (5) planting or seeding is at a rate that insures a dense plant population; (6) insects and disease are consistently controlled by spraying or other means; (7) fertilizer is applied in kinds and amounts indicated by soil tests; and (8) for irrigated crops, water should be conserved and applied with care.

If some or all of these practices are omitted or if they are poorly applied, the yields to be expected are those for the common management (columns A).

Interpreting soils by capability classification

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

In the capability system, all the kinds of soils are grouped at three levels; the class, the subclass, and the unit. Following is a descriptive outline of the system as it applies in Phillips County. The placement of any mapping unit in the grouping can be learned by turning to the "Guide to Mapping Units" at the back of this survey, or by referring to the notation that ends the description of each mapping unit in the section that describes the soils of the county.

Class I. Soils that have few limitations that restrict their use. (Areas of class I land were not mapped separately in this survey.)

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

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

Capability unit IIe-1 (Dryland).—Deep, nearly

TABLE 2.—*Predicted average acre yields of principal nonirrigated crops grown under two levels of management*

[Absence of a yield figure indicates that the crop is not grown on the soil]

Soil	Wheat		Barley		Corn		Grain sorghum		Forage sorghum	
	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Ton*	*Ton*
Anselmo loamy fine sand, marly substratum variant, 0 to 3 percent slopes	7	12	8	13	10	16	10	15	1. 0	1. 3
Ascalon sandy loam, 0 to 3 percent slopes	21	26	22	27	------	------	20	25	1. 7	2. 3
Ascalon sandy loam, 3 to 5 percent slopes	19	25	20	26	------	------	17	21	1. 6	2. 2
Ascalon sandy loam, 5 to 9 percent slopes	16	23	18	23	------	------	15	20	. 9	1. 1
Chappell and Dix sandy loams, 0 to 3 percent slopes	14	19	12	17	13	27	13	17	1. 4	2. 1
Dawes loam	22	27	22	29	------	------	22	30	1. 5	2. 0
Haxtun loamy sand, 0 to 3 percent slopes	16	25	17	22	22	42	23	39	1. 6	2. 2
Haxtun loamy sand, 3 to 5 percent slopes	14	20	13	20	20	40	19	32	1. 4	2. 0
Haxtun sandy loam, 0 to 3 percent slopes	20	28	23	31	25	45	28	43	1. 8	2. 4
Julesburg loamy sand, 0 to 3 percent slopes	14	18	15	21	------	------	15	20	1. 4	1. 9
Julesburg loamy sand, 3 to 5 percent slopes	11	16	12	17	------	------	------	------	------	------
Platner loam, 0 to 3 percent slopes	23	28	23	30	------	------	23	31	1. 8	2. 3
Platner loam, 3 to 5 percent slopes	20	26	20	27	------	------	20	28	1. 6	2. 1
Pleasant loam	23	28	27	32	------	------	27	34	1. 5	2. 0
Rago and Kuma loams	25	31	30	36	------	------	29	37	2. 0	2. 5
Richfield loam, 0 to 3 percent slopes	21	28	23	30	------	------	23	31	1. 9	2. 3
Richfield loam, 3 to 5 percent slopes	18	25	20	27	------	------	21	28	1. 7	2. 1
Wages-Campus-Weld loams, 0 to 3 percent slopes	13	21	12	20	------	------	11	19	1. 1	1. 8
Wages-Campus-Weld loams, 3 to 5 percent slopes	12	18	11	17	------	------	10	17	1. 0	1. 5

TABLE 3.—*Yield predictions for principal irrigated crops under two levels of management*

[Absence of data indicates that the crop normally is not grown on the soil]

Soil	Sugar beets		Corn		Alfalfa		Beans		Wheat		Potatoes	
	A	B	A	B	A	B	A	B	A	B	A	B
	Ton	*Ton*	*Bu.*	*Bu.*	*Ton*	*Ton*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Anselmo loamy fine sand, marly substratum variant, 0 to 3 percent slopes	10	16	58	87	1. 6	3. 0	22	28	31	41	------	------
Ascalon sandy loam, 0 to 3 percent slopes	13	18	75	115	2. 8	3. 7	32	37	33	46	------	------
Chappell and Dix sandy loams, 0 to 3 percent slopes	9	15	56	85	1. 2	2. 7	20	26	29	39	200	365
Dawes loam	13	23	76	105	3. 2	5. 0	27	34	35	49	320	480
Dunday fine sand	11	15	60	85	1. 8	3. 3	24	30	32	45	240	400
Haxtun loamy sand, 0 to 3 percent slopes	11	17	65	110	3. 5	5. 0	26	32	34	46	240	400
Haxtun loamy sand, 3 to 5 percent slopes	10	16	60	98	3. 0	4. 8	24	28	34	44	------	------
Haxtun sandy loam, 0 to 3 percent slopes	13	18	75	118	2. 9	3. 8	33	38	36	48	245	410
Julesburg loamy sand, 0 to 3 percent slopes	11	14	60	85	3. 0	4. 6	23	29	33	42	240	400
Julesburg loamy sand, 3 to 5 percent slopes	10	13	57	72	2. 6	3. 9	21	26	30	40	------	------
Platner loam, 0 to 3 percent slopes	13	21	76	115	3. 5	5. 1	30	38	38	50	320	480
Platner loam, 3 to 5 percent slopes	12	19	73	110	3. 2	4. 9	28	36	35	48	------	------
Pleasant loam	13	20	77	118	3. 6	5. 1	31	39	39	52	------	------
Rago and Kuma loams	15	23	80	120	3. 9	5. 3	33	40	40	55	330	490
Richfield loam, 0 to 3 percent slopes	13	22	76	115	3. 5	5. 1	30	38	38	50	320	480
Richfield loam, 3 to 5 percent slopes	12	19	73	110	3. 2	4. 9	28	36	35	48	------	------
Wages-Campus-Weld loams, 0 to 3 percent slopes	12	18	70	100	3. 2	5. 0	27	34	35	49	270	420
Wages-Campus-Weld loams, 3 to 5 percent slopes	11	17	50	80	2. 5	3. 5	20	23	33	46	------	------

level to gently sloping soils that have a sandy loam surface layer and a clay loam or sandy clay loam subsoil.

Capability unit IIe-2 (Irrigated).—Deep and moderately deep, nearly level to gently sloping soils that have a loam surface layer and a clay loam subsoil.

Capability unit IIe-3 (Irrigated).—Deep, nearly level to gently sloping soils that have a sandy loam surface layer and a clay loam or sandy clay loam subsoil.

Subclass IIc. Soils that have slight limitations because of climatic conditions.

Capability unit IIc-1 (Dryland).—Deep, nearly level to gently sloping soils that have a loam surface layer and a clay loam subsoil.

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

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

Capability unit IIIe-1 (Dryland).—Deep, gently sloping soils that have a loam surface layer and a clay loam subsoil.

Capability unit IIIe-2 (Dryland).—Deep, gently sloping soils that have a sandy loam surface layer and a sandy clay loam subsoil.

Capability unit IIIe-3 (Dryland).—Deep, gently sloping soils that have a loamy sand surface layer and a sandy loam or clay loam subsoil.

Capability unit IIIe-4 (Irrigated).—Deep, gently sloping soils that have a loam surface layer and a clay loam subsoil.

Capability unit IIIe-5 (Irrigated).—Moderately deep soils that are nearly level, gently sloping, or moderately sloping, and that have a loam or sandy loam surface layer and a clay loam subsoil.

Capability unit IIIe-6 (Irrigated).—Deep and moderately deep, nearly level to gently sloping soils that have a loamy sand surface layer and a sandy loam or clay loam subsoil.

Capability unit IIIe-7 (Irrigated).—Moderately deep and shallow soils that have a sandy loam surface layer and subsoil.

Subclass IIIs. Soils that have severe limitations of moisture capacity or tilth.

Capability unit IIIs-1 (Dryland).—Deep, nearly level soils that have a loam surface layer and a thick, clayey subsoil.

Capability unit IIIs-2 (Dryland).—Moderately deep, nearly level to gently sloping soils that have a loam surface layer and a clay loam subsoil.

Capability unit IIIs-3 (Irrigated).—Moderately deep, nearly level to gently sloping soils that have a loam surface layer and a clay loam subsoil.

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

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

Capability unit IVe-1 (Dryland).—Moderately deep soils that are moderately sloping and that have a loam surface layer and a clay loam subsoil.

Capability unit IVe-2 (Dryland).—Deep, strongly sloping soils that have a sandy loam surface layer and a sandy clay loam subsoil.

Capability unit IVe-3 (Dryland).—Deep, moderately sloping soils that have a loamy sand surface layer and a sandy loam or clay loam subsoil.

Capability unit IVe-4 (Dryland).—Shallow to moderately deep, nearly level to gently sloping soils that have a surface layer of sandy loam or loamy fine sand and a sandy loam subsoil.

Capability unit IVe-5 (Irrigated).—Deep, moderately sloping soils that have a sandy surface layer and a subsoil of sandy loam or clay loam.

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

Capability unit IVs-1 (Irrigated).—Deep, nearly level to gently sloping soils that are fine sand throughout.

Class V. Soils not likely to erode but that have other limitations, impractical to remove without major reclamation, that limit their use, mainly to pasture or range, woodland or windbreaks, or wildlife food and cover. (None in Phillips County.)

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

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

Capability unit VIe-1 (Dryland).—Shallow to deep soils that are moderately sloping and have a gravelly loam, gravelly sandy loam, or sandy loam surface layer and a gravelly loam or sandy loam subsoil.

Capability unit VIe-2 (Dryland).—Deep, nearly level to gently sloping or steep soils that have a fine sand surface layer.

Capability unit VIe-3 (Dryland).—Shallow to moderately deep, moderately sloping to steep soils that have a surface layer of loam, sandy loam, or gravelly loam and a subsoil of clay loam, sandy loam, or gravelly sandy clay loam.

Class VII. Soils that have very severe limitations that make them unsuitable for cultivation without major reclamation, and that restrict their use largely to grazing, woodland or windbreaks, or wildlife.

Subclass VIIe. Soils very severely limited, chiefly by risk of erosion, unless they are protected.

Capability unit VIIe-1 (Dryland).—Deep soils that are fine sand throughout and are in steep, hilly areas.

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

Capability unit VIIs-1 (Dryland).—Shallow, limy gravelly loams that are moderately sloping to steep.

Class VIII.—Soils and landforms that have limitations that preclude their use, without major reclamation, for commercial production of plants; and restrict their use to recreation, wildlife, water supply, or esthetic purposes. (None in Phillips County.)

As shown in the foregoing list, the broadest grouping, the capability class, is 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. None of the soils in Phillips County are in class I because the little moisture limits their use unless they are irrigated. Under irrigation the nearly level, deep, well-drained, loamy soils are in class I. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products.

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

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

Within the subclasses are the capability units, groups of soils enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Capability units are generally identified by numbers assigned locally, for example, IIe-1 or IIIs-1.

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

Range Management [3]

Approximately 65,000 acres, or 15 percent of the total acreage in Phillips County, is native grasses. The native range vegetation is mainly a mixture of mid and short grasses, but cactus, yucca, sagebrush, and other native plants invade some areas. Raising cows and calves is the main type of livestock enterprise, though many ranchers hold calves born in fall over in their feedlots. The livestock include winter stockers, as well as feeders.

Some areas of cultivated soils in the county are eroded and depleted of natural fertility. These areas can be reseeded to native grasses, but a protective cover is needed until the grasses become established. A good cover of litter provides protection against both soil blowing and water erosion. Livestock production could be increased by better location of fences, salt, and water.

Range sites and condition classes

Range sites are distinctive kinds of rangeland that have a certain potential for producing range plants. Each range site has a distinctive potential plant community, the composition of which depends on a combination of the environment, mainly soil and climate. Unless the site is altered by physicial deterioration, the potential plant community reproduces itself. Range sites are named for one or more prominent features of the soil or topography.

In most areas three or four grasses are characteristic of a range site; for example, sand bluestem, prairie sandreed, and switchgrass are typical of the Deep Sand range site.

Plants on any given range site are classed as *decreasers*, *increasers*, or *invaders*. Decreasers are plants in the original plant community that tend to die out if heavily grazed. On sandy soils they generally are the tallest, most productive, and the most palatable perennials. Increasers are those plants that normally become more abundant as the decreasers decline. Generally they are shorter, and some are less palatable than decreasers. Invaders are not part of the potential plant community for the site, but they may be a part of the potential plant community on other range sites in the same locality. These plants become established when the desirable ones decline. Many invaders are woody plants or herbaceous annuals or perennials. They normally are not counted when the range condition class is determined.

Range condition is determined by comparing the present vegetation on the range site with the original vegetation. Four classes are used to indicate the degree of departure from the original vegetation brought about by grazing or other use (*4*). These classes show the present condition of the native vegetation on a range site compared 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 the original stand. It is in *good condition* if the percentage is between 51 and 75 percent, in *fair condition* if the percentage is between 26 and 50, and in *poor condition* if the percentage is less than 25.

On pastures where decreasers and increasers grow in proper amounts, the range is in excellent condition. If the increasers are more numerous than in the original vegetation, the range is in less than excellent condition. If the range is in poor condition, the bulk of the vegetation is invaders.

One of the main objectives 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. Recognizing important changes in the kind of cover on a range site is important, but the changes take place gradually and are difficult to recognize. Growth encouraged by heavy rainfall may lead to the conclusion that the range is in good condition. Actually, it may have a weedy cover and the trend may be toward reduced forage growth. On the other hand, well-managed rangeland that has been closely grazed for short periods under the supervision of a careful manager may have a degraded appearance that temporarily conceals its ability to recover.

Descriptions of the range sites

In this subsection the soils of Phillips County have been grouped into range sites on the basis of the kinds and amounts of native vegetation produced. The soils that make up each site can be determined by referring to the "Guide to Mapping Units" at the back of this soil survey.

For each site, the kind of soil is described and the important species in the potential plant community are given. Also given is the total annual yield in pounds of air-dry herbage per acre.

[3] By WALTER W. HAMMOND, range conservationist, Soil Conservation Service.

LOAMY PLAINS RANGE SITE

This range site consists of deep to moderately deep soils that have a loam surface layer and a loam, clay loam, or clay subsoil. These soils occur on uplands and are nearly level to steep (fig. 12). They are fertile and have high capacity for holding water. This site makes up about 68 percent of the county.

Short grasses characterize this range site, though western wheatgrass makes vigorous growth and is abundant in depressions and swales. The dominant short grasses are blue grama and buffalograss. On range in good condition, blue grama makes up about 60 percent of the total vegetation. Such plants as cactus, yucca, fringed sagebrush, and snakeweed become a serious concern if the range is continuously overgrazed or if droughts are prolonged.

This site has the potential to produce a total of 2,500 pounds of vegetation per acre in a year of favorable moisture, but the average is as low as 800 pounds in unfavorable years. The amount of forage actually available for cattle ranges from 250 to 1,300 pounds per acre.

SANDY PLAINS RANGE SITE

This site consists of deep to moderately deep soils that have a loamy sand, loamy fine sand, or sandy loam surface layer and a sandy clay loam, clay loam, or sandy loam subsoil. These soils occur on uplands and are nearly level to steep. They have moderate to low capacity for holding water and are medium to low in fertility. All the soils in this site have a rapid to very rapid water intake rate, but water movement in the subsoil and substratum is rapid to slow. This site makes up about 20 percent of the county.

Little bluestem, switchgrass, side-oats grama, sand bluestem, prairie sandreed, needle-and-thread, and other tall and mid grasses form at least 40 percent of the cover. The rest consists of a vigorous growth of blue grama, small spots of sand dropseed and other less important species, and perennial forbs, sand sagebrush, and other shrubs in widely scattered areas. On this site the vegetation is similar to that of the Deep Sand range site, though tall grasses do not make up so much of the cover. Short and mid grasses grow as an understory, but they do not make up a large part of the forage in normal years. In places snakeweed, fringed sagebrush, and wormwood grow in small amounts.

This site has the potential to produce a total of 3,500 pounds of vegetation per acre in a year of favorable moisture, but the average is as low as 1,200 pounds in unfavorable years. The amount of forage actually available for cattle ranges from 400 to 1,800 pounds per acre.

DEEP SAND RANGE SITE

Soils of this range site are deep, sandy throughout the profile, and nearly level, gently sloping, or rolling. The surface layer consists of fine sand, and the underlying layer is fine sand or loamy sand. Moisture penetration is very rapid and to great depth, and the loss from evaporation is less on these soils than on finer textured soils. The water-holding capacity is low, but the moisture available is readily given up to plants. This range site makes up about 9 percent of the county.

Tall grasses, of which sand reedgrass and sand bluestem are the major species, are dominant on this site. Switchgrass is prominent, especially in pockets. Needle-and-thread and other mid grasses make up a fairly large part of the plant composition. Under good management, a small part is short grasses. Sand sagebrush grows but only in small amounts. Plant cover is uniform. Because the grasses are tall and bunchy, this site has a healthy green appearance in summer and appears tawny in winter.

This site has the potential to produce a total of 4,000 pounds of vegetation per acre in a year of favorable moisture, but the average is as low as 1,500 pounds in unfavorable years. The amount of forage actually available for cattle ranges from 450 to 2,200 pounds per acre.

GRAVEL BREAKS RANGE SITE

This range site consists of moderately sloping to steep gravelly loams that are shallow to clean gravel. These soils have low moisture-holding capacity, but the plants on this site make good use of water trapped in depressions and pockets. About 1 percent of the total acreage in the county is in this site.

On this site the dominant species are blue, hairy, and side-oats grama. Also present are fringed sagebrush, hairy goldaster, wormwood, and scattered sand bluestem and sand reedgrass. Lead plant grows in well-managed areas. Forage growth is best where extra moisture accumulates in small draws, on concave slopes that finger into the draws, and in outwash at the base of steep slopes.

This site has the potential to produce a total of 1,400 pounds of vegetation per acre in a year of favorable moisture, but the average is as low as 500 pounds in unfavorable years. The amount of forage actually available for cattle ranges from 125 to 700 pounds per acre.

CHOPPY SAND RANGE SITE

Valentine fine sand, hilly, is the only soil in this range site. This soil is deep, unstable, and sandy throughout the profile. It occupies the sandhills that extend south of Holyoke.

The soil in this site is similar to the soils in the Deep Sand range site in texture and capacity for holding water, but this soil is loose, much less stable, and has little, if any, topsoil. Fertility and moisture-holding capacity are low, and soil blowing is a severe hazard. About 1 percent of the total acreage of Phillips County is in this site.

The plant cover on this site is somewhat similar to that on the Deep Sand range site, but blue grama has been replaced by hairy grama in many places, the plant population is thinner than that on the Deep Sand site, and the cover less uniform. Sand dropseed, blowoutgrass, beadgrass, sandhill muhly, and other grasses are more plentiful on the Choppy Sand range site. Limited amounts of sand sagebrush grow because the soil material is shifty and unstable. Sand reedgrass is the dominant grass, but sand bluestem and other grasses occur in varying amounts.

This site has the potential to produce 1,500 pounds of vegetation per acre in a year of favorable moisture, but the average is as low as 600 pounds in unfavorable years. The amount of forage actually available for cattle ranges from 0 to 450 pounds per acre.

LIMESTONE BREAKS RANGE SITE

In this range site are gently sloping to strongly sloping gravelly loams and sandy loams. These soils formed mostly in material weathered from limestone. They are moderately

Figure 12.—**Good stands of blue grama and western wheatgrass on a Richfield loam in the Loamy Plains range site.**

shallow, immature, and rich in lime. In some places the surface consists almost entirely of soft fragments of limestone. About 0.2 percent of the total acreage in the county is in this site.

The vegetation is dominated by mid grasses, mainly little bluestem and side-oats grama. Of secondary importance are blue grama, big bluestem, and needle-and-thread. Perennial forbs are more noticeable on this site than on most of the other sites in the county. Common plants are buckwheat, mat loco, nailwort, actinea, and fringed sagebrush. Although yucca is present, it makes up only a small part of the total vegetation.

This site has the potential to produce 1,800 pounds of vegetation per acre in a year of favorable moisture, but the average is as low as 600 pounds in unfavorable years. The amount of forage actually available for cattle ranges from 150 to 800 pounds per acre.

CLAYEY PLAINS RANGE SITE

The only soil in this range site is Pleasant loam. This soil is deep and nearly level to gently sloping. The subsoil is dense clay that has strong blocky structure. Although the subsoil is slowly permeable, it has high water-holding capacity. During extended dry periods, however, the soil is somewhat droughty because the clay subsoil releases water slowly to plants. Pleasant loam occupies broad flats southwest of Holyoke. About 0.8 percent of the acreage of Phillips County is in this site.

374-140—71——3

When this site is in excellent condition, western wheatgrass makes up the largest part of vegetation and other important plants are four-wing saltbush, green needlegrass, and winterfat. On overgrazed range, western wheatgrass, four-wing saltbush, green needlegrass, and winterfat decrease, and they are replaced by blue grama, buffalograss, three-awn, snakeweed, low rabbitbrush, and pricklypear. If overgrazing is continuous, desirable plants continue to decrease and curleycup gumweed and annuals invade the site.

This site has the potential to produce a total of 950 pounds of vegetation per acre in a year of favorable moisture, but the average is as low as 400 pounds in unfavorable years. The amount of forage actually available for cattle ranges from 150 to 450 pounds per acre.

Use of Soils for Windbreaks[4]

In this subsection native trees and shrubs, which grow on only a small acreage in the county, are briefly described, and then the use and management of soils for windbreaks are discussed in more detail.

Cottonwood and willows have invaded Frenchman and Patent Creeks since early in the 1900's. Cottonwoods are decreasing and willows are slowly increasing. This increase of willows is mostly along intermittent streams and on the beds of some intermittent lakes. Sand cherries are native to the sandhills. They grow in small numbers in scattered swales and on north-facing slopes of the Valentine and Julesburg soils.

In Phillips County trees have been planted to protect and beautify the farmsteads since early settlement. A few plantings were established early in the 1880's, and some of these still grow.

Windbreaks produce many benefits and are worth their expense. They prevent snow from drifting into yards, protect livestock, reduce the cost of feeding livestock and of heating homes, protect gardens, attract insect-eating birds and other wildlife, and increase the pleasure of living.

Soils of Phillips County developed under grass and are more suited to grass than to trees. Trees can be grown, however, if suitable species of good stock are carefully planted, cultivated, and protected.

For protecting farmsteads or livestock, windbreaks should be at least five rows wide, or wide enough to trap most of the blowing snow. A good wind barrier is provided by planting low shrubs, tall shrubs or trees of medium height, and tall trees. At least a third of the rows should be planted to juniper (redcedar), pine, or other adapted evergreens. Because evergreens live longer, they greatly extend the life of the windbreak. Juniper trees have a dense growth near the ground, and pines add height to the windbreaks as they grow older.

Field windbreaks and shelterbelts are beneficial because they help in controlling soil blowing on cropland and in preventing strong winds from damaging crops. They also hold snow on fields, reduce evaporation of soil moisture, and furnish food and nesting cover for wildlife.

Field windbreaks and shelterbelts should be spaced at regular intervals, but they need to be only 1 to 2 rows wide. They afford protection for a distance equal to about 20 times the height of the trees. Juniper and pine are more suitable than Siberian elm and other species that have shallow, spreading roots because they do not interfere so much with crop growth.

Clean cultivation is essential if new plantings for homestead or field windbreaks are to make satisfactory growth. Except on extremely sandy soils and on irrigated soils, clean cultivation should be continued throughout the life of the planting. For irrigated windbreaks, clean cultivation is not required after 5 or 6 years. Where soil blowing is the main concern, only a band along the rows should be cultivated. Sorghums, sudangrass, or other plants suitable for cover should be seeded in strips between the rows. After the trees are dormant in fall, a heavy watering helps to reduce winterkilling and adds moisture that assists starting growth in spring.

Livestock should be excluded from the windbreaks. Means other than burning are needed to remove accumulations of loose weeds and trash that occasionally are blown into the windbreaks. Snow or rain usually packs the weeds into mats, which decay and disappear.

Assistance in establishing windbreaks and shelterbelts can be obtained from the local representative of the Soil Conservation Service or from the county agricultural agent.

Windbreak suitability groups

The soils of Phillips County have been placed in four windbreak suitability groups. The soils in each group are similar, are suited to similar kinds of trees, and support about the same growth rate under good management. For each windbreak group, table 4 shows the growth rate (height in 20 to 25 years) of three kinds of trees commonly planted in windbreaks and the percentage of planted trees expected to survive.

Refer to the "Guide to Mapping Units" at the back of this survey to determine the soils in any windbreak group. Because inclusions of soils other than those named in a group may occur, it is advisable to investigate a site before planting trees and shrubs. Careful investigation is feasible because only a few windbreaks cover large areas.

WINDBREAK SUITABILITY GROUP 1

This group consists of deep and moderately deep, well-drained loams and sandy loams on terraces and uplands. These soils are nearly level to steep, and most of them have a loamy or clayey subsoil. They are in the Ascalon, Campus, Dawes, Haxtun, Kuma, Platner, Pleasant, Rago, Richfield, Wages, and Weld series.

Suitable for planting on the soils of this group are the *shrubs*, squawbush, lilac, caragena, and chokeberry; the *evergreens*, Rocky Mountain juniper, eastern redcedar, ponderosa pine, and Austrian pine; and the *broad-leaved* trees, Siberian elm, Russian-olive, and hackberry.

If trees can be established, they generally grow well. The chief hazards to establishment are wind, drought, and blowing soil. Fallowing for a summer before planting is a way to overcome these hazards. Cover crops between rows may be desirable for the first 2 or 3 years. Where practical, the trees should be watered by diverting water from other areas.

WINDBREAK SUITABILITY GROUP 2

This group consists of well-drained sandy and loamy soils of the Anselmo, Bayard, Chappell, Dix, Dunday, Haxtun, and Julesburg series. Except for the Chappell and Dix soils, these soils are deep. The Chappell and Dix soils are shallow.

The soils in this group are well suited to trees. Species suitable for planting are the *shrubs*, squawbush, American plum, caragena, sand cherry (short lived), and lilac; the *evergreens*, Rocky Mountain juniper, eastern redcedar, ponderosa pine, and Austrian pine; and the *broad-leaved* trees, Siberian elm, Russian-olive, hackberry, and green ash.

Soil blowing, the main hazard, can be overcome by strips of growing plants or of stubble between the rows. It is

[4] By WILFRED S. SWENSON, woodland conservationist, Soil Conservation Service.

TABLE 4.—*Predicted height in 20 to 25 years and expected survival of trees planted in windbreaks*

[The symbol > means greater than; < means less than]

Windbreak suitability group	Siberian (Chinese) elm		Ponderosa pine		Rocky Mountain juniper	
	Growth rate (height)	Expected survival	Growth rate (height)	Expected survival	Growth rate (height)	Expected survival
	Ft.	*Pct.*	*Ft.*	*Pct.*	*Ft.*	*Pct.*
1	>35	90	>20	90	>15	85
2	>35	90	>20	90	>15	85
3	<25	70	15–20	80	13–15	75
4	<25	70	<15	70	10–13	60

not necessary to fallow for a summer before planting. Because Dunday soils are erodible and should not be cultivated, they are suited only to plantings of evergreens.

WINDBREAK SUITABILITY GROUP 3

This group consists of the well-drained Canyon and Eckley soils. These soils generally have less than 24 inches of root zone over limestone or gravel.

These soils generally are not suitable for planting trees, because the root zone is shallow, survival is poor, and tree growth is slow. These soils, however, are mostly used for grazing, and windbreaks are needed in only a few places. Careful onsite examination is necessary so as to locate areas of deep soil before any trees are planted. In these areas Siberian elm, ponderosa pine, and Rocky Mountain juniper are suitable for planting.

WINDBREAK SUITABILITY GROUP 4

This group consists of deep, sandy, rolling and hilly Valentine soils and the many level beds of intermittent playa lakes on the hardlands. The local office of the Soil Conservation Service should be consulted before trees are planted on these soils.

Use of Soils for Recreation [5]

Soil is important in determining the feasibility of establishing various recreational enterprises that furnish income. Some soils in the county are suitable for constructing fishponds (fig. 13), for growing vegetation in recreational areas, and for establishing hunting areas and other recreational facilities.

Table 5 evaluates the degree of limitations of the soil associations in Phillips County for specified recreational uses. Because a soil association is a general soil area that contains different kinds of soils, the ratings may not apply to all the soils in the associations. An investigation is needed at specific sites before a recreational facility is established. The soil associations in Phillips County are described in the section "General Soil Map" (see fig. 2).

In rating the soil associations for recreational uses, factors other than the kinds of soils and availability of water were considered. Among these factors were the lack of spectacular scenery, hot summers, and distance from population centers. For example, in Phillips County a long distance from centers of population is an obstacle to the success of shooting preserves that offer put-and-take game, though plants that provide food and cover for this game do grow there or can be established. Studies indicate that preserves farther than 50 miles from large cities have little chance of success.

[5] By ELDIE W. MUSTARD, biologist, Soil Conservation Service.

Other kinds of hunting, however, have a better potential for producing income than any other kind of recreation in Phillips County. Hunting areas that provide pheasant could be leased and fees collected for allowing hunters to hunt. Areas that produce antelope could be created. Even for these kinds of hunting, however, the distance from population centers would be a limiting factor.

Because a main transcontinental highway bisects the county, transient camps for tourists are a potential source of income. Campsites have to be chosen on the basis of individual soil characteristics, but all of the soil associations offer some potential.

The information in the subsection "Use of Soils for Wildlife" is helpful in creating and maintaining suitable habitat for specified kinds of wildlife. Assistance in planning outdoor recreational facilities can be obtained from the local representative of the Soil Conservation Service.

Use of Soils for Wildlife [6]

Wildlife is a product of the soil on which it lives. The habitat largely determines the kinds and numbers of wildlife present in any area. Generally, the largest number of wildlife frequent areas that provide enough food, cover, and water for their survival.

Wildlife was important in Phillips County because it provided food for early settlers. Today, interest in wildlife is mostly in its use for outdoor recreation.

Some kinds of wildlife decreased in the county mainly because of changes in land use. These changes have altered the habitat so much that it could not support large numbers of certain kinds of wildlife. For example, great herds of bison and antelope and flocks of prairie chickens once shared the grasslands of Phillips County. Now only small numbers of antelope and prairie chickens and no bison remain, because grainfields have replaced grassland on much of the acreage. The ring-necked pheasant, however, currently is the most important game bird in the county because it depends on the grainfields for its food.

[6] By ELDIE W. MUSTARD, biologist, Soil Conservation Service.

***Figure 13.*—Water impounded behind dam provides boating or fishing on Frenchman Creek west of Holyoke. The lake is within Wages-Eckley-Dix complex (soil association *1*).**

TABLE 5.—*Limitations of soil associations for selected recreational uses*

[Absence of data indicates that soil association is not suited to given use]

Recreational use	Degree of limitation		
	Soil association 1	Soil association 2	Soil association 3
Vacation farms and dude ranches	Moderate	Severe	Severe.
Picnic and sports areas	Severe	Severe	Severe.
Fishing [1]	Moderate		
Camping, scenery, and recreation	Severe	Severe	Severe.
Hunting areas:			
Big game		Moderate	Moderate.
Upland game	Slight	Slight	Moderate.
Shooting preserves	Severe	Severe	
Rural cottages, campsites, and homesites	Severe	Severe	

[1] Only developed areas in Phillips County are suitable for fishing.

Table 6 shows the suitability of the soils by soil associations, as habitat for the major kinds of wildlife in this county. The general soil map shows the location of the soil associations in the county (see figure 2). For descriptions of the soil associations, see the section "General Soil Map."

The Rago-Platner-Kuma and the Haxtun-Julesburg soil associations have a good potential for producing many kinds of wildlife. Most of the cropland in Phillips County is in these associations, and it furnishes an excellent food supply. Plants could be established for protective cover and escape lanes in some areas, but intensive farming prevents establishing cover in most places.

The pheasant population in the Rago-Platner-Kuma and the Haxtun-Julesburg associations could be increased if these birds were provided more permanent nesting places and winter cover. Pheasant populations are already large on these soil associations, but they could be increased.

The large unbroken grainfields in these associations offer little of the variety in habitat that game birds prefer, but habitat variety could be increased by stripcropping.

Farmstead windbreaks and field shelterbelts furnish necessary cover during winter, and they are also valuable in other seasons. But many of the trees and shrubs planted in windbreaks are so old that they furnish little cover for wildlife. Wildlife would benefit greatly if some shrubs were planted in the old windbreaks.

Information on planting trees and shrubs is given in the subsection "Use of Soils for Windbreaks."

Most of the acreage in the Valentine soil association is grassland used for range. Although antelopes are scarce throughout the country, their potential appears to be fairly high in the Valentine association.

On well-managed range, antelope and cattle compete little for food, but competition may be severe on overgrazed range where cattle are forced to graze on certain weeds and other plants they usually do not eat. Antelope, however, generally lose when they compete with cattle for food.

One study made in Colorado showed that antelope ate more cacti than grass and that weeds were an important part of their diet (*6*). They also ate many plants considered to be poisonous to cattle.

All soil associations in the county have fair populations of mourning doves. The doves eat waste grain and seeds from many kinds of grasses and weeds. They generally are not hunted much in this county, and hunting areas could be created.

Although much waste grain is available in the county as food for waterfowl, they are not numerous. Large reservoirs or other suitable areas of water are lacking. Waterfowl feed in areas of water and return to them for rest.

Natural streams, lakes, and ponds are poorly suited as fishing waters in Phillips County. Only farm ponds contribute to this sport. The Haxtun-Julesburg and Valentine soil associations generally are not suitable for farm ponds, because the highly porous soils do not retain water well. Some features that affect the suitability of the soils for farm ponds are given in table 8. Warm-water fish, such as bass and bluegills, are generally suitable for stocking farm ponds in the county.

In Phillips County most of the acreage is privately owned and managed. Wildlife production is tied to the land and the kind of farming or land use. Well-managed lands on which basic soil conservation is practiced increase the numbers of wildlife.

Among the practices that aid in increasing wildlife populations are proper range use, planting windbreaks and shelterbelts, building farm ponds and other water impoundments, and creating wildlife areas.

Areas for wildlife and fish, except those for migratory

TABLE 6.—*Suitability of soil associations for wildlife habitat*

Soil association	Wildlife	Suitability for— Food	Suitability for— Cover
1. Rago-Platner-Kuma	Pheasant	Well suited	Moderately well suited.
	Mourning dove	Well suited	Moderately well suited.
	Waterfowl	Well suited	Poorly suited.
	Deer	Poorly suited	Poorly suited.
	Cottontail	Well suited	Moderately well suited.
	Jackrabbit	Well suited	Poorly suited.
	Fish	Poorly suited	Poorly suited.
2. Haxtun-Julesburg	Pheasant	Well suited	Well suited.
	Mourning dove	Well suited	Moderately well suited.
	Waterfowl	Well suited	Poorly suited.
	Antelope	Well suited	Poorly suited.
	Deer	Poorly suited	Poorly suited.
	Cottontail	Well suited	Well suited.
	Jackrabbit	Well suited	Poorly suited.
3. Valentine	Mourning dove	Moderately well suited	Poorly suited.
	Antelope	Well suited	Poorly suited.
	Deer	Poorly suited	Poorly suited.
	Cottontail	Well suited	Moderately well suited.
	Jackrabbit	Well suited	Poorly suited.

birds, are managed by the Colorado Game, Fish and Parks Department. Areas for migratory birds are managed jointly by that department and the U.S. Fish and Wildlife Service.

Engineering Uses of Soils

In this subsection important engineering properties of the soils in the county are estimated so that the suitability of the soils for construction purposes can be determined. Also given are engineering interpretations of the soils in the county.

Some soil properties are of special interest to engineers because they affect construction and maintenance of roads, airports, pipelines, building foundations, water storage facilities (fig. 14), erosion control structures, drainage systems, and sewage disposal systems. Among the soil properties most important to engineers are permeability to water, shear strength, compaction characteristics, soil drainage, shrink-swell characteristics, grain size, plasticity, and reaction. Depth to water table, depth to bedrock, and relief are also important.

The information in this survey can be used to—

1. Make studies of soil and land use that will aid in selecting and developing industrial, business, residential, and recreational sites.
2. Make preliminary estimates of the engineering properties of soils for use in planning agricultural drainage systems, farm ponds, terraces, waterways, dikes, diversion terraces, irrigation canals, and irrigation systems.
3. Make preliminary evaluations of soil and ground conditions that will aid in selecting locations for highways and airports, and in planning detailed investigations of the selected locations.
4. Locate probable sources of sand, gravel, and other construction materials.
5. Correlate performance of engineering structures with soil mapping units, and thus develop information that will be useful in planning and designing certain engineering practices and structures.
6. Determine the suitability of soil units for cross-country movement of vehicles and construction equipment.

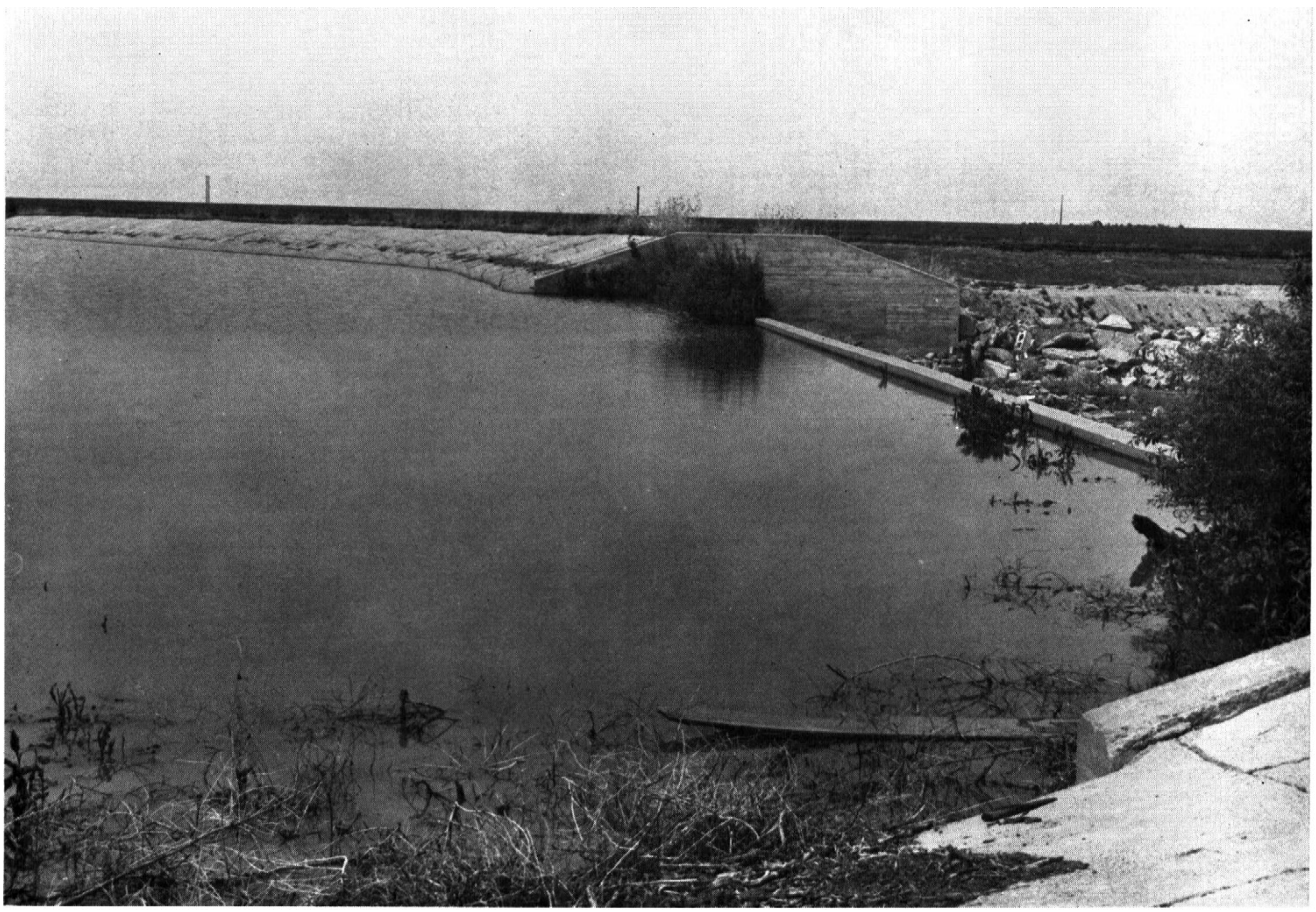

***Figure 14.*—A dam constructed on Frenchman Creek within Wages-Eckley-Dix complex is used for erosion control and water storage.**

7. Supplement the information obtained from other published maps and reports and aerial photographs for the purpose of making maps and reports that will be more useful to engineers.
8. Make preliminary evaluation of the suitability of a particular area for construction purposes.

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

Some of the terms used by the soil scientist may not be familiar to the engineer, and some terms may have a special meaning in soil science. Some of these terms are defined in the Glossary.

Most of the information in this subsection is in tables 7 and 8, but additional information useful to engineers can be found in other sections of this soil survey, particularly "Descriptions of the Soils," and "Formation and Classification of Soils."

Engineering classification systems

Agricultural scientists classify soils by using the textural classification of the U.S. Department of Agriculture. In this system, the textural classification is determined by the proportion of sand, silt, and clay in the soil material (*11*). The engineering systems most widely used to classify soils are the Unified system (*13*) and the system developed by the American Association of State Highway Officials (AASHO) (*1*).

The Unified system is based on identification of soils according to their texture, plasticity, and liquid limit. The symbols SW and SP identify clean sand; SM and SC, sand that contains fines; GM and GC, gravel that contains fines; ML and CL, fine-grained material that has low liquid limit; and MH and CH, fine-grained material that has a high liquid limit. Soils on the borderline between two classifications are given a joint classification, for example, SP–SM. Liquid limit is the moisture content at which the soil passes from a plastic to a liquid state. A high liquid limit indicates that the soil has a high content of clay and a low capacity for supporting loads.

The AASHO system is based on field performance of the soils in highways. It groups soils that have about the same general load-carrying capacity. In this system the soils are placed in seven principal groups. The groups range from A–1, the best soils for road subgrades, to A–7, which consists of clayey soils that have low strength when wet, the poorest soils for subgrades.

Engineering properties of soils

Table 7 gives soil classification and estimated properties of soils that are important in construction. Some variations from the values listed should be expected because the estimates are for a typical profile. A profile typical for each series in the county is described in the section "Descriptions of the Soils."

For each soil layer significant in engineering, the USDA textural and the estimated Unified and AASHO classifications are listed in table 7. The columns headed "Percentage passing sieve" show the percentage of soil material small enough to pass the openings of No. 4, 10, 40, and 200 sieves.

Permeability, given in table 7 in inches per hour, refers only to the movement of water downward through undisturbed soil. The estimates are based on soil structure and porosity. These estimates have been compared with the results of permeability tests on undisturbed cores of similar soil materials.

Available water capacity, measured in inches of water per inch of soil, is an estimate of the water held for plant use. It is the water held in a soil between field capacity and permanent wilting point.

Reaction refers to the degree of acidity or alkalinity of a soil and is expressed in pH values. The soil pH indicates the corrosiveness of the soil and the protection needed for pipelines and similar structures placed in the soil. The classes of acidity or alkalinity are defined under "Reaction" in the Glossary.

Shrink-swell potential indicates the change in volume that occurs in a soil when the moisture content changes. In general, clayey soils classified as CH or A–7 have high shrink-swell potential, but clean, structureless sands and other nonplastic soil materials have low shrink-swell potential.

Dispersion is not estimated in table 7, because it is not a significant problem in Phillips County. It is the degree that the particles smaller than 0.005 millimeter are separated, or dispersed, in water. Salinity also is not significant and is not estimated.

Depth to bedrock has been omitted from table 7 because the only soils in the county that have impervious material are the Canyon. In the Canyon soils, caliche or limestone is at depths of about 15 inches. None of the soils in Phillips County have a high water table.

Engineering interpretations

In table 8 the soils of Phillips County are rated according to suitability as sources of topsoil, sand and gravel, and road fill. Soil features affecting foundation supports, the location of highways, and the construction of terraces and diversions, farm ponds, and irrigation structures are shown, and also the soil limitations for disposal of sewage effluent. The information in table 8 is based on field experience with the soils and on the estimated engineering properties in table 7.

A rating of *very good*, *good*, *fair*, or *poor* shows suitability of soil material as a source of topsoil and road fill. Topsoil is the soil material used to topdress slopes, roadbanks, and other places where vegetation is to be established and maintained. Road fill is soil material used for building up road grades. It is the material that supports the base layers.

The selection of highway locations is affected by susceptibility to flooding, traffic-supporting capacity of the soil, shrink-swell potential, and other factors that affect construction.

Important soil features that affect reservoir areas of farm ponds include permeability, seepage, and flooding. Some of the important features that affect pond embankments are strength and stability of the soil, seepage, permeability, shrink-swell potential, and susceptibility to flooding and to erosion.

TABLE 7.—*Estimated engineering*

[The symbol > means greater than;

Soil series and map symbols	Depth from surface	Classification: USDA texture	Classification: AASHO	Classification: Unified
	Inches			
Anselmo: AnB	0–8	Loamy fine sand	A–2	SM
	8–32	Fine sandy loam	A–4	SM
	32–52	Loam	A–4	ML
Ascalon: AsB, AsC, AsD	0–10	Sandy loam	A–2	SM
	10–19	Sandy clay loam	A–6 or A–2	SC
	19–60	Sandy loam, sandy clay loam	A–2	SM
Bayard: BcC (For properties of the Canyon soil in this mapping unit, refer to the Canyon series.)	0–60	Sandy loam	A–2	SM
Campus (Mapped only in complexes.)	0–6	Gravelly sandy loam	A–2 or A–4	SM or ML
	6–30	Loam	A–4	ML
	30–56	Sandy loam	A–2 or A–4	ML or SM
Canyon: CcD	0–15	Gravelly loam	A–2	SM
	15	Cemented caliche.		
Chappell: CdB (For properties of the Dix soil in this mapping unit, refer to the Dix series.)	0–11	Sandy loam	A–2	SM
	11–36	Sandy loam	A–2	SM
	36–60	Gravelly coarse sand	A–1	SP or SM
Dawes: Da	0–7	Loam (lower 2 inches very fine sandy loam).	A–4	ML
	7–15	Clay to clay loam	A–7	CH
	15–27	Loam	A–4	ML
	27	Cobbly and gravelly limestone material.		
Dix Mapped only in a complex and in an undifferentiated unit.)	0–18	Sandy loam	A–2	SM
	18–42	Gravelly coarse sand	A–2	SM
	42–60	Sand and gravel	A–1	SW
Dunday: Du	0–12	Fine sand	A–2	SM
	12–58	Loamy sand to medium sand	A–3	SP or SM
Eckley (Mapped only in an association and in a complex.)	0–10	Gravelly loam, gravelly sandy clay loam.	A–2	SM
	10–35	Coarse sand and gravel	A–1	SW
	35	Gravelly coarse sand.		
Haxtun: HtB, HtC, HxB	0–9	Loamy sand or sandy loam	A–2	SM
	9–19	Sandy loam	A–2	SM
	19–33	Clay loam	A–4	SM or ML
	33–50	Loam	A–4, A–2	ML or SM
Julesburg: JuB, JuC	0–11	Loamy sand	A–2	SM
	11–19	Sandy loam	A–2	SM
	19–60	Loamy sand	A–2 or A–3	SM or SP–SM
Kuma (Mapped only in an undifferentiated unit.)	0–8	Loam	A–4	ML
	8–37	Clay loam or loam	A–6	CL
	37–60	Loam	A–4	ML
Platner: PaB, PaC, PeC (For properties of the Eckley soil in mapping unit PeC, refer to the Eckley series.)	0–5	Loam	A–4	ML
	5–12	Clay	A–7	CH
	12–17	Clay loam	A–6	CL
	17–24	Loam	A–4	ML
	24–48	Sandy clay loam	A–2 or A–4	SM
Pleasant: Ps	0–5	Loam	A–4	ML
	5–40	Silty clay, clay	A–7	CH
	40–52	Silt loam	A–4	ML
	52–60	Gravelly loamy sand.		

properties of soils

< means less than]

Percentage passing sieve— No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	Permeability	Available water capacity	Reaction	Shrink-swell potential
				Inches per hour	*Inches per inch of soil*	*pH*	
100	100	80–95	10–25	>6. 3	0. 08	7. 4–7. 8	Low.
100	100	80–95	20–35	>6. 3	. 10	7. 4–7. 8	Low.
100	100	70–80	60–70	0. 63–6. 3	. 16	8. 5–9. 0	Low.
95–100	95–100	70–90	20–35	>6. 3	. 10	6. 6–7. 3	Moderate.
95–100	95–100	75–95	30–50	<0. 63	. 16	6. 6–7. 3	Moderate.
95–100	95–100	75–90	20–35	>6. 3	. 10	7. 4–7. 8	Low.
95–100	90–100	75–90	20–35	>6. 3	. 10	6. 6–7. 3	Low.
85–95	65–85	60–80	30–60	>6. 3	. 10	7. 9–8. 4	Low.
85–95	85–95	75–90	50–70	0. 63–6. 3	. 16	7. 9–8. 4	Low.
85–95	85–95	65–80	30–55	>6. 3	. 10	8. 5–9. 0	Low.
50–90	50–85	30–50	25–30	0. 63–6. 3	. 16	6. 6–7. 3	Low.
90–100	85–95	55–70	20–35	>6. 3	. 10	6. 6–7. 3	Low.
90–100	85–95	40–55	25–30	>6. 3	. 10	6. 6–7. 3	Low.
75–90	50–80	30–45	5–12	>6. 3	. 08	6. 6–7. 3	Low.
100	95–100	85–100	75–80	0. 63–6. 3	. 16	6. 6–7. 3	Low.
100	95–100	85–100	80–95	<0. 63	. 16	7. 9–8. 4	High.
100	95–100	85–100	80–95	0. 63–6. 3	. 16	8. 5–9. 0	Low.
95–100	85–95	50–75	20–35	>6. 3	. 10	6. 6–7. 3	Low.
70–90	40–60	20–50	12–20	>6. 3	. 08	6. 6–7. 3	Low.
70–90	40–60	25–45	0–5	>6. 3	. 08	6. 6–7. 3	Low.
100	100	90–100	15–35	>6. 3	. 08	6. 6–7. 3	Low.
100	100	90–100	5–12	>6. 3	. 08	6. 6–7. 3	Low.
70–90	50–75	20–35	20–30	0. 63–6. 3	. 16	6. 6–7. 3	Low.
70–90	40–60	25–45	0–5	>6. 3	. 08	6. 6–7. 3	Low.
95–100	95–100	80–100	20–35	>6. 3	. 08	6. 6–7. 3	Low.
95–100	95–100	80–95	20–35	>6. 3	. 10	6. 6–7. 3	Low.
95–100	95–100	80–95	40–70	<0. 63	. 16	6. 6–7. 3	Moderate.
95–100	95–100	75–90	20–70	0. 63–6. 3	. 16	7. 4–7. 8	Low.
100	95–100	70–90	12–20	>6. 3	. 08	6. 6–7. 3	Low.
100	100	70–95	20–30	>6. 3	. 10	6. 6–7. 3	Low.
100	95–100	65–95	5–15	>6. 3	. 08	6. 6–7. 3	Low.
100	95–100	90–100	75–95	0. 63–6. 3	. 16	6. 6–7. 3	Low.
100	95–100	90–100	80–95	<0. 63	. 16	6. 6–7. 3	Low.
95–100	95–100	90–100	75–95	0. 63–6. 3	. 16	7. 9–8. 4	Low.
95–100	95–100	80–90	50–70	0. 63–6. 3	. 16	6. 6–7. 3	Low.
95–100	95–100	85–95	80–95	<0. 63	. 16	6. 6–7. 3	High.
95–100	95–100	85–95	65–80	<0. 63	. 16	7. 4–7. 8	Moderate.
90–95	85–95	80–90	65–80	0. 63–6. 3	. 16	8. 5–9. 0	Low.
60–85	65–85	50–75	20–50	>6. 3	. 10	8. 5–9. 0	Low.
100	95–100	80–95	70–85	0. 63–6. 3	. 16	6. 6–7. 3	Low.
100	100	90–100	80–95	<0. 63	. 16	6. 6–7. 8	High.
100	95–100	90–100	75–95	0. 63–6. 3	. 16	7. 4–7. 8	Low.

TABLE 7.—*Estimated engineering*

Soil series and map symbols	Depth from surface	Classification		
		USDA texture	AASHO	Unified
	Inches			
Rago: Ra (For properties of the Kuma soil in this mapping unit, refer to the Kuma series.)	0–9 9–26 26–60	Loam Clay loam or silty clay loam Loam or silt loam	A–4 A–6 A–4	ML CL ML
Richfield: RcB, RcC	0–6 6–15 15–33 33–60	Loam Clay loam Loam Sandy loam to very fine sandy loam.	A–4 A–7 A–4 A–4	ML CL ML ML
Valentine: VaD, VaE	0–60	Fine sand	A–3	SP
Wages: WcB, WcC, WeE (For properties of the Campus and Weld soils in mapping units WcB and WcC, and of the Eckley and Dix soils in unit WeE, refer to their respective series.)	0–5 5–24 24–60	Loam Clay loam Gravelly sandy loam	A–4 A–4 A–2 or A–4	ML ML SM
Weld (Mapped only in complexes.)	0–6 6–12 12–60	Loam Clay Loam to fine sandy loam	A–4 A–7 A–4	ML CH ML

TABLE 8.—*Engineering*

Soil series and map symbols	Suitability as source of—				
	Topsoil	Road fill	Sand and gravel	Foundation support	Highway location
Anselmo: AnB	Fair	Fair	Not suited	(1)	Erodibility
Ascalon: AsB, AsC, AsD	Fair	Good	Not suited	(1)	(1)
Bayard: BcC (For interpretations of Canyon soil in this mapping unit, see the Canyon series.)	Fair	Good	Poor	(1)	Erodibility
Campus (Mapped only in complexes.)	Fair	Fair to good	Not suited	Moderate shear strength.	Limestone or marl within a depth of 5 feet in most places.
Canyon: CcD	Poor	Fair to good	Not suited	Shallowness to caliche or limestone.	Limestone at a depth of 10 to 20 inches.
Chappell: CdB (For interpretations of Dix soil in this mapping unit, see the Dix series.)	Fair	Good	Fair for sand; good for gravel below a depth of 3 feet.	(1)	Erodibility

See footnote at end of table.

properties of soils—Continued

Percentage passing sieve—				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	90–100	75–95	0. 63–6. 3	. 16	6. 6–7. 3	Low.
100	95–100	90–100	80–95	<0. 63	. 16	6. 6–7. 3	Moderate.
95–100	95–100	90–100	75–95	0. 63–6. 3	. 16	7. 9–8. 4	Low.
100	95–100	80–95	60–85	0. 63–6. 3	. 16	6. 6–7. 3	Low.
95–100	95–100	85–95	75–95	<0. 63	. 16	6. 6–7. 3	High.
95–100	95–100	90–100	75–95	0. 63–6. 3	. 16	6. 6–7. 3	Low.
95–100	95–100	80–95	60–80	0. 63–6. 3	. 10	7. 4–7. 8	Low.
100	100	95–100	0–4	>6. 3	. 08	6. 6–7. 3	Low.
100	95–100	80–95	60–85	0. 63–6. 3	. 16	6. 6–7. 3	Low.
90–100	90–100	85–95	75–85	<0. 63	. 16	7. 9–8. 4	Low.
60–85	65–85	50–75	20–50	>6. 3	. 10	8. 5–9. 0	Low.
100	95–100	80–95	60–85	0. 63–6. 3	. 16	6. 6–7. 3	Low.
95–100	95–100	85–95	80–95	<0. 63	. 16	6. 6–7. 3	High.
95–100	95–100	80–95	60–80	0. 63–6. 3	. 10	7. 9–8. 4	Low.

interpretations of soils

Soil features affecting—				Soil limitations for sewage disposal	
Farm ponds		Irrigation	Terraces and diversions	Septic tank filter fields	Sewage lagoons
Reservoir area	Embankment				
High seepage	Moderate permeability if compacted.	Low water-holding capacity; undulating topography.	High erodibility; high intake rate.	Slight	Severe: high seepage.
High seepage	Moderate permeability if compacted; fair stability.	Steep slopes in some areas.	Hazard of soil blowing.	Slight where slopes are less than 5 percent, and moderate where slopes are more than 5 percent.	Moderate where slopes are 0 to 5 percent, and severe on steeper slopes.
High seepage	Moderate permeability if compacted; fair stability.	Rapid intake rate; low water-holding capacity.	Sandy soil	Slight	Severe: high seepage.
Moderate seepage	(1)	Steep slopes in some areas.	Limestone outcrops in many places.	Slight	Moderate: moderate seepage.
High seepage	Soil shallow to borrow material.	Shallow soil to limestone or caliche; steep soils in some areas.	Shallow soil to limestone or caliche.	Severe: limestone or marl at a depth of 10 to 20 inches.	Severe: limestone or marl at a depth of 10 to 20 inches.
High seepage	Moderate permeability if compacted.	Moderate to low water-holding capacity.	High hazard of soil blowing.	Slight	Severe: high seepage.

TABLE 8.—*Engineering*

Soil series and map symbols	Suitability as source of—				
	Topsoil	Road fill	Sand and gravel	Foundation support	Highway location
Dawes: Da	Fair	Poor to fair	Not suited	Clayey subsoil	Plastic subsoil
Dix (Mapped only in a complex and in an undifferentiated unit.)	Poor	Very good to good.	Fair for sand below 1 foot; good for sand and gravel below 3 feet.	(1)	(1)
Dunday: Du	Poor	Good if binder is added.	Fair for fine sand.	(1)	Erodibility
Eckley (Mapped only in a complex and in an association.)	Fair	Good	Good for sand and gravel below a depth of 12 inches.	(1)	(1)
Haxtun: HtB, HtC, HxB	Fair	Fair to good	Poor for sand; no gravel.	(1)	(1)
Julesburg: JuB, JuC	Poor	Good if binder is added.	Fair for sand below a depth of 3 feet.	(1)	Erodibility
Kuma (Mapped only in an undifferentiated unit.)	Good	Fair	Not suited	Moderate shear strength.	Fair compaction
Platner: PaB, PaC, PeC (For interpretations of Eckley soil in mapping unit PeC, see the Eckley series.)	Fair	Fair	Fair for sand; gravel in some places below a depth of 2 feet.	Clayey subsoil	Plastic subsoil
Pleasant: Ps	Good	Poor to fair	Not suited	Clayey subsoil; high shrink-swell potential.	Plastic subsoil
Rago: Ra (For interpretations of Kuma soil in this mapping unit, see the Kuma series.)	Good	Poor to fair	Not suited	Clayey subsoil	Plastic subsoil
Richfield: RcB, RcC	Good	Poor to fair	Not suited	Clayey subsoil	Plastic subsoil
Valentine: VaD, VaE	Poor	Good if binder is added.	Fair for sand	(1)	Erodibility
Wages: WcB, WcC, WeE (For interpretations of Campus and Weld soils in mapping units WcB and WcC, and of Eckley and Dix soils in unit WeE, see their respective series.)	Fair	Good	Poor	(1)	(1)
Weld (Mapped only in complexes.)	Fair	Poor to fair	Not suited	Clayey subsoil	Plastic subsoil

[1] No significant unfavorable features.

interpretations of soils—Continued

Soil features affecting—				Soil limitations for sewage disposal	
Farm ponds		Irrigation	Terraces and diversions	Septic tank filter fields	Sewage lagoons
Reservoir area	Embankment				
Low seepage	(1)	Variable water intake rate after leveling.	Nearly level and gently sloping.	Severe: slow permeability; cobbly limestone within depth of 5 feet.	Slight.
High seepage	Sandy soil; binder needed.	Steep slopes; low water-holding capacity.	Steep slopes; high intake rate.	Slight where slopes are less than 5 percent, and moderate on steeper slopes.	Severe: high seepage.
High seepage	Sandy soil; binder needed.	Low water-holding capacity.	Sandy soil	Slight	Severe: high seepage.
High seepage	Moderate permeability if compacted.	Low water-holding capacity.	Erodibility; high water intake rate.	Slight where slopes are less than 5 percent, and moderate on steeper slopes.	Severe: high seepage.
High seepage	(1)	Moderate water-holding capacity.	High water intake rate.	Slight	Moderate: moderate seepage.
High seepage	Moderate to rapid permeability if compacted.	Low water-holding capacity.	Severe hazard of soil blowing; high water intake rate.	Slight	Severe: high seepage.
Low seepage	Fair stability	(1)	Nearly level and gently sloping.	Slight	Moderate: moderate seepage.
Low seepage	(1)	Moderate to slow water intake rate; steep slopes in some areas.	(1)	Moderate: slow permeability.	Slight where slopes are 0 to 3 percent, and moderate where slopes are 3 to 5 percent.
Low seepage	(1)	Slow water intake rate.	(1)	Severe: slow to very slow permeability.	Slight.
Low seepage	(1)	(1)	Nearly level and gently sloping.	Moderate: slow permeability.	Slight.
Low seepage	(1)	Moderate to slow water intake rate; steep slopes in some areas.	(1)	Slight	Slight.
High seepage	Sandy soil; binder needed.	Very low water-holding capacity.	Sandy soil	Moderate to severe: sloping to hilly.	Severe: high seepage.
Low seepage	Fair stability	(1)	(1)	Slight	Moderate where slopes are 0 to 5 percent, and severe on steeper slopes.
Low seepage	(1)	Moderate to slow water intake rate; steep slopes in some areas.	(1)	Slight	Slight.

Features that affect irrigation include rate of water intake, permeability, available water capacity, and slope. Slope, the hazard of erosion, and permeability are features that affect use of a soil for terraces and diversions.

In table 8 the soils are rated *slight*, *moderate*, or *severe*, according to the degree of their limitations for use as septic tank filter fields and sewage lagoons. Where the rating is moderate or severe, the main limitation or limitations are also given.

Formation and Classification of Soils

In this section the factors that affected the formation of the soils in Phillips County are discussed, and processes of soil horizon formation are given. Then the current system of soil classification is explained, and the soil series are placed in some classes of that system and in great soil groups of an older system. The soil series in the county, including a profile typical for each series, are described in the section "Descriptions of the Soils."

Factors of Soil Formation

Soils in Phillips County, as well as those everywhere, have formed as a result of complex physical, chemical, and biological processes. The kinds of soil that develop at any given place depend on the influence that each of the five major factors of soil formation have exerted. These factors are parent material, climate, plants and animals, relief, or lay of the land, and time. Even though the five factors are important in the formation of every soil in this county, some factors have exerted a greater influence than others at a given place.

Described in the following paragraphs are the five factors of soil formation as they affect the formation of soils in Phillips County.

Parent material

Five kinds of parent material occur in Phillips County. They are (1) material weathered from Tertiary limestone of the Ogallala formation; (2) Pleistocene sand and gravel or reworked Ogallala material, possibly of the Grand Island formation; (3) eolian sands, or reworked material of the Grand Island formation; (4) alluvium; and (5) loess (Peorian and possibly Bignell) (*3*, *5*). Figure 15 shows the major soils in the county and their parent materials.

Canyon soils formed in place in material weathered from highly calcareous outwash from the Ogallala formation. This limy material was washed from the Rocky Mountains and was deposited on a large part of the Great Plains during the Tertiary period. At the close of the Tertiary period, this Ogallala formation was deeply eroded by water and the loosely consolidated material was redeposited as beds of Pleistocene sand and gravel. The Eckley soils formed in this reddish-brown gravelly material, which also contains reddish or pink zones of shalelike and clayey material.

In another period of erosion and deposition, wind and water sifted and sorted the sand and gravel into deep, rolling and hilly, sandy landforms south of Holyoke and north of Paoli. Also formed at this time were the major intermittent streams in the county. The Valentine soils

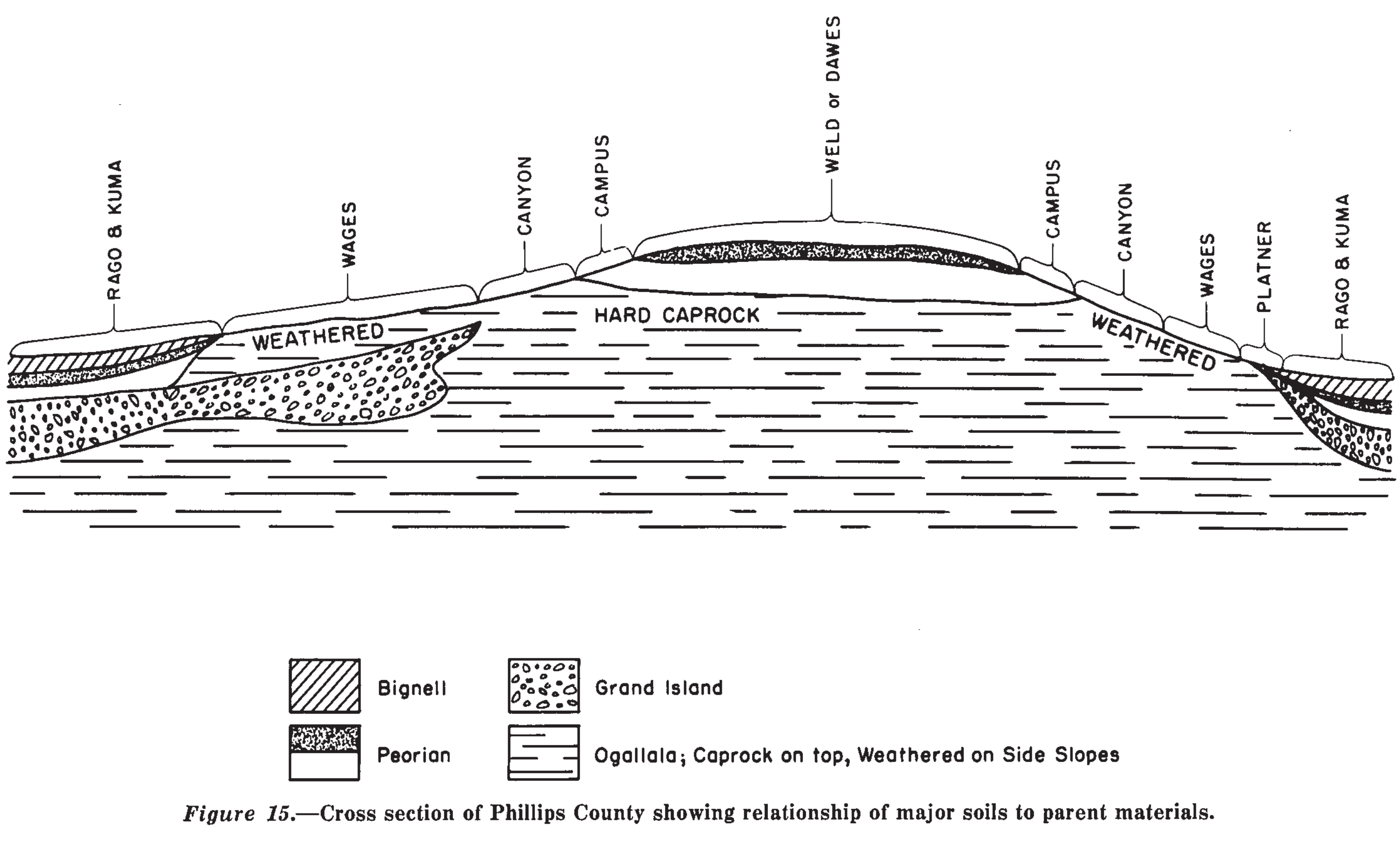

Figure 15.—**Cross section of Phillips County showing relationship of major soils to parent materials.**

developed in the sandy deposits, but Chappell and Dix soils formed in the alluvium deposited by intermittent streams.

The next major deposit was the mantle of Peorian loess. This mantle covered most of Phillips County, including valleys within areas of Valentine fine sand. Weld, Dawes, and Richfield soils formed in the deposits of Peorian loess. The buried soils in Phillips County indicate that a second mantle of loess covered the first, or that the Peorian loess was reworked and redeposited, possibly as Bignell loess. Rago and Kuma soils formed under this second deposit of loess.

At about the time of the second loessal deposit, there was further shifting of sand from sandhills and stream channels. These sands covered the Peorian loess in areas around and north of Haxtun. The Haxtun soils formed in these sands. Platner, Wages, and Pleasant soils formed in a mixture of Grand Island material and Peorian loess. Campus soils formed mostly in Ogallala material, but loess had a minor influence. Bayard, Dunday, and Julesburg soils formed in reworked sands, and Ascalon soils formed in a mixture of eolian sands and Grand Island material.

Climate

Phillips County has a temperate, semiarid climate that is typical for the High Plains. Days are hot during July and August, but except for July, nights are cool in summer. In winter, which is cold, the wind is considerable and blows the snow, but warm chinook winds occur occasionally. The growing season is about 147 days, and the mean annual temperature is about 49° F.

The amount of precipitation varies from year to year, and comes mostly as rain during April, May, June, and July. The annual average precipitation is 17.8 inches. Because this amount is not enough to leach any of the soils completely, calcium carbonate has accumulated in the lower part of the subsoil of the Rago, Kuma, Richfield, Dawes, Weld, and other well-developed soil. Likewise, precipitation has leached clay from the surface layer of these soils into the subsoil.

Soils under the stated growing season and level of precipitation generally produce enough plants to return large amounts of organic matter. The soils in this county, therefore, have dark-colored surface layers. Roots of plants help to develop the blocky structure in the subsoil.

Wind has influenced soil formation by removing soil material from one place and depositing it in another. The effect of the wind can be seen in the pattern of soil areas shown on the soil map in the back of this survey. Long, narrow soil areas that trend southeast are distinct and were formed by winds blowing from the northwest. The pattern of surface drainage that was cut by runoff water also follows a southeasterly direction.

Climate has indirectly affected the formation of soils in Phillips County by strongly influencing the kinds of plants that grow.

Plants and animals

Various forms of plants and animals live on and in the soil and are active in the soil-forming processes. The changes brought about by these biological forces depend on the kinds of life processes peculiar to each plant or animal. The kinds of plants and animals that live on and in the soil are determined by climate, parent material, relief and drainage, age of the soil, and by associated plants and animals. Vegetation is mainly controlled by the climate.

The well-developed soils of Phillips County have been greatly influenced by the effects of plants and animals on the parent material. As is typical of soils formed under grass, these soils are dark colored. They formed under short and mid grasses, which supplied abundant organic matter. The organic matter was changed to humus in the soil by the activity of micro-organisms, earthworms, and other animal life, and by direct chemical reactions. Small burrowing animals and earthworms have influenced soil formation by mixing the organic and mineral matter and by extending the zone in which organic matter accumulates. By bringing unleached material to the surface, they increase the supply of minerals in the surface layer.

Relief

The soils of Phillips County are nearly level to steep. The amount of runoff, of infiltration into the soil, and of erosion is partly determined by the kind and percentage of slope.

In Phillips County the soils that show the strongest development are nearly level to moderately sloping. Because less water runs off the less sloping soils, more of it enters those soils. Consequently, weathering is greater than on the more sloping soils, and the clay particles and soluble minerals have been leached to greater depths. Because more moisture is absorbed, more vegetation grows, and in this way, more organic matter is added to the soil. The deep Rago, Kuma, and Pleasant soils are examples of soils formed in nearly level or gently sloping areas. The Pleasant soils formed in areas where sandhills in the loess-mantled uplands are a barrier to intermittent drainageways. Following heavy rains, the blocked streams spread out as shallow temporary ponds from which water seeps into the underlying loess. Partly because extra moisture encourages a more dense growth of vegetation and more leaching, the soils are deep and strongly developed.

In Phillips County the profiles of soils in strongly sloping areas are thinner, lighter in color, and less well developed because more water was lost as runoff, and less water entered the soil. The thin Campus and Canyon soils are good examples.

The amount of water that enters and passes through the soil mainly determines the degree of soil formation in a given period, on a certain kind of parent material, and under similar vegetative covers. In general, soils are thicker and have better developed profiles where they are nearly level.

Time

The length of time required for soils to develop from parent material varies according to the kinds of parent material. Surface soils are darkened when organic matter, mostly that from decayed plants, is added to the soil. Calcium carbonate and other soluble minerals are leached from the surface horizon and deposited in the subsoil during periods of rainfall. Clay is also leached from the surface horizon, but this leaching is slow and depends on how fast materials weathered in the upper horizons. Soils such as the Dawes, Weld, Richfield, Rago, and Kuma generally have well-defined, genetically related horizons. They developed from similar material that has been in place for a long time. Chappell, Dix, and similar soils formed in alluvium that has been considerably reworked and has been in place for only a short time.

The formation of soils on steep slopes or on weather-resistant limestone, gravel, or sand requires still more time. Steep Eckley and Valentine soils formed in sand or gravel, which is resistant parent material. In many steep areas of this kind of material, geologic erosion takes place as fast as the material weathers, even though the soil is very rapidly permeable. Although the parent material has been in place for a long time, these soils are young in profile development. Here, relief, as well as time, is exerting a strong influence on the soil.

Canyon soils formed on old, extremely weather-resistant Ogallala limestone. In degree of development, they are also considered young soils, though they have been in place a long time. Relief again has exerted a stronger influence than time.

The balance of all five factors of soil formation determines the kind of soil that forms over a given period. If they are out of balance, then the soil developed begins to reflect the effects of the factors that show the strongest influence.

Processes of Soil Formation

As a result of the interaction of the factors of soil formation, soil horizons begin to form. The soils in Phillips County developed through one or more of the following processes: (1) accumulation of organic matter, (2) leaching of calcium carbonate, and (3) formation and translocation of silicate clay minerals. In most soils of the county, more than one of these processes has been active in soil formation.

Surface horizons form because organic matter increases in them and carbonates and silicate clay minerals are lost. The carbonates are leached downward into the substratum and the clay minerals accumulate in the subsoil. The carbonates are generally leached downward before the clay minerals begin to move.

The marks that the soil-forming factors leave on the soil are recorded in the soil profile, which is a succession of layers, or horizons, extending from the surface to the parent rock. The horizons may be thick or thin. They differ in one or more properties such as color, texture, structure, consistence, porosity, and reaction.

Most soil profiles contain three major horizons called A, B, and C. The Richfield are a good example of soils with A, B, and C horizons. In some young soils a B horizon has not developed.

Classification of Soils

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

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

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (*2*) and later revised (*10*). The system currently used was adopted for general use by the National Cooperative Soil Survey in 1965 and is under continual study (*12*). Readers who are interested in developments of the current system should search the latest literature available (*9*).

In this report the classes in the newer system, and the orders and the great soil groups of the older system, are given in table 9. Except for series, the classes in the current system are briefly defined in the following paragraphs.

ORDER: Soils are grouped into orders according to properties that seem to have resulted from the same processes acting to about the same degree on the parent material. Ten soil orders are recognized in the current system: Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The Entisols and Mollisols are represented in this county.

Entisols are young soils in which genetic horizons are just beginning to develop. This order includes many of the soils previously called Alluvial soils, Regosols, and Lithosols.

Mollisols have well-expressed horizons. The surface layer is dark colored and generally more than 7 inches thick. This layer is more than 1 percent organic matter and is soft and friable. Leaching has caused a B horizon to form, and much lime has accumulated below the B horizon.

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

GREAT GROUP: Suborders are separated into great groups according to the presence or absence of genetic horizons and the arrangement of these horizons. The horizons used to make separations are those in which clay, iron, or humus has accumulated or those that have pans that interfere with the growth of roots or the movement of water. The features used are the self-mulching properties of clay, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like. The great group is not shown separately in table 9, because it is the last word in the name of the subgroup.

SUBGROUP: Great groups are subdivided into subgroups. One of these subgroups represents the central, or typic, segment of a group, and the others, called intergrades, contain those soils that have properties mostly of one great group, but also one or more properties of soils in another great group, suborder, or order. Subgroups may also be made in those instances where soil properties

TABLE 9.—*Soil series in Phillips County classified into higher categories* [1]

Series [2]	Current classification system: Family	Subgroup	Order	1938 system Great soil group
Ascalon	Fine-loamy, mixed, mesic	Aridic Argiustolls	Mollisols	Chestnut soils.
Bayard	Coarse-loamy, mixed, mesic	Torriorthentic Haplustolls	Mollisols	Chestnut soils.
Campus	Fine-loamy, mixed, mesic	Typic Calciustolls	Mollisols	Calcisols.
Canyon	Loamy, mixed, calcareous, mesic, shallow.	Ustic Torriorthents	Entisols	Lithosols.
Chappell	Sandy, mixed, mesic (sandy-skeletal).	Aridic Haplustolls	Mollisols	Chestnut soils.
Dawes	Fine, mixed, mesic	Abruptic Paleustolls	Mollisols	Solodized-Solonitz soils.
Dix	Sandy-skeletal, mixed, mesic	Torriorthentic Haplustolls	Mollisols	Chestnut-Regosol soils.
Eckley	Fine-loamy over sandy or sandy-skeletal, mixed, mesic.	Aridic Argiustolls	Mollisols	Chestnut soils.
Haxtun	Fine-loamy, mixed, mesic	Pachic Argiustolls	Mollisols	Chestnut soils.
Julesburg	Coarse-loamy, mixed, mesic	Aridic Argiustolls	Mollisols	Chestnut soils.
Kuma	Fine-silty, mixed, mesic	Pachic Argiustolls	Mollisols	Chestnut soils.
Platner	Fine, montmorillonitic, mesic	Abruptic Aridic Paleustolls	Mollisols	Chestnut soils.
Pleasant	Fine, montmorillonitic, mesic	Pachic Argiustolls	Mollisols	Chestnut soils.
Rago	Fine, montmorillonitic, mesic	Aridic Argiustolls	Mollisols	Chestnut soils.
Richfield	Fine, montmorillonitic, mesic	Aridic Argiustolls	Mollisols	Chestnut soils.
Wages	Fine-loamy, mixed, mesic	Aridic Argiustolls	Mollisols	Chestnut soils.
Weld	Fine, montmorillonitic, mesic	Abruptic Aridic Paleustolls	Mollisols	Chestnut soils.

[1] Classification of series as of August 1969. Placement of some series in the current system of classification, particularly in families, may change as more precise information becomes available.

[2] The soil mapped as a substratum variant from the Anselmo series is more like soils in the Alice series than those in the Anselmo series. Soils of the Alice series are coarse-loamy, mesic Aridic Haplustolls that have a horizon of calcium carbonate. The Anselmo variant is a coarse-loamy, mesic Aridic Calciustoll. The Dunday series would be called the Dailey series, and the Valentine series would be called the Valent series. Classification of the series in the higher categories is as follows: Dailey series—sandy, mixed, mesic Torriorthentic Haplustolls; Valent series—mixed, mesic Ustic Torripsamments.

intergrade outside of the range of any other great group, suborder, or order.

FAMILY: Each subgroup is divided into families, primarily on the basis of properties important to the growth of plants or to the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

Physical and Chemical Analyses

The data obtained by physical and chemical analyses for five selected soils in Phillips County are given in table 10. The samples were taken from profiles representative of the Ascalon, Haxtun, Kuma, Platner, and Rago series. Profiles typical of these soils are described in the section "Descriptions of the Soils." The data in table 10 are useful to soil scientists in classifying soils and in understanding their genesis. They are also helpful in determining water-holding capacity, soil blowing, fertility, tilth, and other characteristics that affect soil management.

Field and Laboratory Methods

Samples were collected from carefully selected pits. If necessary, a sample was sieved after it had been dried, and the rock fragments larger than three-fourths of an inch in diameter were discarded. All the material less than three-fourths of an inch in diameter was rolled, crushed, and sieved by hand; the rock fragments larger than 2 millimeters in diameter were discarded. Only ovendry material that passed the 2-millimeter sieve was analyzed.

Determinations of clay were made by the hydrometer method; otherwise, standard methods of the Soil Survey Laboratory were used to obtain most of the data in table 10. Soil reaction was measured with a glass electrode. Organic carbon was determined by wet combustion, using a modification of the Walkley-Black method described by Peech (*8*). Calcium carbonate equivalent was obtained by measuring the volume of carbon dioxide emitted from soil samples that have been treated with concentrated hydrochloric acid.

General Nature of the County

This section was prepared mainly for those not familiar with Phillips County. Physiography, relief, and drainage; climate; and farming and ranching are briefly discussed. Statistics are taken from the 1964 Census of Agriculture.

Physiography, Relief, and Drainage

Phillips County is in the western part of the Great Plains where elevations range from 4,000 feet above sea level at Haxtun to 3,745 feet at Holyoke. The general slope is less than 1 percent to the southeast.

Rago, Kuma, Richfield, and Platner soils are loamy, nearly level to gently sloping, and occur on uplands. Valentine soils occur in the sandhills and are nearly level to steep.

374-140—71——4

TABLE 10.—*Laboratory data on selected*

[Analysis by Soil Survey Laboratory, Fort Collins, Colo. Absence of data

Soil and sample number	Horizon	Depth from surface	Particle size distribution—			
			Very coarse sand (2 to 1 mm.)	Coarse sand (1 to 0.5 mm.)	Medium sand (0.5 to 0.25 mm.)	Fine sand (0.25 to 0.10 mm.)
		Inches	*Percent*	*Percent*	*Percent*	*Percent*
Ascalon sandy loam: S61 Colo–48–11(1–6).	Ap	0–5	0. 4	6. 1	15. 3	26. 7
	B21t	5–10	. 5	5. 1	11. 2	19. 0
	B22t	10–19	. 2	3. 7	9. 0	17. 8
	B3	19–27	. 1	1. 5	5. 1	17. 6
	C1ca	27–44	. 1	3. 8	13. 1	25. 0
	C2	44–60	. 9	10. 6	16. 7	24. 5
Haxtun loamy sand: S58 Colo–48–6(1–7).	Ap	0–9	1. 8	5. 9	20. 0	39. 1
	AB	9–12	1. 5	5. 3	14. 8	31. 6
	B2t	12–19	2. 6	5. 6	8. 0	16. 0
	IIB2tb	19–26	1. 0	2. 9	3. 7	8. 3
	IIB3tb	26–33	. 6	1. 2	7. 6	7. 0
	IIC1cab	33–50	. 2	. 5	. 7	5. 8
	IIIC2ca	50–60	1. 6	4. 5	4. 6	9. 9
Kuma loam: S58 Colo-48–4(1–6).	Ap	0–5	. 1	. 1	. 1	1. 7
	AB	5–8	<. 1	. 1	. 1	1. 6
	B2t	8–16	<. 1	. 1	. 1	1. 0
	B2tb	16–29	<. 1	. 1	. 1	1. 0
	B3b	29–37	<. 1	. 1	. 1	1. 2
	C1ca	37–60	<. 1	<. 1	<. 1	1. 2
Platner loam: S61 Colo-48–13(1–6).	Ap	0–5	7. 0	12. 0	8. 3	10. 5
	B2t	5–12	1. 5	3. 1	2. 8	4. 3
	B3	12–17	1. 3	3. 6	4. 1	6. 9
	C1ca	17–24	3. 1	6. 5	6. 9	12. 1
	IIC2ca	24–48	3. 0	5. 9	6. 3	8. 2
	IIC3	48–60	1. 5	5. 1	7. 1	11. 6
Rago silt loam: S57 Colo-48-1(1–8).	Ap	0–5	1. 1	3. 0	3. 2	5. 8
	B1	5–9	. 7	2. 5	3. 0	5. 6
	B2t	9–14	1. 0	3. 0	3. 2	5. 3
	B2tb	14–23	. 5	1. 9	2. 1	3. 4
	B3cab	23–26	. 3	. 8	. 9	1. 9
	C1ca	26–43	. 3	. 9	1. 1	2. 1
	C2	43–60	. 4	1. 4	1. 6	2. 9

On uplands in the hardland part of Phillips County are shallow surface drainageways and several deep drainage channels. All drainageways in the county are intermittent and extend to the southeast.

Many shallow intermittent streams flow into small lakebeds or into the larger intermittent streams, but some spread water over level to nearly level areas. Sandy Creek, Wildhorse Creek, Patent Creek, and Frenchman Creek are the most significant of the intermittent streams that have well-defined channels. Patent Creek and Sandy Creek flow into large lakebeds southwest of Holyoke next to the western edge of the sandhills.

Climate [7]

Phillips County has a semiarid, continental climate in which temperature, precipitation, and humidity vary considerably. Strong winds at times blow in short gusts and reach speeds of nearly 90 miles per hour. These winds have severely damaged soil, crops, and property. Several tornadoes also have caused severe damage, and damaging hailstorms also are common.

Except for a short hot period in July, most summer days are warm and nights are cool. Winters are mild, but the strong winds make the weather seem much colder than the thermometer indicates.

Temperature and precipitation data based on records kept by the weather station at Holyoke are given in table 11. These data are representative of Phillips County.

According to the records of the U.S. Weather Bureau at Holyoke, the last expected killing frost in spring is about May 15, and the first expected killing frost in fall is about September 9. The average annual temperature of Phillips County is about 50° F. Chinook winds are common during winter.

[7] Data compiled by J. W. BERRY, State climatologist, Denver.

soils of Phillips County

indicates determination was not made. The symbol < means less than]

Particle size distribution—Continued				Dominant textural class	Reaction (1:5)	Organic carbon	Calcium carbonate equivalent
Very fine sand (0.10 to 0.05 mm.)	Total sand	Silt (0.05 to 0.002 mm.)	Clay (0.002 mm.)				
Percent	*Percent*	*Percent*	*Percent*		*pH*	*Percent*	*Percent*
18. 7	67. 2	16. 9	15. 9	Sandy loam	7. 3	0. 8	<1
17. 1	52. 9	20. 1	27. 0	Sandy clay loam	7. 3	. 7	1
20. 7	51. 4	23. 9	24. 7	Sandy clay loam	7. 4	. 4	1
32. 6	56. 9	25. 2	17. 9	Sandy loam	8. 0	. 3	1
19. 4	61. 4	20. 5	18. 1	Sandy loam	8. 9	. 1	9
26. 2	78. 9	13. 3	7. 8	Loamy sand	9. 3	. 06	3
21. 2	88. 0	7. 0	5. 0	Loamy sand	7. 2	. 3	------------
26. 8	80. 0	12. 0	8. 0	Loamy sand	6. 7	. 3	------------
26. 8	59. 0	26. 0	15. 0	Sandy loam	7. 0	. 4	------------
20. 1	36. 0	36. 0	28. 0	Clay loam	7. 1	. 5	------------
22. 6	33. 0	52. 0	15. 0	Silt loam	7. 4	. 4	------------
25. 8	33. 0	52. 0	15. 0	Silt loam	8. 7	. 3	12
37. 4	58. 0	27. 0	15. 0	Sandy loam	8. 7	. 2	6
26. 0	28. 0	54. 0	18. 0	Silt loam	6. 5	1. 5	<1
27. 2	29. 0	48. 0	23. 0	Loam	6. 9	1. 0	<1
27. 8	29. 0	48. 0	23. 0	Loam	7. 3	. 5	<1
16. 8	18. 0	51. 0	31. 0	Silty clay loam	7. 4	1. 2	<1
18. 6	20. 0	59. 0	21. 0	Silt loam	8. 0	. 5	<1
26. 8	28. 0	56. 0	16. 0	Silt loam	8. 4	. 3	2
14. 6	52. 4	34. 3	13. 3	Loam	7. 6	. 8	1
10. 5	22. 2	35. 9	41. 9	Clay	7. 6	. 9	1
17. 1	33. 0	41. 7	25. 3	Loam	7. 9	. 7	1
16. 5	45. 1	40. 3	14. 6	Loam	8. 4	. 5	9
23. 2	46. 6	21. 9	31. 5	Fine sandy clay loam	8. 5	. 2	5
28. 4	53. 7	22. 6	23. 7	Very fine sandy clay	8. 3	. 06	1
14. 9	28. 0	52. 0	20. 0	Silt loam	7. 2	1. 6	------------
11. 2	23. 0	54. 0	23. 0	Silt loam	6. 8	1. 1	------------
10. 5	23. 0	50. 0	27. 0	Clay loam	6. 9	. 9	------------
8. 1	16. 0	45. 0	39. 0	Silty clay loam	7. 4	1. 2	------------
7. 1	11. 0	53. 0	36. 0	Silty clay loam	8. 3	. 8	------------
4. 6	9. 0	62. 0	29. 0	Silty clay loam	8. 6	. 3	------------
6. 7	13. 0	67. 0	20. 0	Silt loam	------------	. 2	------------

In table 12, probabilities of the last freezing temperatures occurring in spring and the first such temperatures in fall are given for specified dates.

The average number of days is 147 between the last freezing temperature of 32° or lower in spring and the first such temperature in fall, is 167 days between spring and fall temperatures of 28° or lower, is 189 days between temperatures of 24° or lower, is 207 days between temperatures of 20° or lower, and is 225 days between temperatures of 16° or lower.

The average annual precipitation at Holyoke in Phillips County is 17.8 inches. Most of the moisture that falls in the county is rain. The wettest months are April through August. Heavy snows fall in winter, but they are infrequent. Because much of the snow blows or drifts, all of its moisture does not enter the soil where needed.

Rains in spring generally are gentle and misty, but those in summer come in thunderstorms. In some areas as much as 4 inches of rainfall has been recorded in one thunderstorm. Hailstorms are most frequent in summer, and in nearly every year hail damages some area of the county.

Precipitation data may be misleading, because it does not show the amount of moisture that enters the soil and is available to plants. In a hard, heavy rain, water is lost in runoff, or if a rain is followed by hot temperatures or high winds, the water evaporates rapidly. In addition, strong, hot winds often burn plant leaves and slow crop growth. Normally, however, the precipitation in fall, winter, and spring is enough to replace the moisture lost during the growing season and is enough for the next dryland crops.

Phillips County is in an area of climatic transition from semiarid in the west to subhumid in the east. In this area, the average annual total precipitation during the period 1931–60 ranged from 14.1 inches at Sterling, about 30 miles west of the Phillips County western border, to 18.2 inches at Ogallala, Nebr., about 40 miles northeast of Holyoke. The average annual precipitation is more than 19 inches at Madrid, Nebr., about 25 miles east of the Phillips County border.

TABLE 11.—*Temperature and precipitation*

[All data from records kept at Holyoke]

Month	Temperature: Average daily maximum	Temperature: Average daily minimum	Temperature: Two years in 10 will have at least 4 days with—: Maximum temperature equal to or higher than—	Temperature: Two years in 10 will have at least 4 days with—: Minimum temperature equal to or lower than—	Precipitation: Average total	Precipitation: Two years in 10 will have—: Less than—	Precipitation: Two years in 10 will have—: More than—	Precipitation: Average number of days with snow cover	Precipitation: Average depth of snow on days with snow cover
	°F.	°F.	°F.	°F.	Inches	Inches	Inches		Inches
January	41	14	60	−6	0.31	0.1	0.5	7	3
February	45	16	66	−1	.35	.1	.5	7	3
March	51	22	73	4	.99	.4	1.7	6	3
April	63	33	81	20	1.91	.7	3.4	2	3
May	73	43	88	32	3.19	1.8	4.5	0	----------
June	84	53	99	42	3.37	2.0	5.0	0	----------
July	92	60	101	52	2.46	.9	3.1	0	----------
August	90	58	100	50	2.00	.9	2.8	0	----------
September	82	47	97	36	1.48	.4	2.3	0	----------
October	69	35	87	25	.92	.2	1.5	(1)	3
November	52	23	70	7	.44	.1	.6	4	3
December	44	17	61	1	.39	.2	.7	7	2
Year	66	35	[2] 104	[3] −15	17.81	13.8	22.1	33	3

[1] Less than one-half day.
[2] Average annual highest temperature.
[3] Average annual lowest temperature.

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

Probability	32° F. or lower	28° F. or lower	24° F. or lower	20° F. or lower	16° F. or lower
Spring:					
1 year in 10 later than	May 28	May 17	May 3	April 24	April 16
2 years in 10 later than	May 22	May 11	April 27	April 18	April 10
5 years in 10 later than	May 10	April 30	April 16	April 6	March 29
Fall:					
1 year in 10 earlier than	September 19	September 29	October 8	October 16	October 25
2 years in 10 earlier than	September 24	October 4	October 13	October 21	October 30
5 years in 10 earlier than	October 4	October 14	October 22	October 30	November 9

Farming and Ranching

Farming is the principal enterprise in Phillips County. Wheat, the main crop, is dryfarmed and irrigated. The next most important crops are sorghums, barley, corn, potatoes, and alfalfa. In Phillips County dryfarming is much more extensive than irrigated farming.

According to the 1964 Census of Agriculture, the crops harvested in the county were 76,915 acres of wheat, 10,436 acres of barley, 16,312 acres of sorghums used for all purposes except sirup, and 8,673 acres of corn.

The first irrigation well drilled in the county was in 1941. More wells have been developed, and the acreage irrigated has increased. In 1964, the irrigated area was 6,400 acres. Of this acreage, 5,088 acres was harvested cropland and 854 acres was pasture or grazing land. The principal irrigated crops were corn and hay. Sorghums and winter wheat were irrigated in only a small acreage. The irrigation is mostly on the nearly level to gently sloping Rago and Kuma, Richfield, Pleasant, Haxtun, and Platner soils. Both the gravity system and sprinklers are used.

Cattle ranching is the main enterprise in the sandhills, because soils there are not suited to crops. Nearly one-fourth of the farm and ranch income of the county comes from sale of livestock that was raised either in feedlots or on range on the Valentine soils south of Holyoke (fig. 16).

In 1964, on farms and ranches in the county, there were 21,373 cattle and calves, 8,097 sheep and lambs, and 4,595 hogs and pigs.

In 1964, 460 farms were in the county. In recent years the trend has been toward fewer but larger farms. The average-sized farm increased from 930 acres in 1959 to 1,041 acres in 1964.

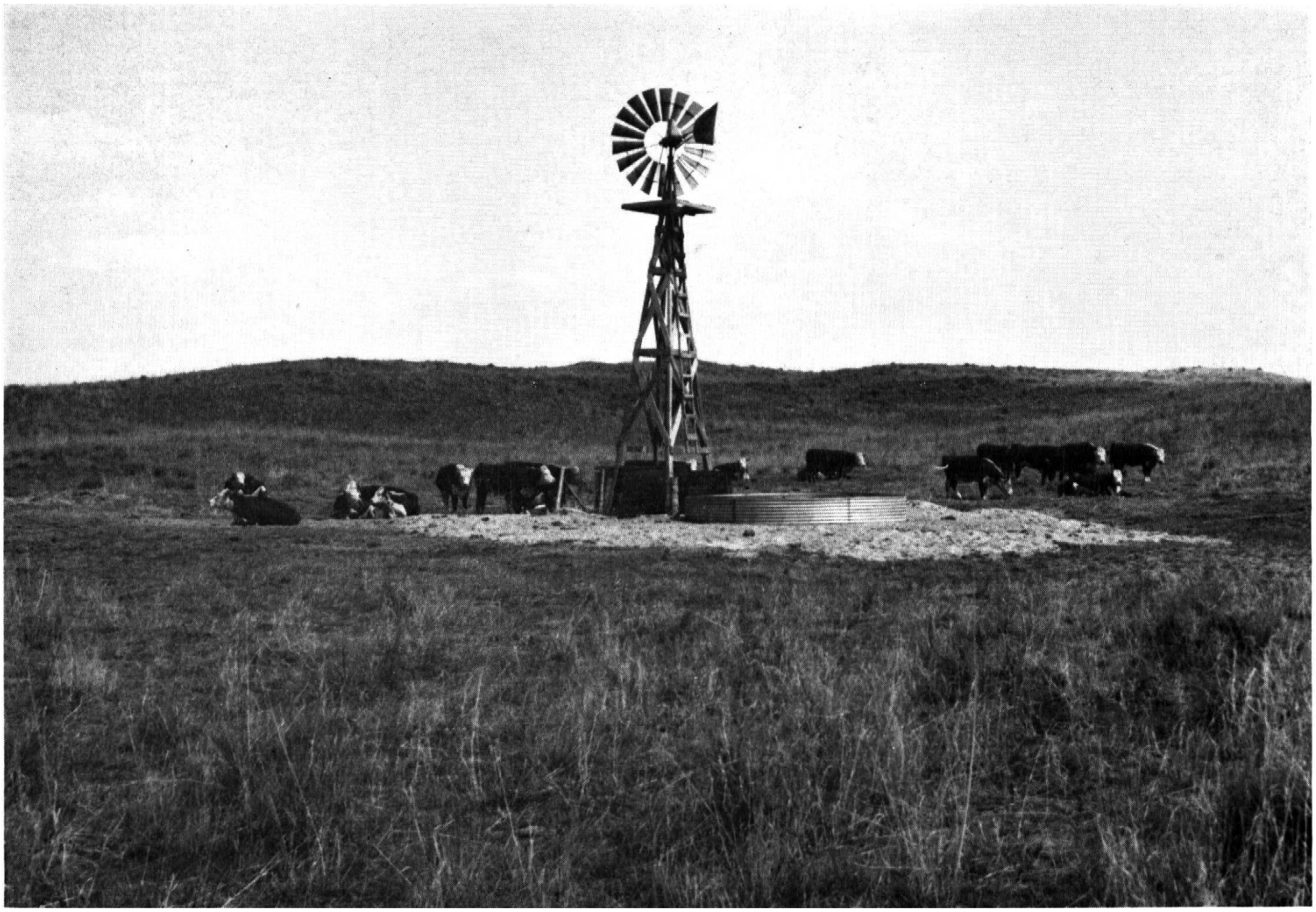

Figure 16.—**A windmill pumps water from a shallow well on Valentine soils into a storage tank for watering livestock.**

Literature Cited

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

(2) Baldwin, Mark, Kellogg, Charles E., and Thorp, James.
1938. soil classification. U.S. Dept. Agr. Ybk.: 978–1001, illus.

(3) Condra, G. E., Reed, E. C., and Gordon, E. D.
1950. correlation of the pleistocene deposits of nebraska. Nebraska Geol. Survey Bul. 15A. 77 pp., illus.

(4) Dyksterhuis, E. J.
1958. range conservation as based on sites and condition classes. Jour. Soil and Water Cons. 13: 151–155, illus.

(5) Hill, Dorothy R. and Tompkin, Jessie M.
[n.d.] general and engineering geology of the wray area, colorado and nebraska. Geol. Survey Bul. 1001, 65 pp., illus.

(6) Hoover, Robert L., Till, C. E., and Ogilvie, Stanley.
1959. the antelope of colorado. State of Colo., Dept. of Game and Fish. Tech. Bul. No. 4, 110 pp., illus.

(7) Overton, R. S.
1963. colorado agricultural statistics. Bul. 64–1, Colo. Dept. Agr., 81 pp.

(8) Peech, Michael, Alexander, L. T., Dean, L. A., and Reed, J. Fielding.
1947. methods of soil analysis for soil fertility investigations. U.S. Dept. Agr., Cir. 757, 25 pp.

(9) Simonson, Roy W.
1962. soil classification in the united states. Sci. 137: 1027–1034.

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

(11) United States Department of Agriculture.
1951. soil survey manual. U.S. Dept. of Agr. Handbook 18, 503 pp., illus.

(12) ———
1960. soil classification, a comprehensive system, 7th approximation. 265 pp., illus. [Supplement issued in March 1967]

(13) Waterways Experiment Station, Corps of Engineers.
1953. unified soil classification system. Tech. Memo. 3–357, 2 v., and app., illus.

Glossary

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

Available water capacity. The capacity of a soil to hold water in a form available to plants. Amount of moisture held in soil between field capacity, or about one-third atmosphere of tension, and the wilting coefficient, or about 15 atmospheres of tension.

Broad-base terrace. A ridge-type terrace 10 to 20 inches high and 15 to 30 feet wide that has gently sloping sides, a rounded crown, and a dish-shaped channel along the upper side. This kind of terrace controls erosion by diverting runoff along the contour at a nonscouring velocity. It may be nearly level or have a grade toward one or both ends.

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

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

Caliche. A more or less cemented deposit of calcium carbonate in many soils of warm-temperature areas, as in the Southwestern States. The material may consist of soft, thin layers in the soil or of hard, thick beds just beneath the solum, or it may be exposed at the surface by erosion.

Claypan. A compact, slowly permeable soil horizon that contains more clay than the horizon above and below it. A claypan is commonly hard when dry and plastic or stiff when wet.

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.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the oven-dry weight, after the gravitational, or free, water has been allowed to drain away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

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.

Humus. The well-decomposed, more or less stable part of the organic matter in mineral soils.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineralogical, and biological properties of the various horizons, and their thickness and arrangement in the soil profile.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Natural soil drainage. 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 have mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and in Podzolic soils commonly have mottlings below 6 to 16 inches, in the lower A horizon and in the B and C horizons.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

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.

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

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

Plowpan. A compacted layer formed in the soil immediately below the plowed layer.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

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

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

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

Soil separates. Mineral particles, less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *Very coarse sand* (2.0 to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter). The separates recognized by the International Society of Soil Science are as follows: I (2.0 to 0.2 millimeter); II (0.2 to 0.02 millimeter); III (0.02 to 0.002 millimeter); IV (less than 0.002 millimeter).

Soil variant. A soil having properties sufficiently different from those other known soils to justify establishing a new soil series, but of such limited known area that creation of a new series is not believed to be justified. The only soil variant in Phillips County is Anselmo loamy fine sand, marly substratum variant, 0 to 3 percent slopes.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the 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."

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.

GUIDE TO MAPPING UNITS

The suitability of the soils for use as cropland and rangeland is discussed in the soil descriptions. The capability classification is discussed on pages 26 to 29. In referring to a range site or windbreak group, read the introduction to the section it is in for general information about its management. Additional information is given in tables as follows:

Acreage and extent, table 1, page 5.
Predicted yields, tables 2 and 3, page 27.
Engineering uses of the soils, tables 7 and 8, pages 38 through 43.

Map symbol	Mapping unit	Described on page	Capability unit: Irrigated Symbol	Capability unit: Dryland Symbol	Range site Name	Windbreak suitability group Number
AnB	Anselmo loamy fine sand, marly substratum variant, 0 to 3 percent slopes----------	6	IIIe-6	IVe-4	Sandy Plains	2
AsB	Ascalon sandy loam, 0 to 3 percent slopes-	7	IIe-3	IIe-1	Sandy Plains	1
AsC	Ascalon sandy loam, 3 to 5 percent slopes-	7	(1/)	IIIe-2	Sandy Plains	1
AsD	Ascalon sandy loam, 5 to 9 percent slopes-	7	(1/)	IVe-2	Sandy Plains	1
BcC	Bayard-Canyon complex, 3 to 5 percent slopes----------------------------------	8				
	Bayard soils--------------------------	--	(1/)	VIe-1	Sandy Plains	2
	Canyon soils--------------------------	--	(1/)	VIe-1	Limestone Breaks	3
CcD	Canyon complex, 3 to 9 percent slopes-----	9	(1/)	VIIs-1	Limestone Breaks	3
CdB	Chappell and Dix sandy loams, 0 to 3 percent slopes----------------------------	10	IIIe-7	IVe-4	Sandy Plains	2
Da	Dawes loam-------------------------------	11	IIIs-3	IIIs-2	Loamy Plains	1
Du	Dunday fine sand-------------------------	12	IVs-1	VIe-2	Deep Sand	2
HtB	Haxtun loamy sand, 0 to 3 percent slopes--	13	IIIe-6	IIIe-3	Sandy Plains	2
HtC	Haxtun loamy sand, 3 to 5 percent slopes--	14	IVe-5	IVe-3	Sandy Plains	2
HxB	Haxtun sandy loam, 0 to 3 percent slopes--	14	IIe-3	IIe-1	Sandy Plains	1
JuB	Julesburg loamy sand, 0 to 3 percent slopes----------------------------------	15	IIIe-6	IIIe-3	Sandy Plains	2
JuC	Julesburg loamy sand, 3 to 5 percent slopes----------------------------------	15	IVe-5	IVe-3	Sandy Plains	2
PaB	Platner loam, 0 to 3 percent slopes-------	16	IIe-2	IIc-1	Loamy Plains	1
PaC	Platner loam, 3 to 5 percent slopes-------	17	IIIe-4	IIIe-1	Loamy Plains	1
PeC	Platner-Eckley association, 3 to 5 percent slopes--------------------------------	17				
	Platner soils-------------------------	--	(1/)	VIe-3	Loamy Plains	1
	Eckley soils--------------------------	--	(1/)	VIe-3	Gravel Breaks	3
Ps	Pleasant loam----------------------------	18	IIe-2	IIIs-1	Clayey Plains	1
Ra	Rago and Kuma loams----------------------	19	IIe-2	IIc-1	Loamy Plains	1
RcB	Richfield loam, 0 to 3 percent slopes-----	20	IIe-2	IIc-1	Loamy Plains	1
RcC	Richfield loam, 3 to 5 percent slopes-----	20	IIIe-4	IIIe-1	Loamy Plains	1
VaD	Valentine fine sand, rolling-------------	21	(1/)	VIe-2	Deep Sand	4
VaE	Valentine fine sand, hilly---------------	21	(1/)	VIIe-1	Choppy Sand	4
WcB	Wages-Campus-Weld loams, 0 to 3 percent slopes----------------------------------	22	IIe-2	IIIs-2	Loamy Plains	1
WcC	Wages-Campus-Weld loams, 3 to 5 percent slopes----------------------------------	23	IIIe-5	IVe-1	Loamy Plains	1
WeE	Wages-Eckley-Dix complex, 5 to 25 percent slopes--------------------------------	23				
	Wages soils---------------------------	--	(1/)	VIe-3	Loamy Plains	1
	Eckley soils--------------------------	--	(1/)	VIe-3	Gravel Breaks	3
	Dix soils-----------------------------	--	(1/)	VIe-3	Gravel Breaks	2

1/ Not irrigated.

Accessibility Statement

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

Nondiscrimination Statement

Nondiscrimination Policy

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

To File an Employment Complaint

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

To File a Program Complaint

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

Persons with Disabilities

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

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

Supplemental Nutrition Assistance Program

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

All Other Inquiries

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