SOIL SURVEY OF

# Hodgeman County, Kansas

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

Issued June 1973

Major fieldwork for this soil survey was done in the period 1960–63. Soil names and descriptions were approved in 1966. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1963. This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Hodgeman County 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, United States Department of Agriculture, Washington, D.C. 20250.

# HOW TO USE THIS SOIL SURVEY

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

## Locating Soils

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

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

## Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil is described and the page for the range site and capability unit 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 descriptions of the capability units, range sites, and windbreak groups.

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

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

*Engineers and builders* can find, under "Use of the Soils in Engineering," tables that give estimates of soil properties and information about soil features that affect engineering practices.

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

*Newcomers* in Hodgeman 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 "Additional Facts About the County."

**Cover: Young windbreak on Harney silt loam, 0 to 1 percent slopes.**

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Issued June 1973

# SOIL SURVEY OF HODGEMAN COUNTY, KANSAS

BY ROGER LEE HABERMAN, DAROLD A. DODGE, AND JOHN BRADLEY BAUMANN, SOIL CONSERVATION SERVICE

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

HODGEMAN COUNTY is in the west-central part of Kansas (fig. 1).

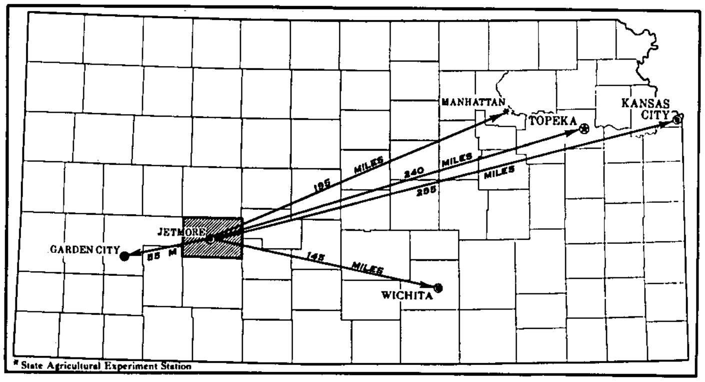


*Figure 1.*—**Location of Hodgeman County in Kansas.**

It has a land area of 860 square miles, or 550,400 acres. It extends about 24 miles from north to south and 36 miles from east to west. Jetmore, the county seat, is in the center of the county.

Farming is the principal industry. Wheat, grain sorghum, and cattle are the main enterprises and sources of income.

## *How This Survey Was Made*

Soil scientists made this survey to learn what kinds of soil are in Hodgeman County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and 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 (*11*).[1]

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. Harney and Penden, 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, Harney silt loam, 0 to 1 percent slopes, is one of several phases within the Harney 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 streams, 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 the 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. Two such kinds of mapping units are shown on the soil map of Hodgeman County: soil complexes and undifferentiated groups.

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

[1] Italic numbers in parentheses refer to Literature Cited, page 55.

of the names of the dominant soils, joined by a hyphen. Campus-Canlon complex is an example.

An undifferentiated 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." Roxbury and Bridgeport soils, channeled, is an example.

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

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

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way as to be readily useful to different groups of users, among them farmers, managers of woodland and rangeland, and engineers.

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

# General Soil Map

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

A map showing soil associations is useful to people who want a general idea of the soils in the county, who want to compare different parts of the county, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

A soil in this county may be identified by a different name in a recently published survey of an adjacent county. Such differences in name result from changes in the concept of soil classification that have occurred since publication.

The six soil associations in Hodgeman County are described in the following pages.

## *1. Harney association*

*Deep, nearly level to gently sloping, well-drained, loamy soils on uplands*

This association is mainly on tableland and the associated knobs and on the sides of drainageways. Slopes of 1 percent or less are dominant, but on the knobs and the sides of drainageways slopes are as much as 5 percent.

This association makes up about 20 percent of the county. It is about 73 percent Harney soils (fig. 2). The rest is Ost, Richfield, Spearville, Uly, Ness, and Penden soils.

Harney soils formed in loess. Their surface layer is about 13 inches thick. The top 7 inches is silt loam, and the lower 6 inches is light silty clay loam. The subsoil is about 27 inches thick. The upper 4 inches is firm silty clay loam, and the rest is very firm light silty clay. The lower 14 inches of the subsoil is calcareous. The underlying material is calcareous silty clay loam. These soils have high fertility, moderately slow permeability, and high available water capacity. Slopes are 0 to 5 percent.

Ness and Penden soils occur in all parts of the county. The other less extensive soils are in the western half. Ness soils occupy depressions. Penden and Uly soils occupy the sides of drainageways. Ost, Richfield, Spearville, and some Penden soils are nearly level and occupy uplands. Richfield soils are gently sloping also.

Except in small areas where slopes are more than 6 percent, this association can be cultivated. The main crops are wheat and sorghum. Inadequate rainfall is the principal limitation. Soil blowing is a hazard. Water erosion is a hazard on slopes of more than 1 percent and on long slopes of up to 1 percent.

## *2. Harney-Penden association*

*Deep, nearly level to sloping, well-drained, loamy soils on uplands*

This association is on uplands that are dissected by many drainageways. Slopes are dominantly 1 to 3 percent, but in some areas they are 1 percent or less, and on the sides of drainageways they are as much as 12 percent.

This association makes up about 16 percent of the county. It is about 68 percent Harney soils and 21 percent Penden soils. The rest is Uly, Ness, Roxbury, and Bridgeport soils.

Harney soils formed in loess. Their surface layer is about 13 inches thick. The top 7 inches is silt loam, and the lower 6 inches is light silty clay loam. The subsoil is about 27 inches thick. The upper 4 inches is firm silty clay loam, and the rest is very firm light silty clay. The lower 14 inches of the subsoil is calcareous. The underlying material is calcareous silty clay loam. These soils have high fertility, moderately slow permeability, and high available water capacity. Slopes are 0 to 5 percent.

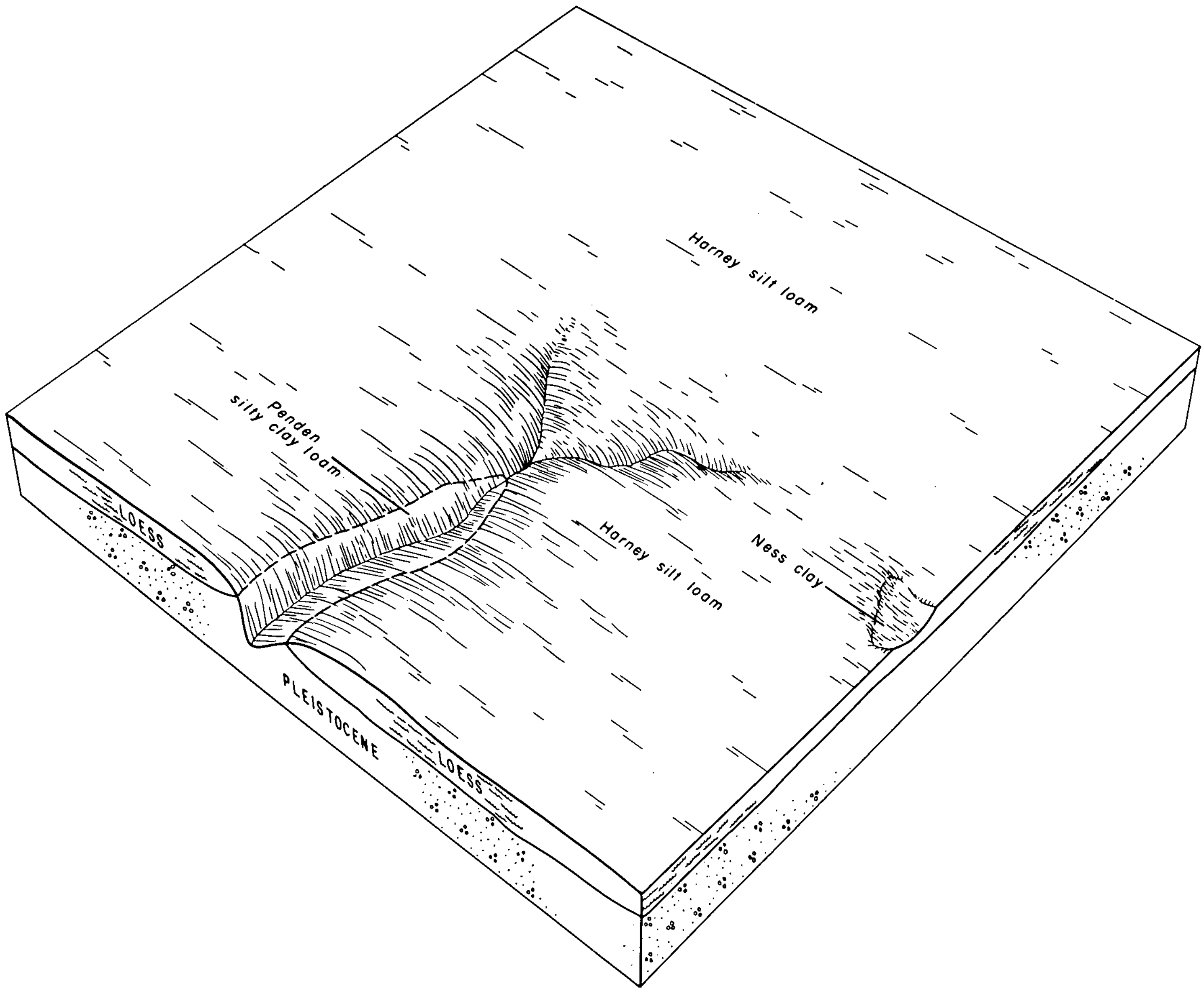


*Figure 2.*—**Pattern of soils in association 1.**

Penden soils formed in calcareous clay loam outwash. They are mainly on sides of drainageways and have slopes of 1 to 12 percent. Their surface layer is silty clay loam about 16 inches thick. The next layer is friable clay loam about 12 inches thick. The underlying material is friable clay loam. These soils have high fertility, moderate to moderately slow permeability, and high available water capacity.

Uly soils are on sides of drainageways, Ness soils in upland depressions, Roxbury soils on foot slopes below rock outcrops, and Bridgeport soils on narrow flood plains.

This association can be cultivated except in areas where slopes are more than 6 percent or the soils are broken or channeled. The main crops are wheat and sorghum. The chief concerns in management are conserving moisture and controlling erosion.

### 3. *Harney-Penden-Bridgeport association*

*Deep, nearly level to sloping, well drained to moderately well drained, loamy soils on uplands and narrow flood plains*

This association is on uplands that are cut by many drainageways that have associated narrow flood plains and low terraces. Slopes range from 0 to 12 percent and are dominantly more than 3 percent.

This association makes up about 32 percent of the county. It is about 37 percent Harney soils, 34 percent Penden soils, and 3 percent Bridgeport soils (fig. 3). The rest is Coly, Kim, Uly, Wakeen, and Richfield soils.

Harney soils formed in loess. Their surface layer is about 13 inches thick. The upper 7 inches is silt loam, and the lower 6 inches is light silty clay loam. The subsoil is about 27 inches thick. The upper 4 inches is firm silty clay

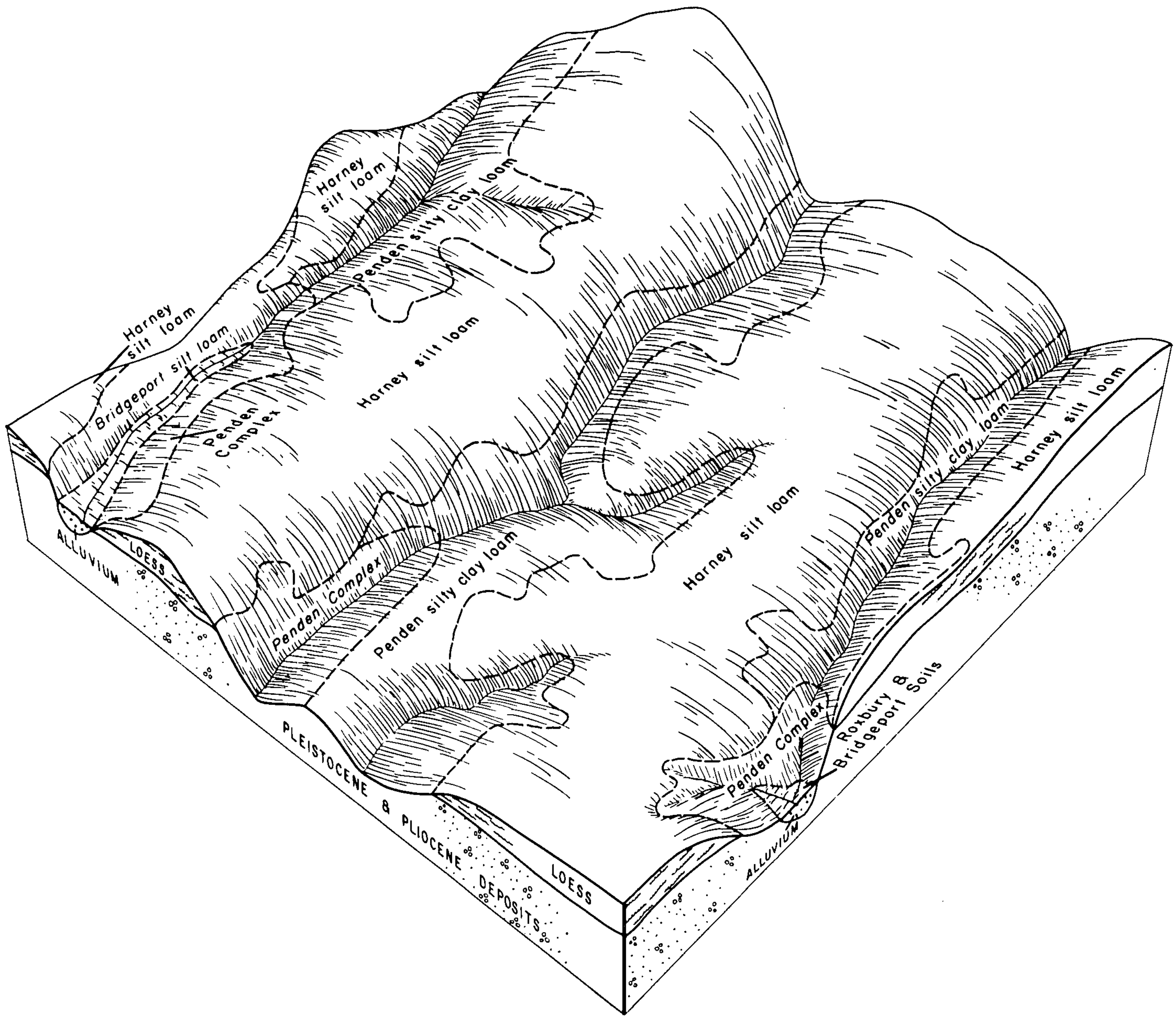


*Figure 3.*—Pattern of soils in association 3.

loam, and the rest is very firm light silty clay. The lower 14 inches of the subsoil is calcareous. The underlying material is calcareous silty clay loam. These soils have high fertility, moderately slow permeability, and high available water capacity. Slopes are 0 to 5 percent.

Penden soils formed in calcareous clay loam outwash. They are mainly on sides of drainageways and have slopes of 1 to 12 percent. The surface layer is silty clay loam about 16 inches thick. The next layer is friable clay loam about 12 inches thick. The underlying material is clay loam. These soils have high fertility, moderate to moderately slow permeability, and high available water capacity.

Bridgeport soils formed in calcareous silty alluvium. They are mainly on narrow flood plains, but also occupy low terraces. Slopes are 0 to 1 percent. The surface layer is silt loam about 10 inches thick. The next layer is friable silt loam about 19 inches thick. The underlying material is heavy silt loam. These soils have high fertility, moderate permeability, and high available water capacity.

Coly, Kim, Uly, and Wakeen are on side slopes along drainageways. Richfield soils are gently sloping and occupy uplands.

This association is used as cropland and native range. Wheat and sorghum are the main crops. In cultivated areas the chief concern in management is controlling erosion. Areas where the slopes are more than 6 percent or the soils are broken or channeled are mostly in grass and are used for grazing.

### 4. *Harney-Spearville association*

*Deep, nearly level to gently sloping, well drained to moderately well drained, loamy soils on uplands*

This association is on tableland that is dominantly nearly level but has low gently sloping ridges, small depressions, and weakly defined drainageways. Slopes are 0 to 3 percent.

This association makes up about 12 percent of the county. It is about 49 percent Harney soils and 42 percent Spearville soils. The rest is Ness, Penden, and Richfield soils.

Harney soils formed in loess. They have a surface layer about 13 inches thick. The upper 7 inches is silt loam, and the lower 6 inches is light silty clay loam. The subsoil is about 27 inches thick. The upper 4 inches is firm silty clay loam, and the rest is very firm light silty clay. The lower 14 inches of the subsoil is calcareous. The underlying material is calcareous silty clay loam. These soils have high fertility, moderately slow permeability, and high available water capacity. Slopes are 0 to 3 percent.

Spearville soils formed in loess. They have a surface layer of silty clay loam about 7 inches thick. The subsoil is about 18 inches thick. The upper 11 inches is very firm silty clay, and the lower 7 inches is firm, calcareous heavy silty clay loam that contains a few lime concretions. The underlying material is calcareous heavy silt loam. These soils have high fertility, slow permeability, and high available water capacity. Slopes are 0 to 1 percent.

Ness soils occupy upland depressions. Penden soils are on sides of drainageways. Richfield soils are nearly level and gently sloping and are on uplands.

A large part of this association is cultivated. Wheat and sorghum are the main crops, and the Harney soils are well suited to both. Spearville soils, because the subsoil is droughty, are better suited to wheat than to sorghum. Inadequate rainfall is the principal limitation. Soil blowing is a hazard. Water erosion is a hazard on slopes of more than 1 percent.

### 5. *Penden-Campus-Canlon association*

*Deep to shallow, gently sloping to steep, well-drained to somewhat excessively drained, loamy, calcareous soils on uplands*

This association has many outcrops of rocks and is dissected by many drainageways. About 10 percent of the county is in this association. Approximately 26 percent of the association is Penden soils, 24 percent Campus soils, and 13 percent Canlon soils. The rest is Kipson, Wakeen, Roxbury, Bridgeport, and Harney soils.

Penden soils formed in calcareous clay loam outwash. Their surface layer is silty clay loam about 16 inches thick. The next layer is friable clay loam about 12 inches thick. The underlying material is friable clay loam. These soils have high fertility, moderate to moderately slow permeability, and high available water capacity. Slopes range from 1 to 12 percent.

Campus soils formed in highly calcareous, semiconsolidated caliche. These gently sloping to sloping soils occupy areas just below the tableland. Their surface layer is loam about 8 inches thick. The next layer is friable clay loam about 8 inches thick. A strong zone of lime accumulation is at a depth of 16 inches, and semiconsolidated caliche occurs at a depth of 30 inches. These soils have medium fertility, moderate permeability, and low available water capacity.

Canlon soils formed in semiconsolidated caliche. In areas of these soils the landscape is somewhat broken, slopes range from 3 to 40 percent, and outcrops of caliche are common. The surface layer is loam about 6 inches thick. The next layer is friable loam about 7 inches thick. Both layers contain many fragments of caliche. They are underlain by semiconsolidated caliche. These soils have low fertility, moderate permeability, and very low available water capacity.

Kipson and Wakeen soils are just below the tableland and in somewhat broken areas, as are Campus and Canlon soils, but they occupy lower positions on the landscape than those soils, and they formed in chalky shale. Roxbury soils are on foot slopes below rock outcrops. Roxbury and Bridgeport soils are on narrow flood plains. Harney soils occupy the crests of ridges.

Only about one-third of this association is arable. In this part slopes are 1 to 6 percent. Wheat and sorghum are the main crops. The chief concerns in management are controlling erosion and maintaining and improving the native forage plants. The arable part of the association generally is bordered by nonarable areas that are mostly in native grasses.

### 6. *Roxbury-Bridgeport association*

*Deep, nearly level, well drained to moderately well drained, loamy soils on low terraces and flood plains*

This association occupies low terraces and flood plains that are incised by a stream channel. The terraces are 15 to 25 feet higher than the streambed. Slopes are mainly 0 to 1 percent.

This association makes up about 10 percent of the county (fig. 4). It is about 61 percent Roxbury soils and 10 percent Bridgeport soils. The rest is Broken alluvial land and Detroit, Hord, and Ness soils.

Roxbury soils occur throughout the association. They formed in calcareous alluvium. Their surface layer is silt loam about 22 inches thick. The lower 14 inches of the surface layer is calcareous. The subsoil is friable light silty clay loam about 20 inches thick. The underlying material is clay loam. These soils have high fertility, moderate permeability, and high available water capacity.

Bridgeport soils are mainly in the western half of the county. They formed in calcareous silty alluvium. Their surface layer is silt loam about 10 inches thick. The next layer is friable silt loam about 19 inches thick. The underlying material is heavy silt loam. These soils have high fertility, moderate permeability, and high available water capacity.

Broken alluvial land is on streambanks that have slopes of 6 to 40 percent. Detroit soils and Hord soils are on low stream terraces. Ness soils are in depressions.

Most of this association can be cultivated. It is suitable for both irrigated and dryland farming. Under dryland management, wheat, sorghum, and some alfalfa are grown. Under irrigation, the soils are suited to all the adapted irrigated crops. The chief concerns in management are conserving moisture and controlling soil blowing. Inadequate rainfall is the principal limitation. Broken alluvial land is not suitable for cultivation and has little value for grazing.

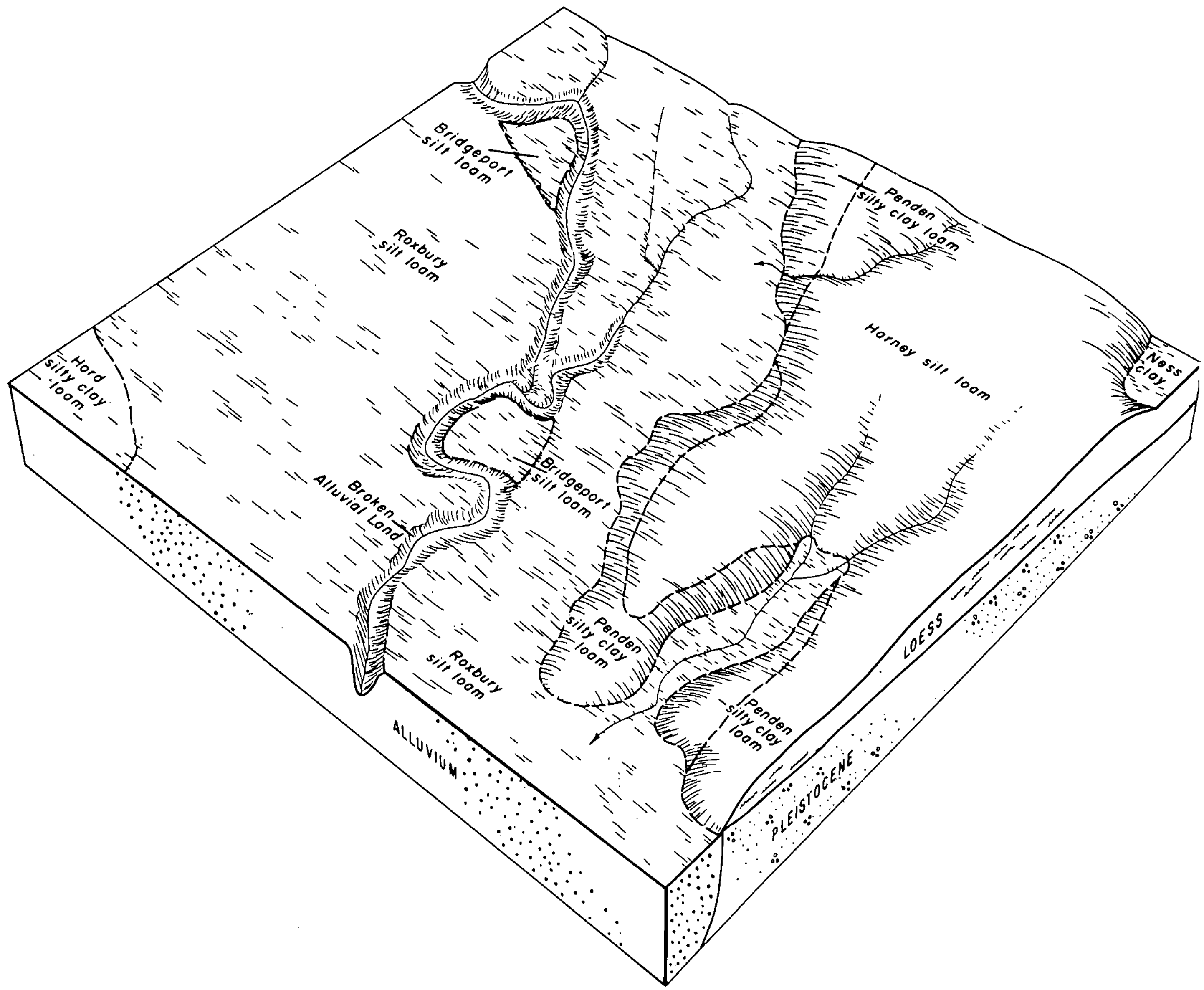


*Figure 4.*—**Pattern of soils in associations 6 and 2.**

## *Effects of Erosion*

Erosion is a process in which soil and geologic material are moved by natural forces, mainly wind, running water, and gravity. Accelerated erosion should not be confused with natural geologic erosion, the gradual, normal process of soil removal. Geologic erosion takes place under natural conditions in an undisturbed environment, but accelerated erosion is brought about by changes in the natural cover or conditions of the soil caused by the activities of man.

Soil blowing and water erosion are the prinicipal active forces that cause soil removal in Hodgeman County. Soil blowing is a continuing hazard, one that becomes more serious during recurring periods of drought. High wind velocity and sparse vegetation, both of which are characteristic of droughty conditions on the High Plains, are conducive to widespread soil blowing.

Erosion by water is a hazard in cultivated areas or in areas where slopes are more than 1 percent. Runoff occurs during hard, intense thunderstorms when rain falls more rapidly than water can enter the soil. On unprotected silty soil, runoff removes thin layers of soil material more or less evenly from the entire surface and causes sheet erosion. In cultivated areas the evidence of sheet erosion is sometimes obliterated and little evidence of destructive erosion is apparent until the subsoil or other underlying material is exposed.

Practices that slow down or decrease runoff help in conserving valuable moisture and controlling water erosion. Examples are managing crop residue, terracing, contouring, stripcropping, seeding severely eroded and nonarable areas to suitable native grasses, and managing the range to avoid overgrazing.

During the fieldwork on this soil survey, the following effects of erosion were observed:

> Soil blowing is a hazard in cultivated fields where the soil is dry and no clods are left on the surface, or where there is no plant or residue cover. Small, low hummocks and drifts of soil material form in cultivated fields, in fence rows, and in areas of native grass adjacent to cultivated fields where active soil blowing is in progress. These unstable hummocks and drifts continue to erode unless they are smoothed out and the soil is tilled to provide a rough surface that is resistant to erosion.
>
> Soil material tends to drift from actively eroded cultivated fields onto adjacent rangeland, where it damages or destroys the native vegetation. No permanent damage occurs, but the use of the land is impaired until the grass is reestablished by deferred grazing or by reseeding.

Some effects of erosion are permanent. The soil is damaged so severely that a change in its use and management is required. Other effects impair the soil only temporarily.

The effects of erosion in Hodgeman County show that erosion is serious, not only in the permanent modification of the soil, but also in the short-time damage to crops and forage. Replanting crops, reseeding rangeland, and emergency tilling and smoothing correct most of the temporary effects of erosion and restore full use of the land, but they are time consuming and costly.

The eroded soils in Hodgeman County are mapped separately only if erosion has modified some important quality or characteristic of the soil that is significant to its use and management. Many soils have been eroded to some degree and are subject to further erosion. The management needed in controlling erosion varies according to the kind of soil, the degree of slope, and the land use. The erosion hazard on each soil in the county and the practices needed for erosion control are indicated in the section "Use and Management of the Soils."

## *Descriptions of the Soils*

This section describes the soil series and mapping units in Hodgeman County. Each soil series is described in considerable detail, and then, briefly, each mapping unit in that series. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second, detailed and in technical terms, is for scientists, engineers, and others who need to make thorough and precise studies of soils. Unless it is otherwise stated, the colors given in the description are those of a dry soil.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Broken alluvial land and Rough broken land, for example, do not belong to a soil series, but nevertheless are listed in alphabetic order along with the soil series.

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

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

A given soil series in this county may be identified by a different name in a recently published soil survey of an adjacent county. Such differences in name result from

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

| Soil | Area | Extent |
|---|---|---|
| | *Acres* | *Percent* |
| Bridgeport silt loam, 0 to 1 percent slopes | 6, 102 | 1. 1 |
| Broken alluvial land | 6, 974 | 1. 3 |
| Campus-Canlon complex | 22, 495 | 4. 1 |
| Canlon soils | 2, 305 | . 4 |
| Detroit silty clay loam | 5, 180 | . 9 |
| Harney silt loam, 0 to 1 percent slopes | 108, 372 | 19. 7 |
| Harney silt loam, 1 to 3 percent slopes | 104, 193 | 18. 9 |
| Harney silt loam, 3 to 5 percent slopes | 9, 111 | 1. 7 |
| Harney silty clay loam, 1 to 3 percent slopes, eroded | 13, 326 | 2. 4 |
| Harney silty clay loam, 3 to 5 percent slopes, eroded | 10, 522 | 1. 9 |
| Hord silty clay loam | 5, 346 | 1. 0 |
| Kim-Penden silty clay loams, 3 to 6 percent slopes, eroded | 19, 179 | 3. 5 |
| Kipson-Wakeen complex | 14, 384 | 2. 6 |
| Ness clay | 2, 116 | . 4 |
| Ost silt loam, 0 to 1 percent slopes | 4, 402 | . 8 |
| Otero gravelly complex | 909 | . 2 |
| Penden silty clay loam, 0 to 1 percent slopes | 3, 245 | . 6 |
| Penden silty clay loam, 1 to 3 percent slopes | 15, 775 | 2. 9 |
| Penden silty clay loam, 3 to 6 percent slopes | 34, 730 | 6. 3 |
| Penden complex | 40, 959 | 7. 4 |
| Penden-Campus clay loams, 1 to 4 percent slopes | 2, 686 | . 5 |
| Richfield silt loam, 0 to 1 percent slopes | 3, 860 | . 7 |
| Richfield silt loam, 1 to 3 percent slopes | 7, 215 | 1. 3 |
| Richfield silty clay loam, 2 to 5 percent slopes, eroded | 684 | . 1 |
| Rough broken land | 918 | . 2 |
| Roxbury silt loam | 37, 376 | 6. 8 |
| Roxbury and Bridgeport soils, channeled | 12, 324 | 2. 2 |
| Roxbury silty clay loam, 2 to 5 percent slopes | 4, 068 | . 7 |
| Spearville silty clay loam, 0 to 1 percent slopes | 31, 066 | 5. 7 |
| Spearville complex, 1 to 3 percent slopes, eroded | 558 | . 1 |
| Uly silt loam, 1 to 3 percent slopes | 4, 372 | . 8 |
| Uly silt loam, 3 to 6 percent slopes | 5, 329 | 1. 0 |
| Uly-Coly silt loams, 3 to 6 percent slopes, eroded | 3, 407 | . 6 |
| Wakeen silt loam, 1 to 3 percent slopes | 2, 409 | . 4 |
| Wakeen silt loam, 3 to 6 percent slopes | 4, 413 | . 8 |
| Gravel pits | 90 | (1) |
| Total | 550, 400 | 100. 0 |

[1] Less than 0.05 percent.

changes in the concepts of soil classification that have occurred since publication. The characteristics of the soil series described in this county are considered to be within the range defined for that series. In those instances where a soil series has one or more features outside the defined range, the differences are explained.

## Bridgeport Series

The Bridgeport series consists of deep, well drained to moderately well drained, calcareous soils on low stream terraces and narrow bottom lands. Slopes are mainly less than 1 percent. These soils formed in calcareous, silty alluvium.

In a representative profile the surface layer is about 10 inches of grayish-brown silt loam. The next layer, about 19 inches thick, is light brownish-gray, friable silt loam. The underlying material, to a depth of 60 inches, is light brownish-gray heavy silt loam.

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

Representative profile of Bridgeport silt loam, 0 to 1 percent slopes, 1,550 feet east and 1,800 feet south of the northwest corner sec. 19, T. 21 S., R. 25 W., in native range:

A1—0 to 10 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; slightly calcareous; mildly alkaline; gradual, smooth boundary.

AC—10 to 29 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, medium, subangular blocky structure parting to moderate, medium, granular; slightly hard when dry, friable when moist; many worm casts; calcareous; moderately alkaline; gradual, smooth boundary.

C—29 to 60 inches, light brownish-gray (10YR 6/2) heavy silt loam, dark grayish brown (10YR 4/2) when moist; massive; soft when dry, very friable when moist; few thin strata of darker colored silt loam in lower part of horizon; calcareous; moderately alkaline.

In most places these soils are calcareous throughout the profile but in some they become calcareous at a depth of 5 inches. The A1 horizon ranges from silt loam to light clay loam in texture, from dark grayish brown to brown in color, and from 8 to 15 inches in thickness. The AC and C horizons range from silt loam to clay loam. Colors of grayish brown or darker extend to a depth of 8 to 15 inches. These soils show distinct stratification in areas where they are frequently flooded.

Bridgeport soils are near Hord, Detroit, and Roxbury soils. They are darkened less deep than those soils, and they lack a B horizon. They are not so deeply leached of lime as Hord and Detroit soils.

**Bridgeport silt loam, 0 to 1 percent slopes** (Be).—This soil has the profile described as representative for the Bridgeport series. It is mainly on low terraces. In places these terraces are several feet lower than those occupied by the adjacent Roxbury and Hord soils. In other places, they are on the same level, about 15 to 25 feet above the streambed.

Included in mapping were small areas of Hord and Roxbury soils and a few small areas where slopes are 1 to 2 percent. Small areas of clay spots, less than 5 acres in size, are indicated by spot symbols on the soil map.

Wheat and sorghum are the principal crops. Alfalfa is also grown. Inadequate rainfall is the principal limitation. Conserving moisture and controlling soil blowing are concerns in management. In some places this soil receives runoff from adjacent areas. Capability unit IIc–2, dryland; capability unit I–1, irrigated; Loamy Terrace range site; Deep Loamy Lowland windbreak group.

## Broken Alluvial Land

Broken alluvial land (6 to 40 percent slopes) (Br) consists of broken banks and deeply incised stream channels of the Pawnee River and Buckner, Hackberry, Sawlog, and White Woman Creeks, and their tributaries. Most areas are 150 feet or more wide. The streambanks have slopes of 6 to 40 percent. This entire mapping unit is under water during periods of high water.

Broken alluvial land is not suitable for cultivation and has little value for grazing. Frequent flooding and the resulting scouring and deposition are the principal hazards. The vegetation consists of annual weeds, annual grasses, and trees, mainly elm, ash, hackberry, and cottonwood (fig. 5). Capability unit VIIw–1, dryland; no irrigated capability unit or range site; Deep Loamy Lowland windbreak group.

## Campus Series

The Campus series consists of moderately deep, well-drained, calcareous soils of the uplands. Slopes are 1 to 12 percent. These soils formed in highly calcareous, semiconsolidated caliche.

In a representative profile the surface layer is grayish-brown loam about 8 inches thick. The next layer, about 8 inches thick, is light brownish-gray, friable clay loam that contains small fragments of caliche. The underlying material is very pale brown loam that contains caliche fragments and is about 14 inches thick. At a depth of about 30 inches is semiconsolidated caliche.

Campus soils have low available water capacity, medium fertility, and moderate permeability.

Representative profile of Campus loam, in an area of Campus-Canlon complex, 1,060 feet north and 400 feet east of the southwest corner sec. 14, T. 23 S., R. 24 W., in native range:

A1—0 to 8 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine and medium, granular structure; slightly hard when dry, friable when moist; numerous worm casts; scattered fragments of caliche; calcareous; moderately alkaline; gradual, smooth boundary.

AC—8 to 16 inches, light brownish-gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; numerous worm casts; small fragments of caliche; calcareous, some peds coated with lime; moderately alkaline; gradual, smooth boundary.

Cca—16 to 30 inches, very pale brown (10YR 8/3) loam, very pale brown (10YR 7/3) when moist; massive; hard when dry, firm when moist; penetrated by roots; varying numbers of caliche fragments; strongly calcareous; moderately alkaline; clear, wavy boundary.

R—30 inches, semiconsolidated caliche.

The depth to semiconsolidated caliche ranges from 20 to 36 inches. The A1 horizon ranges from loam to clay loam and from dark grayish brown to grayish brown. Colors of grayish brown or darker extend to a depth of 7 to 11 inches. The Cca horizon is within a depth of 24 inches. The lime content of the Cca horizon ranges from about 25 to 40 percent.

*Figure 5.*—**Area of Broken alluvial land showing streambanks lined with trees.**

Campus soils are near Canlon, Kipson, Penden, Wakeen, and Uly soils. They are underlain by semiconsolidated caliche and have a stronger zone of lime accumulation than Penden, Wakeen, and Uly soils. They are deeper over caliche than Canlon soils. They are deeper than Kipson soils, which are underlain by chalky shale.

**Campus-Canlon complex** (3 to 30 percent slopes) (Cc).—This mapping unit is about 60 percent Campus soil and 30 percent Canlon soil. These soils are on uplands. The Canlon soil is in all parts of the complex. The Campus soil is on the crests and sides of ridges. Outcrops of caliche are common (fig. 6). Campus and Canlon soils have profiles similar to those described as representative for their respective series.

Included in mapping were outcrops of caliche and small areas of Penden, Kipson, and Wakeen soils.

The soils of this mapping unit are not suitable for cultivation because they are shallow to only moderately deep over caliche, have outcrops of caliche, and are highly susceptible to erosion in areas where their slope is more than 6 percent. These soils are productive if they are well managed and used as grassland. Capability unit VIe-2, dryland; not placed in an irrigated capability unit or a windbreak group. Campus soil in Limy Upland range site and Canlon soil in Breaks range site.

## Canlon Series

The Canlon series consists of shallow, somewhat excessively drained soils on uplands. The landscape is somewhat broken. Slopes are 3 to 40 percent. These soils formed in semiconsolidated caliche. Caliche outcrops are common.

In a representative profile the surface layer, about 6 inches thick, is grayish-brown loam that contains many fragments of caliche. The underlying material, about 7 inches thick, is very pale brown, friable loam that contains many caliche fragments. At a depth of about 13 inches is white, semiconsolidated caliche.

Canlon soils have very low available water capacity, low fertility, and moderate permeability.

Representative profile of Canlon loam in an area of Canlon soils, 2,640 feet south and 50 feet east of the northwest corner sec. 14, T. 23 S., R. 24 W., in native range:

A1—0 to 6 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) when moist; weak, medium, granular structure; slightly hard when dry, friable when moist; many fragments of caliche; calcareous; moderately alkaline; gradual, smooth boundary.

C—6 to 13 inches, very pale brown (10YR 7/3) loam, brown (10YR 5/3) when moist; weak, medium, granular

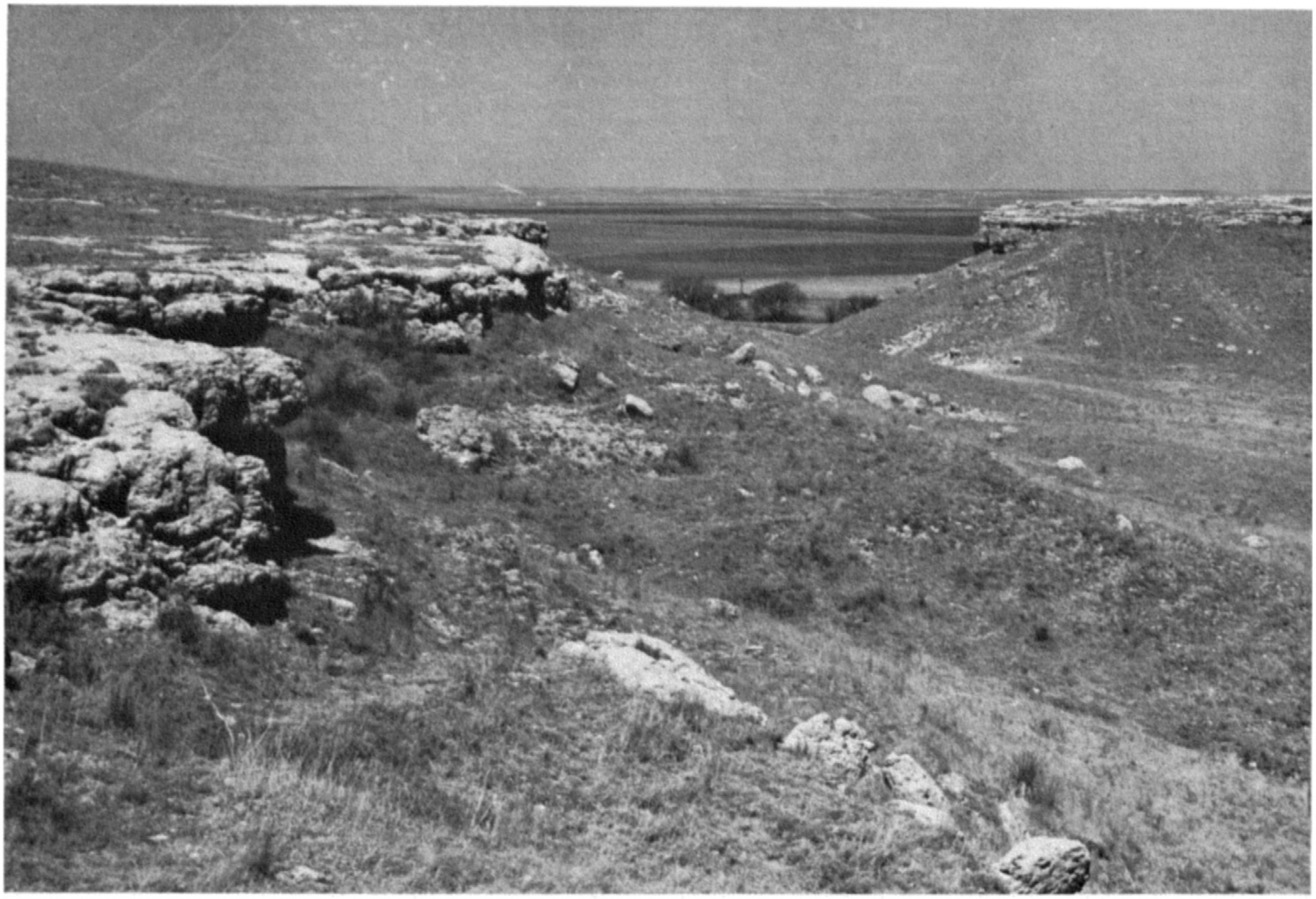

*Figure 6.*—An area of Campus-Canlon complex showing outcrops of caliche.

structure; slightly hard when dry, friable when moist; many fragments of caliche; calcareous; moderately alkaline; gradual, wavy boundary.

R—13 inches, white, semiconsolidated caliche.

The depth to semiconsolidated caliche ranges from 10 to 20 inches. The A horizon ranges from pale brown to grayish brown in color, from 3 to 6 inches in thickness, and from silt loam to loam in texture. Colors of grayish brown or darker extend to a depth of no more than 4 inches.

Canlon soils are near Campus, Kipson, and Wakeen soils. They are not so deep as Campus and Wakeen soils. They differ from Kipson soils in that they are underlain by caliche, whereas Kipson soils are underlain by chalky shale.

**Canlon soils** (3 to 40 percent slopes) (Cn).—These soils have the profile (fig. 7) described as representative for the Canlon series, except in areas where the surface layer is silt loam. They occupy the somewhat broken uplands.

Included in mapping were outcrops of caliche and small areas of Campus, Kipson, and Wakeen soils.

Canlon soils are not suitable for cultivation, because they are shallow and have many rock outcrops. They are suitable for grazing. Overgrazing must be avoided. Capability unit VIIs-1, dryland; no irrigated capability unit or windbreak group; Breaks range site.

## Coly Series

The Coly series consists of deep, well-drained, calcareous soils of the uplands. Slopes are convex and range from 3 to 6 percent. These soils formed in loess.

In a representative profile the surface layer is grayish-brown silt loam about 4 inches thick. The next layer, about 5 inches thick, is very pale brown, friable silt loam that contains lime concretions. The underlying material, to a depth of 60 inches, is very pale brown silt loam.

Coly soils have high available water capacity, medium fertility, and moderate permeability.

Representative profile of Coly silt loam, in an area of Uly-Coly silt loams, 3 to 6 percent slopes, eroded, 400 feet east and 600 feet north of the southwest corner sec. 32, T. 22 S., R. 26 W., in a cultivated field:

Ap—0 to 4 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; calcareous; moderately alkaline; abrupt, smooth boundary.

ACca—4 to 9 inches, very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) when moist; moderate, very fine, granular structure; slightly hard when dry, friable when moist; dark streaks of worm casts throughout

*Figure 7.*—**Profile of a Canlon soil. Caliche is at a depth of 10 inches.**

horizon; few lime concretions; calcareous; moderately alkaline; gradual, smooth boundary.

C1ca—9 to 22 inches, very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) when moist; massive; slightly hard when dry, friable when moist; porous; few lime concretions; calcareous; moderately alkaline; gradual, smooth boundary.

C2—22 to 60 inches, very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) when moist; massive; slightly hard when dry, friable when moist; calcareous; moderately alkaline.

Variations in profile characteristics are few. The texture throughout the profile ranges from silt loam to light silty clay loam. The A horizon ranges from 3 to 5 inches in thickness. Colors of grayish brown or darker extend to a depth of no more than 5 inches.

Coly soils are near Uly, Kim, and Penden soils. They have a thinner A horizon than Uly soils and do not have a B horizon. They contain less sand in the AC and C horizons than Kim and Penden soils. Also, in contrast with Penden soils, they are dark colored to depth of only 4 inches.

The Coly soils in Hodgeman County are mapped only with Uly soils.

## Detroit Series

The Detroit series consists of deep, well drained to moderately well drained soils on low stream terraces. Slopes are mainly less than 1 percent. These soils formed in calcareous, silty alluvium.

In a representative profile the surface layer is dark grayish-brown silty clay loam about 12 inches thick. The subsoil is about 28 inches thick. The upper 13 inches is dark grayish-brown, firm, noncalcareous light silty clay, and the lower 15 inches is grayish-brown, firm, calcareous heavy silty clay loam. The underlying material, to a depth of 60 inches, is light brownish-gray, calcareous silty clay loam.

Detroit soils have high available water capacity, high fertility, and slow permeability.

Representative profile of Detroit silty clay loam, 75 feet east and 50 feet north of the center sec. 18, T. 21 S., R. 21 W., in a cultivated field:

A1—0 to 12 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) when moist; moderate, fine and medium, granular structure; slightly hard when dry, friable when moist; noncalcareous; mildly alkaline; gradual, smooth boundary.

B2t—12 to 25 inches, dark grayish-brown (10YR 4/2) light silty clay, very dark grayish brown (10YR 3/2) when moist; moderate, fine, blocky structure; hard when dry, firm when moist; noncalcareous; mildly alkaline; gradual, smooth boundary.

B3ca—25 to 40 inches, grayish-brown (10YR 5/2) heavy silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak blocky structure parting to moderate, fine, granular; hard when dry, firm when moist; thin strata of darker colored silty clay loam; calcareous; mildly alkaline; gradual, smooth boundary.

Cca—40 to 60 inches, light brownish-gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; massive; hard when dry, firm when moist; thin strata of darker colored silty clay loam; thin films and concretions of lime; calcareous; moderately alkaline.

The thickness of the solum ranges from 24 to 45 inches. The depth to lime ranges from 22 to 30 inches. The A horizon ranges from dark grayish brown to very dark grayish brown in color and from 9 to 13 inches in thickness. The B2t horizon is generally light silty clay but ranges to heavy silty clay loam. Colors of grayish brown or darker extend to a depth of 20 to 45 inches.

Detroit soils are near Bridgeport, Harney, Hord, Ness, and Roxbury soils. They have a more clayey B horizon than Hord and Roxbury soils. They are dark colored to a greater depth than Bridgeport and Harney soils. They are more deeply leached of lime than Bridgeport and Roxbury soils. They have a B horizon, which Bridgeport soils lack. They have a thinner, less clayey A horizon than Ness soils, and they are better drained.

**Detroit silty clay loam** (0 to 1 percent slopes) (Dt).—This soil occupies low terraces about 15 to 25 feet above the streambed.

Included in mapping were areas of Hord and Roxbury soils. Small areas, less than 5 acres in size, of clay spots are indicated by spot symbols on the soil map.

Wheat and sorghum are the principal crops. Alfalfa is also grown. Inadequate rainfall is the main limitation. Conserving moisture and controlling soil blowing are the major concerns in management. In some areas this soil receives runoff from adjacent areas. Capability unit IIc–2, dryland; capability unit I–1, irrigated; Loamy Terrace range site; Deep Loamy Lowland windbreak group.

## Harney Series

The Harney series consists of deep, well-drained soils on uplands. These soils have slopes of 0 to 5 percent. They formed in loess.

In a representative profile the surface layer is about 13 inches thick. The upper 7 inches is dark grayish-brown silt loam, and the lower 6 inches is dark grayish-brown light silty clay loam. The subsoil is about 27 inches thick. The upper 4 inches is dark grayish-brown, firm silty clay loam, and the lower 23 inches is grayish-brown, very firm light silty clay. The lower 14 inches of the subsoil is calcareous. The underlying material, to a depth of 60 inches, is pale-brown silty clay loam that contains lime concretions.

Harney soils have high available water capacity, high fertility, and moderately slow permeability.

Representative profile of Harney silt loam, 0 to 1 percent slopes, 2,640 feet east and 200 feet south of the northwest corner sec. 23, T. 23 S., R. 21 W., in a cultivated field:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; noncalcareous; slightly acid; abrupt, smooth boundary.

A3—7 to 13 inches, dark grayish-brown (10YR 4/2) light silty clay loam, very dark brown (10 YR 2/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; noncalcareous; neutral; gradual, smooth boundary.

B21t—13 to 17 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, subangular blocky structure; hard when dry, firm when moist; noncalcareous; mildly alkaline; gradual, smooth boundary.

B22t—17 to 26 inches, grayish-brown (10YR 5/2) light silty clay, dark grayish brown (10YR 4/2) when moist; moderate, fine and medium, blocky structure; very hard when dry, very firm when moist; noncalcareous; mildly alkaline; gradual, smooth boundary.

B3ca—26 to 40 inches, grayish-brown (10YR 5/2) light silty clay, dark grayish brown (10YR 4/2) when moist; moderate, medium, blocky structure grading to massive; very hard when dry, very firm when moist; few lime concretions; calcareous; moderately alkaline; gradual, smooth boundary.

C1ca—40 to 55 inches, pale-brown (10YR 6/3) silty clay loam, dark grayish brown (10YR 4/2) when moist; massive; hard when dry, firm when moist; lime concretions; calcareous; moderately alkaline; gradual, smooth boundary.

C2ca—55 to 60 inches, pale-brown (10YR 6/3) silty clay loam, brown (10 YR 5/3) when moist; massive; slightly hard when dry, friable when moist; lime concretions; calcareous; moderately alkaline.

The thickness of the solum ranges from 25 to 70 inches. The depth to lime averages about 24 inches but ranges from 18 to 30 inches. The A1 horizon ranges from 4 to 14 inches in thickness, and the A3 horizon from 4 to 10 inches. The Bt horizon ranges from heavy silty clay loam to light silty clay. Colors of grayish brown or darker extend to a depth of 10 to 20 inches. In some places there is a buried soil at a depth of 36 inches. In other places clay loam outwash is at a depth of more than 40 inches.

Harney soils are near Detroit, Hord, Ness, Ost, Richfield, and Spearville soils. They are leached of lime to a greater depth than Ost and Richfield soils. They are more clayey than Ost soils. They have a thicker transition between the Ap horizon and the B2t horizon than Spearville soils. They are not darkened to as great a depth as Detroit and Hord soils. Harney soils have a more clayey B horizon than Hord soils. They have a thinner, less clayey A horizon than Ness soils and are better drained.

**Harney silt loam, 0 to 1 percent slopes** (Ha).—This soil has the profile described as representative for the Harney series. It occupies tableland in slightly concave to convex areas.

Included in mapping were small areas of Ost, Penden, Richfield, and Spearville soils. Also included were knobs, about 3 acres in size, of eroded Harney soils where slopes are 1 to 3 percent. Small areas, less than 5 acres in size, of limy spots, clay spots, and rock outcrops are indicated by spot symbols on the soil map.

This Harney soil is well suited to wheat (fig. 8) and sorghum. Inadequate rainfall is the main limitation. Con-

*Figure 8.*—**Yearling cattle grazing wheat pasture on Harney silt loam, 0 to 1 percent slopes.**

serving moisture and controlling soil blowing are concerns in management. Water erosion is a hazard on long slopes. Unless protected, the surface of this soil tends to seal when wet and to form a crust when dry. Capability unit IIc–1, dryland; capability unit I–1, irrigated; Loamy Upland range site; Deep Loamy Upland windbreak group.

**Harney silt loam, 1 to 3 percent slopes** (Hb).—This soil has slightly concave and convex slopes. The surface layer is about 11 inches thick, and the depth to lime is about 22 inches, but otherwise the profile is similar to that described as representative for the Harney series.

Included in mapping were small areas of Penden, Richfield, and Uly soils. Small areas, less than 5 acres in size, of rock outcrops and limy spots are indicated by spot symbols on the soil map.

This Harney soil is well suited to wheat and sorghum. Controlling water erosion and soil blowing is the major concern in management. Unless protected, the surface of this soil tends to seal when wet and to form a crust when dry. Capability unit IIe–1, dryland; capability unit IIe–1, irrigated; Loamy Upland range site; Deep Loamy Upland windbreak group.

**Harney silt loam, 3 to 5 percent slopes** (Hc).—This soil generally occupies sides of drainageways. It has convex slopes. The surface layer is about 9 inches thick, and the depth to lime is about 20 inches, but otherwise the profile is similar to that described as representative for the Harney series.

Included in mapping were small areas of Penden and Uly soils. Small areas of rock outcrops and limy spots, less than 5 acres in size, are indicated by spot symbols on the soil map.

This Harney soil is well suited to wheat and sorghum. Controlling water erosion and soil blowing is the major concern in management. Unless protected, the surface of this soil tends to seal when wet and to form a crust when dry. Capability unit IIIe–1, dryland; no irrigated capability unit; Loamy Upland range site; Deep Loamy Upland windbreak group.

**Harney silty clay loam, 1 to 3 percent slopes, eroded** (Hd).—Erosion has removed most or all of the original surface layer from this soil. The present surface layer is a mixture of the original material and part of the subsoil. The surface layer is about 7 inches thick, and the depth to lime is about 16 inches, but otherwise the profile is similar to that described as representative for the Harney series. Slopes are convex. This soil has a thinner surface layer and is shallower over lime than is appropriate to the range defined for the Harney series. These differences, however, do not significantly alter the use or the behavior of the soil.

Included in mapping were small areas of Penden and Uly soils. Small areas, less than 5 acres in size, of rock outcrops and limy spots are indicated by spot symbols on the soil map.

This Harney soil is well suited to wheat and sorghum. Controlling further water erosion and soil blowing is the major concern in management. Unless protected, the surface of this soil tends to seal when wet and to form a crust when dry. Capability unit IIe–3, dryland; no irrigated capability unit; Loamy Upland range site; Deep Loamy Upland windbreak group.

**Harney silty clay loam, 3 to 5 percent slopes, eroded** (He).—Erosion has removed most or all of the original surface layer from this soil. The present surface layer is a mixture of the original material and part of the subsoil. The surface layer is about 6 inches thick, and the depth to lime is about 15 inches, but otherwise the profile is similar to that described as representative for the Harney series. Slopes are convex. This soil has a thinner surface layer and is shallower over lime than is appropriate to the range defined for the Harney series. These differences, however, do not significantly alter the use or the behavior of the soil.

Included in mapping were small areas of Penden and Uly soils. Small areas, less than 5 acres in size, of rock outcrops and limy spots are indicated by spot symbols on the soil map.

This Harney soil is suited to wheat and sorghum. Controlling further water erosion and soil blowing are the major concerns in management. Unless protected, the surface of this soil tends to seal when wet and to form a crust when dry. Capability unit IIIe–5, dryland; no irrigated capability unit; Loamy Upland range site; Deep Loamy Upland windbreak group.

## Hord Series

The Hord series consists of deep, well-drained soils on low stream terraces. Slopes are mainly less than 1 percent. These soils formed in calcareous, silty alluvium.

In a representative profile the surface layer is dark grayish-brown light silty clay loam about 12 inches thick. The subsoil is about 25 inches thick. The upper 10 inches is dark grayish-brown, firm silty clay loam, and the lower 15 inches is grayish-brown, firm, calcareous silty clay loam that contains films and concretions of lime. The underlying material, to a depth of 60 inches, is pale-brown, calcareous silty clay loam.

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

Representative profile of Hord silty clay loam, 100 feet west and 300 feet south of the northeast corner sec. 9, T. 21 S., R. 24 W., in a cultivated field:

A1—0 to 12 inches, dark grayish-brown (10YR 4/2) light silty clay loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; noncalcareous; neutral; gradual, smooth boundary.

B2—12 to 22 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, subangular blocky structure; hard when dry, firm when moist; noncalcareous; mildly alkaline; gradual, smooth boundary.

B3ca—22 to 37 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, subangular blocky structure grading to massive; hard when dry, firm when moist; dark-colored streaks of worm casts in horizon; films and concretions of lime; calcareous; moderately alkaline; gradual, smooth boundary.

Cca—37 to 60 inches, pale-brown (10YR 6/3) silty clay loam, dark brown (10YR 4/3) when moist; massive; hard when dry, firm when moist; stratified, dark-colored lenses of silty clay loam; films of lime; calcareous; moderately alkaline.

The thickness of the solum ranges from 35 to 45 inches. The depth to lime ranges from 12 to 30 inches. The A horizon ranges from heavy silt loam to silty clay loam and from dark grayish brown to grayish brown. Colors of grayish brown or darker extend to a depth of 20 to 30 inches.

Hord soils are near Bridgeport, Detroit, Harney, Ness, and Roxbury soils. They are more deeply leached of lime than Bridgeport soils and are dark colored to a greater depth. They have a B horizon, which Bridgeport soils lack. They are more deeply leached of lime than Roxbury soils. They have a less clayey B2 horizon than Detroit and Harney soils. They are dark colored to a greater depth than Harney soils. Hord soils are less clayey in the upper 30 inches than Ness soils, and they are better drained.

**Hord silty clay loam** (0 to 1 percent slopes) (Ho).—This soil occupies fans and low terraces. The terraces are about 15 to 25 feet above the streambed.

Included in mapping were small areas of Roxbury, Detroit, and Harney soils and small areas where the slope gradient is as much as 2 percent. Small areas, less than 5 acres in size, of limy spots and clay spots are indicated by spot symbols on the soil map.

Wheat and sorghum are the principal crops. Alfalfa is also grown. Inadequate rainfall is the main limitation. Conserving moisture and controlling soil blowing are the major concerns in management. In some places this soil receives runoff from adjacent areas. Capability unit IIc–2, dryland; capability unit I–1, irrigated; Loamy Terrace range site; Deep Loamy Lowland windbreak group.

## Kim Series

The Kim series consists of deep, well-drained, calcareous soils of the uplands. These soils have slopes of 3 to 6 percent. They formed in calcareous clay loam outwash.

In a representative profile the surface layer is grayish-brown silty clay loam about 4 inches thick. The next layer, about 6 inches thick, is brown, friable clay loam. The underlying material, to a depth of 60 inches, is pale-brown clay loam.

Kim soils have high available water capacity, medium fertility, and moderate to moderately slow permeability.

Representative profile of Kim silty clay loam, in an area of Kim-Penden silty clay loams, 3 to 6 percent slopes, eroded, 500 feet south and 600 feet east of the northwest corner sec. 31, T. 22 S., R. 24 W., in a cultivated field:

Ap—0 to 4 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; calcareous; moderately alkaline; abrupt, smooth boundary.

AC—4 to 10 inches brown (10YR 5/3) clay loam, dark brown (10YR 4/3) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; few lime concretions; calcareous; moderately alkaline; gradual, smooth boundary.

Cca—10 to 60 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) when moist; massive; slightly hard when dry, friable when moist; few lime concretions and lime films; calcareous; moderately alkaline.

The A horizon is generally silty clay loam but in places is clay loam. It ranges from 3 to 5 inches in thickness. Colors of grayish brown or darker extend to a depth of no more than 5 inches. These soils are calcareous throughout the profile.

Kim soils are near Coly, Otero, Penden, and Uly soils. They have a thinner A horizon than Penden soils, and they are not darkened as deep as those soils. They are more sandy in all horizons below the A horizon than Coly and Uly soils. They do not have a B horizon, which is typical of Uly soils. They are less sandy throughout the profile than Otero soils.

The Kim soils in Hodgeman County are mapped only with Penden soils.

**Kim-Penden silty clay loams, 3 to 6 percent slopes, eroded** (Kp).—This mapping unit is about 55 percent Kim soils and 35 percent Penden soils. These soils mainly occupy the sides of drainageways. Slopes are slightly convex. In much of the acreage, erosion has removed most or all of the original surface layer from these soils. The present surface layer is a mixture of the original material and part of the subsoil. The Kim soil is the more eroded part of the mapping unit. The surface layer of the Penden soil is about 8 inches thick.

Included in mapping were small areas of Harney and Wakeen soils. Small areas, less than 5 acres in size, of rock outcrops are indicated by spot symbols on the soil map.

All the soils in this mapping unit are cultivated or have been cultivated. Wheat and sorghum are the principal crops. Controlling further water erosion and soil blowing is the major concern in management. Unless protected, the surface of these soils tends to seal when wet and to form a crust when dry. Capability unit IVe–1, dryland; no irrigated capability unit; Limy Upland range site; Deep Loamy Upland windbreak group.

## Kipson Series

The Kipson series consists of very shallow and shallow, somewhat excessively drained soils on uplands. The landscape is somewhat broken. Slopes are about 3 to 25 percent. These soils formed in chalky shale interbedded with limestone. Shale and limestone outcrops are common.

In a representative profile the surface layer, about 10 inches thick, is grayish-brown loam that contains fragments of limestone and shale. The underlying material, about 5 inches thick, is grayish-brown, friable light clay loam that contains fragments of limestone and shale. At a depth of 15 inches is very pale brown chalky shale.

Kipson soils have very low available water capacity, low fertility, and moderate permeability.

Representative profile of Kipson loam, in an area of Kipson-Wakeen complex, 1,600 feet north and 1,300 feet east of the southwest corner sec. 9, T. 23 S., R. 23 W., in native range:

A1—0 to 10 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine and medium, granular structure; slightly hard when dry, friable when moist; fragments of limestone and chalky shale; calcareous; moderately alkaline; gradual, smooth boundary.

C1—10 to 15 inches, grayish-brown (10YR 5/2) light clay loam, dark grayish brown (10YR 4/2) when moist; moderate; medium, granular structure; slightly hard when dry, friable when moist; about 10 percent shale and limestone fragments; calcareous; moderately alkaline; gradual, wavy boundary.

C2—15 inches, very pale brown (10YR 8/3) chalky shale and thin beds of fractured limestone.

The depth to the chalky shale interbedded with limestone ranges from 7 to 20 inches. The A horizon ranges from silt loam to clay loam in texture and from grayish brown to dark grayish brown in color. Colors of grayish brown or darker extend to a depth of 7 to 12 inches. The mean annual precipitation range of the Kipson soils in Hodgeman County is less than the defined range for the series, but this difference does not alter the use or behavior of these soils.

Kipson soils are near Campus, Canlon, and Wakeen soils. In contrast with Campus and Canlon soils, they overlie chalky shale instead of semiconsolidated caliche. They are not so deep as Campus and Wakeen soils.

**Kipson-Wakeen complex** (3 to 25 percent slopes) (Kw).—This mapping unit is about 55 percent Kipson soils and 35 percent Wakeen soils. These soils are on the sides and crests of ridges along drainageways. The Kipson soil occupies the more broken slopes, and the Wakeen soil the less sloping crests and sides of ridges. Both soils have profiles similar to those described as representative for their respective series.

Included in mapping were small areas of Penden, Campus, and Canlon soils. Also included were shale outcrops and soils that are shallow over Dakota Sandstone and have sandstone outcrops.

The soils of this mapping unit are not suited to cultivation because they are very shallow to only moderately deep over chalky shale, have outcrops of sandstone and chalky shale, and are highly susceptible to erosion in areas where their slope is more than 6 percent. They are productive if well managed and used as grassland. Capability unit VIe-2, dryland; not placed in an irrigated capability unit or a windbreak group. Kipson soil in Breaks range site, and Wakeen soil in Limy Upland range site.

## Ness Series

The Ness series consists of deep, poorly drained soils on floors of enclosed depressions. These depressions range from a few inches to about 10 feet below the surrounding soils. They are typically in upland flats and in the outer fringes of broad valley floors. The slope gradient is generally less than 1 percent. These soils formed in clayey alluvium or loess.

In a representative profile the upper 31 inches is very firm, gray clay. The underlying material, to a depth of 60 inches, is light brownish-gray, firm, calcareous silty clay loam.

Ness soils have high available water capacity, high fertility, and very slow permeability.

Representative profile of Ness clay, 2,560 feet north and 130 feet west of the southeast corner sec. 15, T. 22 S., R. 24 W., in native range:

A11—0 to 18 inches, gray (10YR 5/1) light clay, very dark gray (10YR 3/1) when moist; fine granular structure in the upper 2 inches parting to moderate, very fine, blocky structure below; very hard when dry, very firm when moist; noncalcareous; mildly alkaline; gradual, wavy boundary.

A12—18 to 31 inches, gray (10YR 5/1) clay, very dark gray (10YR 3/1) when moist; moderate, fine, blocky structure; some irregular peds having two long axes not parallel to the surface; very hard when dry, very firm when moist; few slickensides on faces of larger peds; noncalcareous; mildly alkaline; gradual, smooth boundary.

C—31 to 60 inches, light brownish-gray (10YR 6/2) silty clay loam that becomes less clayey with increasing depth, grayish brown (10YR 5/2) when moist; massive; slightly hard when dry, firm when moist; few small lime concretions; calcareous; moderately alkaline.

The depth to lime ranges from 24 to 48 inches. The A horizon ranges from silty clay to clay in texture, from gray to very dark gray in color, and from 24 to 48 inches in thickness. The C horizon has a hue of 7.5YR or 10YR and ranges from silt loam to light silty clay.

Ness soils are near Detroit, Harney, Hord, Ost, Richfield, Roxbury, and Spearville soils. They have a thicker, more clayey A horizon than those soils, and they are more poorly drained.

**Ness clay** (0 to 1 percent slopes) (Ne).—This soil occupies depressions that range in size from less than 5 acres to more than 50 acres.

This soil is generally farmed along with the adjoining soils. It is not well suited to crops or grasses because it is ponded and poorly drained. Often it is too wet for planting. Frequently crops are drowned out. The frequency and amount of ponding vary, depending on the extent of the drainage area. Soil blowing is a hazard if this soil is dry and bare. Bare areas are common. The principal vegetation in uncultivated areas is ragweed, smartweed, and a sparse stand of western wheatgrass. Capability unit VIw-1, dryland; no irrigated capability unit, no range site, no windbreak group.

## Ost Series

The Ost series consists of deep, well-drained soils of the uplands. These soils have slopes up to 1 percent. They formed in calcareous plains outwash, modified in the upper part by loess.

In a representative profile the surface layer is about 10 inches thick. The upper 7 inches is dark grayish-brown silt loam, and the lower 3 inches is dark grayish-brown light silty clay loam. The subsoil is about 13 inches thick. The upper 6 inches is dark grayish-brown, firm clay loam, and the lower 7 inches is pale-brown, firm clay loam that is strongly calcareous and contains lime concretions. The underlying material, to a depth of 60 inches, is very pale brown, calcareous clay loam.

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

Representative profile of Ost silt loam, 0 to 1 percent slopes, 2,460 feet east and 100 feet north of the southwest corner sec. 25, T. 23 S., R. 25 W., in a cultivated field:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; noncalcareous; neutral; abrupt, smooth boundary.

A3—7 to 10 inches, dark grayish-brown (10YR 4/2) light silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; noncalcareous; neutral; gradual, smooth boundary.

B2t—10 to 16 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, subangular blocky structure; hard when dry, firm when moist; noncalcareous; mildly alkaline; gradual, smooth boundary.

B3ca—16 to 23 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) when moist; moderate, medium, subangular blocky structure; hard when dry, firm when moist; lime concretions; strongly calcareous; moderately alkaline; gradual, smooth boundary.

Cca—23 to 60 inches, very pale brown (10YR 7/3) clay loam, pale brown (10YR 6/3) when moist; massive; hard when dry, firm when moist; strongly calcareous; moderately alkaline.

The thickness of the solum ranges from 18 to 30 inches. The depth to lime ranges from 12 to 20 inches. The A horizon ranges from 6 to 12 inches in thickness and from grayish brown to dark grayish brown in color. Colors of grayish brown or darker extend to a depth of 8 to 16 inches. The clay content of the B2t horizon ranges from 27 to 35 percent. The annual temperature range of the Ost soils in Hodgeman County is lower than the range defined for the series, but this difference does not significantly alter the use or behavior of these soils.

Ost soils are near Harney, Ness, Penden, and Spearville soils. They are less clayey in the B horizon than Spearville and Harney soils. They are not so deeply leached of lime as Harney soils. In contrast with Penden soils, they have a B horizon and are more deeply leached of lime They are less clayey throughout the profile than Ness soils, and they are better drained.

**Ost silt loam, 0 to 1 percent slopes** (Om).—This soil occupies the tableland above breaks.

Included in mapping were small areas of Harney and Penden soils. Small areas, less than 5 acres in size, of limy spots are indicated by spot symbols on the soil map.

This Ost soil is well suited to wheat and sorghum. Inadequate rainfall is the main limitation. Conserving moisture and controlling soil blowing are the major concerns in management. Unless protected, the surface of this soil tends to seal when wet and to form a crust when dry. Capability unit IIc–1, dryland; capability unit I–1, irrigated; Loamy Upland range site; Deep Loamy Upland windbreak group.

## Otero Series

The Otero series consists of well-drained and somewhat excessively drained soils that are moderately deep over sand and gravel. These soils formed in calcareous sand outwash. They occupy sides of drainageways. Slopes are 6 to 12 percent.

In a representative profile the surface layer is about 4 inches of grayish-brown gravelly sandy loam. Pebbles one-fourth inch to 1 inch in diameter are on the surface. The next layer is about 21 inches of friable gravelly sandy loam that contains lime concretions. The upper 12 inches is light brownish gray, and the lower 9 inches is pale brown. The underlying material is about 5 inches of pale-brown loamy sand and lime concretions over 12 inches of very pale brown sand. It is underlain, to a depth of 60 inches, by very pale brown sand and gravel.

Otero soils have low available water capacity, medium to low fertility, and moderately rapid permeability.

Representative profile of Otero gravelly sandy loam, in an area of Otero gravelly complex, 1,840 feet east and 30 feet north of the southwest corner sec. 34, T. 22 S., R. 26 W., in native vegetation:

A1—0 to 4 inches, grayish-brown (10YR 5/2) gravelly sandy loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; many pebbles one-fourth inch in diameter on surface, and a few one-half to 1 inch in diameter; calcareous; mildly alkaline; gradual, smooth boundary.

AC1ca—4 to 16 inches, light brownish-gray (10YR 6/2) gravelly sandy loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; few lime concretions; calcareous; moderately alkaline; gradual, smooth boundary.

AC2a—16 to 25 inches, pale-brown (10YR 6/3) gravelly sandy loam, brown (10YR 5/3) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; many worm casts; few lime concretions; calcareous; moderately alkaline; gradual, smooth boundary.

C1ca—25 to 30 inches, pale-brown (10YR 6/3) loamy sand, brown (10YR 5/3) when moist; single grain; loose; few lime concretions; calcareous; moderately alkaline; gradual, smooth boundary.

C2—30 to 42 inches, very pale brown (10YR 7/3) sand, brown (10YR 5/3) when moist; single grain; loose; calcareous; moderately alkaline; gradual, smooth boundary.

C3—42 to 60 inches, very pale brown (10YR 7/3) sand and gravel, brown (10YR 5/3) when moist; single grain; loose; calcareous; moderately alkaline.

The A horizon ranges from gravelly loam to gravelly sandy loam in texture. The gravelly sandy loam is more than 20 inches thick over the coarser textured material. Colors of grayish brown or darker extend to a depth of no more than 6 inches. The amount of sand and gravel in the profile varies.

Otero soils are near Kim and Penden soils. They are more sandy throughout the profile than those soils.

**Otero gravelly complex** (6 to 12 percent slopes) (Ox).—This mapping unit is about 40 percent Otero gravelly soil, 40 percent gravelly, calcareous clay loams that overlie sand at varying depths, and 10 percent noncalcareous, sandy soils. These soils occupy sides of upland drainageways. The gravelly and sandy soils vary in texture, depth to sand and gravel, and amount of gravel on the surface.

Included in mapping were small areas of Penden soils and of sandy soils on narrow bottoms of drainageways.

These Otero soils are not suitable for cultivation because they are highly susceptible to erosion. Also, they are too gravelly. If well managed, they are well suited to use as grassland. There are numerous sand and gravel pits in areas of these soils. Capability unit VIe–3, dryland; no irrigated capability unit, no windbreak group; Gravelly Hills range site.

## Penden Series

The Penden series consists of deep, well-drained calcareous soils of the uplands. These soils have slopes up to 12 percent. They formed in calcareous clay loam outwash, modified in the upper part by loess.

In a representative profile the surface layer is about 16 inches thick. The upper 7 inches is dark grayish-brown silty clay loam, and the lower 9 inches is grayish-brown silty clay loam. The next layer, about 12 inches thick, is brown, friable clay loam that contains a few lime concretions. The underlying material, to a depth of 60 inches, is light-brown to very pale brown clay loam. The lower 22 inches contains many lime concretions.

Penden soils have high available water capacity, high fertility, and moderate and moderately slow permeability.

Representative profile of Penden silty clay loam, 3 to 6 percent slopes, 660 feet west and 350 feet north of the southeast corner sec. 2, T. 23 S., R. 22 W., in native range:

A11—0 to 7 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; noncalcareous in upper 2 inches; mildly alkaline; gradual, smooth boundary.

A12—7 to 16 inches, grayish-brown (10YR 5/2) silty clay loam, dark brown (10YR 3/3) when moist; moderate, fine to medium, granular structure; slightly hard when dry, friable when moist; calcareous; moderately alkaline; gradual, smooth boundary.

AC—16 to 28 inches, brown (10YR 5/3) clay loam, dark brown (10YR 4/3) when moist; moderate, coarse, granular structure; slightly hard when dry, friable when moist; few lime concretions; calcareous; moderately alkaline; gradual, smooth boundary.

C1—28 to 38 inches, light-brown (7.5YR 6/4) clay loam, brown (7.5 YR 5/4) when moist; massive; slightly hard when dry, friable when moist; calcareous; moderately alkaline; gradual, smooth boundary.

C2ca—38 to 51 inches, very pale brown (10YR 7/3) clay loam, light yellowish brown (10YR 6/4) when moist; massive; slightly hard when dry, friable when moist; many lime concretions; calcareous; moderately alkaline; gradual, smooth boundary.

C3ca—51 to 60 inches, light-brown (7.5YR 6/4) clay loam, brown (7.5YR 5/4) when moist; massive; slightly hard when dry, friable when moist; many lime concretions; calcareous; moderately alkaline.

Colors of grayish brown or darker extend to a depth of 7 to 20 inches. In most places the A horizon is silty clay loam, but in some it is silt loam or clay loam. It ranges from 7 to 20 inches in thickness. In most places it is calcareous throughout, but in some places it is noncalcareous in the upper 6 inches. The hue of the C horizon is 10YR or 7.5YR.

Penden soils are near Campus, Coly, Kim, Ost, Otero, Uly, and Wakeen soils. They are deeper than Wakeen and Campus soils. They lack the strong zone of lime accumulation that is typical of Campus soils. They are more sandy and less silty in all horizons below the A horizon than Coly, Uly, and Wakeen soils. They have a thicker A horizon than Coly and Kim soils and are dark colored to a greater depth. In contrast with Ost and Uly soils, they do not have a B horizon. They are not so deeply leached of lime as Ost soils. They are less sandy throughout the profile than Otero soils.

**Penden silty clay loam, 0 to 1 percent slopes** (Pd).—This soil occupies the tableland just above breaks. The surface layer is about 18 inches thick, but otherwise the profile is similar to that described as representative for the Penden series.

Included in mapping were small areas of Campus, Ost, and Harney soils. Small areas, less than 5 acres in size, of rock outcrops are indicated by spot symbols on the soil map.

This Penden soil is well suited to wheat and sorghum. Inadequate rainfall is the main limitation. Conserving moisture and controlling soil blowing are major concerns in management. Unless protected, the surface of this soil tends to seal when wet and to form a crust when dry. Capability unit IIc-1, dryland; capability unit I-1, irrigated; Limy Upland range site; Deep Loamy Upland windbreak group.

**Penden silty clay loam, 1 to 3 percent slopes** (Pe).—The surface layer of this soil is about 17 inches thick, but otherwise the profile is similar to that described as representative for the Penden series. Slopes are slightly convex.

Included in mapping were small areas of Harney, Kim, Uly, and Wakeen soils. Small areas, less than 5 acres in size, of rock outcrops are indicated by spot symbols on the soil map.

This Penden soil is well suited to wheat and sorghum. Controlling water erosion and soil blowing is the major concern in management. Unless protected, the surface of this soil tends to seal when wet and to form a crust when dry. Capability unit IIe-2, dryland; capability unit IIe-1, irrigated; Limy Upland range site; Deep Loamy Upland windbreak group.

**Penden silty clay loam, 3 to 6 percent slopes** (Pf).—This soil is mainly on sides of drainageways. It has the profile (fig. 9) described as representative for the Penden series. Slopes are slightly convex.

Included in mapping were small areas of Campus, Kim, Roxbury, Uly, and Wakeen soils. Small areas, less than 5 acres in size, of rock outcrops are indicated by spot symbols on the soil map.

Wheat and sorghum are the main crops. Controlling water erosion and soil blowing are the major concerns in management. Unless protected, the surface of this soil tends to seal when wet and to form a crust when dry. Capability unit IIIe-4, dryland; no irrigated capability unit; Limy Upland range site; Deep Loamy Upland windbreak group.

**Penden complex** (0 to 12 percent slopes) (Pn).—This mapping unit is about 70 percent Penden soils and 20 percent grayish-brown, loamy soils that form in alluvium. Penden soils are on sides of drainageways and have slopes of 6 to 12 percent. Their surface layer is about 12 inches

*Figure 9.*—Profile of Penden silty clay loam, 3 to 6 percent slopes, showing granular structure. Lime concretions are at a depth of about 16 inches.

thick, but otherwise their profile is similar to that described as representative for the Penden series. The loamy soils are on floors of drainageways and have slopes up to 2 percent.

Included in mapping were small areas of Bridgeport, Coly, Campus, Kim, Roxbury, Uly, and Wakeen soils. Small areas of rock outcrops, less than 5 acres in size, are indicated by spot symbols on the soil map.

The soils of this mapping unit are not suitable for cultivation. On the sides of drainageways, they are highly susceptible to erosion. On the floors of drainageways, they are subject to frequent flooding. If kept in grasses, these soils are productive. Capability unit VIe–1, dryland; no irrigated capability unit; Limy Upland range site; Deep Loamy Upland windbreak group.

**Penden-Campus clay loams, 1 to 4 percent slopes** (Pu).—This mapping unit is about 60 percent Penden soils and 30 percent Campus soils. These soils are on erosional uplands. Slopes are slightly convex. Except for texture of the surface layer, both soils have profiles similar to those described for their respective series. The surface layer of the Penden soil is about 17 inches thick.

Included in mapping were small areas of Harney and Kim soils.

The soils of this mapping unit are suited to wheat and sorghum. Controlling water erosion and soil blowing is the major concern in management. Unless protected, the surface of these soils tends to seal when wet and to form a crust when dry. Capability unit IIIe–2, dryland; no irrigated capability unit; Llmy Upland range site; Moderately Deep Loamy Upland windbreak group.

## Richfield Series

The Richfield series consists of deep, well-drained soils on uplands. These soils have slopes up to 5 percent. They formed in loess.

In a representative profile the surface layer is dark grayish-brown silt loam about 7 inches thick. The subsoil is about 14 inches thick. The upper 8 inches is dark grayish-brown, firm silty clay loam, and the lower 6 inches is light brownish-gray, firm, calcareous silty clay loam that contains a few lime concretions. The underlying material, to a depth of 60 inches, is pale-brown, is calcareous, and contains lime concretions. The upper part is light silty clay loam, and the lower part is silt loam.

Richfield soils have high available water capacity, high fertility, and moderately slow permeability.

Representative profile of Richfield silt loam, 1 to 3 percent slopes, 1,980 feet north and 930 feet east of the southwest corner sec. 16, T. 24 S., R. 26 W., in native range:

A1—0 to 7 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; noncalcareous; mildly alkaline; gradual, smooth boundary.

B2t—7 to 15 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine and medium, subangular blocky structure; hard when dry, firm when moist; noncalcareous; mildly alkaline; gradual, smooth boundary.

B3ca—15 to 21 inches, light brownish-gray (10YR 6/2) silty clay loam, brown (10YR 5/3) when moist; weak, fine, subangular blocky structure; hard when dry, firm when moist; few lime concretions; calcareous; moderately alkaline; gradual, smooth boundary.

C1ca—21 to 33 inches, pale-brown (10YR 6/3) light silty clay loam, brown (10YR 5/3) when moist; massive; hard when dry, firm when moist; few small lime concretions; calcareous; moderately alkaline; gradual, smooth boundary.

C2—33 to 60 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) when moist; massive; soft when dry, very friable when moist; few small lime concretions in upper part; calcareous; moderately alkaline.

The thickness of the solum ranges from 16 to 25 inches. The depth to lime averages about 15 inches, but ranges from 10 to 18 inches. The A horizon ranges from 5 to 8 inches in thickness and from silt loam to light silty clay loam in texture. Colors of grayish brown or darker extend to a depth of 10 to 20 inches. The clay content of the B2t horizon ranges from 35 to 42 percent.

Richfield soils are near Harney, Ness, Spearville, and Uly soils. They are less clayey in the B horizon than Spearville soils. They lack the blocky structure in the B horizon that is typical of Spearville soils. They are not so deeply leached of lime as the Harney soils. They are more clayey in the B horizon than Uly soils. They are thinner and less clayey in the A horizon than Ness soils, and they are better drained.

**Richfield silt loam, 0 to 1 percent slopes** (Rm).—This soil occupies the tableland. The surface layer is about 8 inches thick, and the depth to lime is about 16 inches, but otherwise the profile is similar to that described as representative for the Richfield series. Slopes are slightly concave to convex.

Included in mapping were small areas of Harney and Spearville soils. Small areas, less than 5 acres in size, of limy spots and clay spots are indicated by spot symbols on the soil map.

This Richfield soil is well suited to wheat and sorghum. Inadequate rainfall is the main limitation. Conserving moisture and controlling soil blowing are major concerns in management. Water erosion is a hazard on long slopes. Unless protected, the surface of this soil tends to seal when wet and to form a crust when dry. Capability unit IIc-1, dryland; capability unit I-1, irrigated; Loamy Upland range site; Deep Loamy Upland windbreak group.

**Richfield silt loam, 1 to 3 percent slopes** (Rn).—This soil has the profile described as representative for the Richfield series. Slopes are slightly concave to convex.

Included in mapping were small areas of Harney and Uly soils. Small areas, less than 5 acres in size, of limy spots and rock outcrops are indicated by spot symbols on the soil map.

This Richfield soil is well suited to wheat and sorghum. Controlling water erosion and soil blowing is the major concern in management. Unless protected, the surface of this soil tends to seal when wet and to form a crust when dry. Capability unit IIe-1, dryland; capability unit IIe-1, irrigated; Loamy Upland range site; Deep Loamy Upland windbreak group.

**Richfield silty clay loam, 2 to 5 percent slopes, eroded** (Ro).—Erosion has removed most or all of the original surface layer from this soil. The present surface layer is a mixture of the original material and part of the subsoil. The surface layer is about 5 inches thick, and the depth to lime is about 9 inches, but otherwise the profile is similar to that described as representative for the Richfield series. Slopes are convex. This soil has a thinner surface layer and is shallower over lime than is appropriate to the range defined for the Richfield series. These differences, however, do not significantly alter the use or the behavior of the soil.

Included in mapping were small areas of Uly soils. Small areas, less than 5 acres in size, of rock outcrops and limy spots are indicated by spot symbols on the soil map.

This Richfield soil is suited to wheat and sorghum. Controlling further water erosion and soil blowing is the major concern in management. Unless protected, the surface of this soil tends to seal when wet and to form a crust when dry. Capability unit IIIe-5, dryland; no irrigated capability unit; Loamy Upland range site; Deep Loamy Upland windbreak group.

## Rough Broken Land

Rough broken land (10 to 40 percent slopes) (Rr) is 25 to 60 percent barren outcrops of chalky shale, limestone, and noncalcareous sandstone and shale; 30 to 65 percent soil that is calcareous, loamy, shallow and very shallow over bedrock; and about 10 percent small areas of Penden and Wakeen soils. Areas of this land are mainly along drainageways on broken uplands. Slopes are generally more than 25 percent.

Because of the slope, the shallow and very shallow soil, and the many rock outcrops, Rough broken land is not suitable for cultivation. If well managed, it can be used for grazing. Capability unit VIIs-1, dryland; no irrigated capability unit, no windbreak group; Breaks range site.

## Roxbury Series

The Roxbury series consists of deep, well drained to moderately well drained soils on low stream terraces, narrow bottom lands, and foot slopes below outcrops of caliche and chalky shale. The slopes gradient is up to 5 percent. On foot slopes the gradient is mainly more than 2 percent. These soils formed in calcareous alluvium.

In a representative profile the surface layer, about 22 inches thick, is dark grayish-brown silt loam. The lower 14 inches is calcareous. The subsoil, about 20 inches thick, is grayish-brown, friable, calcareous light silty clay loam. The underlying material, to a depth of 60 inches, is light brownish-gray, calcareous clay loam.

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

Representative profile of Roxbury silt loam, 325 feet north and 125 feet west of the southeast corner sec. 34, T. 22 S., R. 22 W., in native range:

A11—0 to 8 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; noncalcareous, neutral; gradual, smooth boundary.

A12—8 to 22 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; calcareous; mildly alkaline; gradual, smooth boundary.

B2—22 to 42 inches, grayish-brown (10YR 5/2) light silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; worm casts; calcareous; mildly alkaline; gradual, smooth boundary.

C—42 to 60 inches, light brownish-gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; few films of lime; calcareous; moderately alkaline.

The thickness of the solum ranges from 25 to 45 inches. The depth to lime is less than 12 inches. The texture of the A and B horizons ranges from silt loam to light silty clay loam. Colors of grayish brown or darker extend to a depth of more than 20 inches.

Roxbury soils are near Bridgeport, Hord, Detroit, and Ness soils. In contrast with Bridgeport soils, they have a B horizon and are dark colored to a greater depth. They are not so deeply leached of lime as Hord and Detroit soils. They are less clayey in the B horizon than Detroit soils. They are thinner and less clayey in the A horizon than Ness soils, and they are better drained.

**Roxbury silt loam** (0 to 1 percent slopes) (Rx).—This soil has the profile described as representative for the Roxbury series. It occupies low terraces about 15 to 25 feet higher than the streambed.

Included in mapping were small areas of Bridgeport, Detroit, and Hord soils. Small areas, less than 5 acres in size, of clay spots are indicated by spot symbols on the soil map.

Wheat and sorghum are the principal crops. Alfalfa is also grown (fig. 10). Inadequate rainfall is the main limitation. Conserving moisture and controlling soil blowing are major concerns in management. In some places this soil receives runoff from adjacent areas. Capability unit IIc-2, dryland; capability unit I-1, irrigated; Loamy Terrace range site; Deep Loamy Lowland windbreak group.

**Roxbury and Bridgeport soils, channeled** (0 to 2 percent slopes) (Ry).—This mapping unit is about 45 percent Roxbury soils, 35 percent Bridgeport soils, and 10 percent stream channels. These soils occupy flood plains that are cut by narrow, meandering channels of local intermittent streams. Areas are more than 150 feet wide and are generally bordered by soils that have slopes of more than 6 percent. In areas where both soils are represented, the Bridgeport soil occupies a slightly lower position next to the stream channel. Some areas are entirely Roxbury soils, and some entirely Bridgeport soils.

Roxbury and Bridgeport soils are similar to those described as representative for their respective series, except that they are more distinctly stratified and their surface layer is silt loam or silty clay loam.

Included in mapping were small areas of sandy soils that generally are associated with the Otero gravelly complex.

These soils are suited to wheat and sorghum. They are well suited to native grasses. In places, they are inaccessible because of uncrossable stream channels or nonarable adjacent slopes. Frequent flooding is the major hazard. Soil blowing is a hazard if the soils are left bare. Capability unit IIIw-1, dryland; no irrigated capability unit; Loamy Lowland range site; Deep Loamy Lowland windbreak group.

**Roxbury silty clay loam, 2 to 5 percent slopes** (Rz).—This soil has a somewhat thinner surface layer and a texture of silty clay loam, but otherwise its profile is similar to that described as representative for the Roxbury series. It is generally on foot slopes below outcrops of caliche and chalky shale.

Included in mapping were small areas of Kim and Penden soils, and soils underlain by calcareous sandstone and clay shale at a depth of about 40 inches. Small areas of rock outcrops, less than 5 acres in size, are indicated by spot symbols on the soil map.

This Roxbury soil is well suited to wheat and sorghum, except in limy areas. Sorghum is highly susceptible to chlorosis in the high lime spots. Controlling water erosion

*Figure 10.*—**Alfalfa in a floodway on Roxbury silt loam. Water from the adjacent upland is spread out to help irrigate this area.**

and soil blowing is the major concern in management. Unless protected, the surface of this soil tends to seal when wet and to form a crust when dry. Capability unit IIe–2, dryland; capability unit IIe–1, irrigated; Loamy Upland range site; Deep Loamy Upland windbreak group.

## Spearville Series

The Spearville series consists of deep, well drained and moderately well drained soils on uplands. Slopes are dominantly less than 1 percent but range to 3 percent. These soils formed in loess.

In a representative profile the surface layer is 7 inches of grayish-brown silty clay loam. The subsoil is about 18 inches thick. The upper 11 inches is grayish-brown, very firm silty clay, and the lower 7 inches is light brownish-gray, firm, calcareous heavy silty clay loam that contains a few lime concretions. The underlying material, to a depth of 60 inches, is pale-brown heavy silt loam and contains a few lime concretions.

Spearville soils have high available water capacity, high fertility, and slow permeability.

Representative profile of Spearville silty clay loam, 0 to 1 percent slopes, 290 feet east and 800 feet north of the southwest corner of sec. 13, T. 23 S., R. 26 W., in a cultivated field:

Ap—0 to 7 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; noncalcareous; neutral; abrupt, smooth boundary

B2t—7 to 18 inches, grayish-brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) when moist; moderate, fine and medium, blocky structure; very hard when dry, very firm when moist; noncalcareous; mildly alkaline; gradual, smooth boundary.

B3ca—18 to 25 inches, light brownish-gray (10YR 6/2) heavy silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate, fine, subangular blocky structure grading to massive; hard when dry, firm when moist; few lime concretions; calcareous; moderately alkaline; gradual, smooth boundary.

C—25 to 60 inches, pale-brown (10YR 6/3) heavy silt loam, becoming slightly less clayey with increasing depth, brown (10YR 5/3) when moist; massive; slightly hard when dry, friable when moist; few small lime concretions; calcareous; moderately alkaline.

The thickness of the solum ranges from 20 to about 40 inches. The depth to lime averages about 18 inches but ranges from 15 to 22 inches. The A horizon ranges from 5 to 10 inches in thickness. Colors of grayish brown or darker extend to a depth of 10 to 20 inches.

Spearville soils are near Harney, Ness, Ost, and Richfield soils. They differ from Ost and Richfield soils in having a more clayey B horizon. They have a thinner transition between the Ap horizon and the B2t horizon than Harney soils. They have a thinner, less clayey A horizon than Ness soils, and they are better drained.

**Spearville silty clay loam, 0 to 1 percent slopes** (Sp).—This soil has the profile described as representative for the Spearville series. It occupies the tableland. Slopes are slightly concave or convex.

Included in mapping were small areas of Harney and Richfield soils. Small areas, less than 5 acres in size, of limy spots and clay spots are indicated by spot symbols on the soil map.

This Spearville soil is well suited to wheat and sorghum if the moisture reserve is high. It is better suited to wheat than to sorghum because the clayey subsoil is likely to be hard and dry in summer, when sorghum needs the most water. Conserving moisture, controlling soil blowing, preserving structure, and keeping the surface layer in good tilth are concerns in management. Unless protected, the surface of this soil tends to seal when wet and to form a crust when dry. Capability unit IIs–1, dryland; capability unit IIs–1, irrigated; Clay Upland range site; Deep Loamy Upland with Clayey Subsoil windbreak group.

**Spearville complex, 1 to 3 percent slopes, eroded** (Sr).—This mapping unit is about 70 percent moderately eroded Spearville soils, 20 percent slightly eroded Spearville soils, and 10 percent eroded, calcareous clay loams. Slopes are convex.

The moderately eroded Spearville soil has a surface layer of heavy silty clay loam or light silty clay and is shallower over lime than is appropriate to the range defined for the Spearville series. These differences, however, do not significantly alter the use or behavior of the soils. Erosion has removed most or all of the original surface layer from this soil. The present surface layer is a mixture of the original material and part of the subsoil. The slightly eroded Spearville soil has a profile similar to the profile described as representative for the Spearville series. The eroded, calcareous clay loams have a surface layer about 10 inches thick that contains lime concretions. The underlying material is pale-brown silty clay loam that becomes slightly less clayey with increasing depth.

These somewhat droughty soils are better suited to wheat than to sorghum. Controlling soil blowing and water erosion is the major concern in management. Unless protected, the surface of these soils tends to seal when wet and to form a crust when dry. Capability unit IIIe–3, dryland; no irrigated capability unit; Clay Upland range site; Deep Loamy Upland with Clayey Subsoil windbreak group.

## Uly Series

The Uly series consists of deep, well-drained soils on uplands. These soils have slopes of 1 to 6 percent. They formed in loess.

In a representative profile the surface layer is 8 inches of grayish-brown heavy silt loam. The upper 5 inches is noncalcareous. The subsoil is 9 inches of grayish-brown, friable, calcareous light silty clay loam. The underlying material, to a depth of 60 inches, is 4 inches of pale-brown, calcareous light silty clay loam over very pale brown, calcareous heavy silt loam.

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

Representative profile of Uly silt loam, 3 to 6 percent slopes, 1,460 feet east and 2,700 feet south of the northwest corner sec. 28, T. 21 S., R. 25 W., in native range:

A1—0 to 8 inches, grayish-brown (10YR 5/2) heavy silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; upper 5 inches noncalcareous; mildly alkaline; gradual, smooth boundary.

B2—8 to 17 inches, grayish-brown (10YR 5/2) light silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; calcareous; moderately alkaline; gradual, smooth boundary.

C1—17 to 21 inches, pale-brown (10YR 6/3) light silty clay loam, brown (10YR 5/3) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; worm casts; calcareous; moderately alkaline; gradual, smooth boundary.

C2—21 to 60 inches, very pale brown (10YR 7/3) heavy silt loam, brown (10YR 5/3) when moist; massive; slightly hard when dry, friable when moist; calcareous; moderately alkaline.

The depth to lime ranges from 0 to 15 inches. The A horizon ranges from 6 to 12 inches in thickness. Colors of grayish brown or darker extend to a depth of 8 to 15 inches. The loess mantle is thin in some areas, and outwash material is below a depth of 40 inches.

Uly soils are near Campus, Coly, Kim, Penden, Richfield, and Wakeen soils. They are deeper than Campus and Wakeen soils. They lack the strong zone of lime accumulation that is typical of Campus soils. In contrast with Coly, Kim, and Penden soils, they have a B horizon. They have a thicker A horizon than Coly soils and are dark colored to a greater depth. They are more silty and less sandy in all horizons below the A horizon than Kim and Penden soils. They differ from Richfield soils in having a less clayey B horizon.

**Uly silt loam, 1 to 3 percent slopes** (Ub).—This soil has a surface layer about 10 inches thick. Otherwise, its profile is similar to that described as representative for the Uly series. Slopes are slightly convex.

Included in mapping were small areas of Coly, Harney, Richfield, and Penden soils. Small areas, less than 5 acres in size, of rock outcrops are indicated by spot symbols on the soil map.

This Uly soil is well suited to wheat and sorghum. Controlling water erosion and soil blowing is the major concern in management. Unless protected, the surface of this soil tends to seal when wet and to form a crust when dry. Capability unit IIe–2, dryland; capability unit IIe–1, irrigated; Loamy Upland range site; Deep Loamy Upland windbreak group.

**Uly silt loam, 3 to 6 percent slopes** (Uc).—This soil has the profile described as representative for the Uly series. It is mainly on the sides of drainageways. Slopes are slightly convex.

Included in mapping were small areas of Coly, Penden, and Harney soils. Small areas, less than 5 acres in size, of rock outcrops are indicated by spot symbols on the soil map.

Wheat and sorghum are the main crops. Controlling water erosion and soil blowing is the major concern in management. Unless protected, the surface of this soil tends to seal when wet and to form a crust when dry. Capability unit IIIe-4, dryland; no irrigated capability unit; Loamy Upland range site; Deep Loamy Upland windbreak group.

**Uly-Coly silt loams, 3 to 6 percent slopes, eroded** (Um).—This mapping unit is about 60 percent Uly soil and 30 percent Coly soil. These soils are mainly on the sides of drainageways. Slopes are slightly convex. In much of the acreage, erosion has removed most or all of the original surface layer from these soils. The present surface layer is a mixture of the original material and part of the subsoil.

Uly and Coly soils are similar to those described as representative for their respective series, except the surface layer of the Uly soil is about 6 inches thick. The Coly soil is lighter colored and more eroded than the Uly soil.

Included in mapping were small areas of Kim and Penden soils.

All the acreage is cultivated, or has been cultivated. Wheat and sorghum are the principal crops. Controlling further water erosion and soil blowing is the major concern in management. Unless protected, the surface of these soils tends to seal when wet and to form a crust when dry. Capability unit IVe-1, dryland; no irrigated capability unit; Limy Upland range site; Deep Loamy Upland windbreak group.

## Wakeen Series

The Wakeen series consists of moderately deep, well-drained, calcareous soils of the uplands. These soils have slopes of 1 to 12 percent. They formed in chalky shale and interbedded limestone, modified in the upper part by loess.

In a representative profile the surface layer is about 10 inches of dark grayish-brown heavy silt loam. The subsoil is 10 inches of grayish-brown, friable silty clay loam that contains a few chalk fragments. The underlying material is light-gray, firm clay loam and contains a few fragments of limestone and chalk. At a depth of about 28 inches is very pale brown, unconsolidated, earthy, impure chalky shale.

Wakeen soils have low available water capacity, medium fertility, and moderate permeability.

Representative profile of Wakeen silt loam, 3 to 6 percent slopes, 160 feet south and 1,700 feet west of the northeast corner sec. 30, T. 21 S., R. 21 W., in native range:

A1—0 to 10 inches, dark grayish-brown (10YR 4/2) heavy silt loam, very dark brown (10YR 2/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; calcareous; moderately alkaline; gradual, smooth boundary.

B2—10 to 20 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; many worm casts; few chalk fragments; calcareous; moderately alkaline; gradual, smooth boundary.

C1—20 to 28 inches, light-gray (10YR 7/2) clay loam, brown (10YR 5/3) when moist; weak, fine, granular structure; hard when dry, firm when moist; few limestone and chalk fragments; calcareous; moderately alkaline; gradual, smooth boundary.

C2—28 inches, very pale brown (10YR 8/4) unconsolidated, earthy, impure chalky shale.

The depth to chalky shale ranges from 20 to 40 inches. The A horizon ranges from 7 to 12 inches in thickness and from silt loam to light silty clay loam in texture. Colors of grayish brown or darker extend to a depth of 7 to 18 inches. In most places, these soils are calcareous throughout the profile.

Wakeen soils are near Campus, Canlon, Kipson, Penden, and Uly soils. They lack the strong zone of lime accumulation that is typical of Campus soils. In contrast with Campus and Canlon soils, they overlie chalky shale instead of semiconsolidated caliche. They are deeper than Canlon and Kipson soils. They are shallower than Penden and Uly soils.

**Wakeen silt loam, 1 to 3 percent slopes** (Wa).—The surface layer of this soil is about 11 inches thick, but otherwise the profile is similar to that described as representative for the Wakeen series. Slopes are slightly concave to convex.

Included in mapping were small areas of Harney and Penden soils. Small areas of rock outcrops, less than 5 acres in size, are indicated by spot symbols on the soil map.

This Wakeen soil is suited to wheat and sorghum, except in limy areas. Sorghum, especially, is susceptible to chlorosis in areas that have a large amount of lime in the root zone. Controlling water erosion and soil blowing is the major concern in management. Unless protected, the surface of this soil tends to seal when wet and to form a crust when dry. Capability unit IIIe-2, dryland; no irrigated capability unit; Limy Upland range site; Moderately Deep Loamy Upland windbreak group.

**Wakeen silt loam, 3 to 6 percent slopes** (Wb).—This soil has the profile described as representative for the Wakeen series. Slopes are slightly concave to convex. Included in mapping were small areas of Kipson, Penden, and Uly soils. Small areas of rock outcrops, less than 5 acres in size, are indicated by spot symbols on the soil map.

Wheat and sorghum are the main crops. Sorghum is highly susceptible to chlorosis in high lime areas. Controlling water erosion and soil blowing is the major concern in management. Unless protected, the surface of this soil tends to seal when wet and to form a crust when dry. Capability unit IVe-1, dryland; no irrigated capability unit; Limy Upland range site; Moderately Deep Loamy Upland windbreak group.

# *Use and Management of the Soils*

The soils of Hodgeman County are used for both dryland and irrigated crops. This section tells how the soils can be managed for these purposes. It explains the capability classification used by the Soil Conservation Service, describes management for each soil in the county by capability unit, and shows predicted yields for the principal dryland crops grown on arable soils under high level management. This section also suggests management in the use of the soils for range, windbreaks, and wildlife habitat.

## Capability Grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The groups are made according to the limitations of the soils when used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to horticultural crops or other crops requiring special management.

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

In the capability system, all kinds of soil are grouped at three levels: the capability class, the subclass, and the unit. These levels are described in the following paragraphs.

Capability Classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

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

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

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

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

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture or range, woodland, or wildlife habitat. (No class V soils in Hodgeman County.)

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

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

Class VIII soils and landforms have limitations that preclude their use for commercial crop production and restrict their use to recreation, wildlife habitat, or water supply, or to esthetic purposes. (No class VIII soils in Hodgeman County.)

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

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

Capability Units are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-1 or IIIe-4. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

## Management of Dryland Soils

The soils of Hodgeman County originally were covered by native grasses. Grass roots penetrated the soil material and contributed to the desirable granular structure that formed. The grass cover also helped in holding the soil material in place and in protecting the surface from strong winds and beating rains. There was only geologic erosion, and it occurred at a natural, gradual rate.

Cultivation reduced the amount of organic matter in the soils, and their structure and tilth deteriorated. As a result of poor tilth and management that left the surface unprotected, the soils became susceptible to water erosion and soil blowing.

Management is needed to restore organic matter, maintain fertility and tilth, and reduce the hazard of erosion. Each soil should be suited to the crop grown and the intended use.

Cropping and management that protect the soil surface at all times are essential. Maintaining a growing crop or a cover of crop residue increases permeability and improves soil structure and tilth. Stubble mulching, limited grazing, and minimum tillage help in maintaining a cover of crop residue. Contour farming, terracing, stripcropping, or grass waterways, or a combination of these practices, help in conserving moisture and reducing the risk of erosion.

Low rainfall limits the choice of dryland crops. Winter wheat and grain sorghum are the two principal crops grown. Summer fallow is commonly used to store moisture for crops grown the following season.

### *Management by capability unit*

Use and management of the soils under dryland farming are suggested, by capability unit, in the pages that follow. The names of the soil series represented are mentioned in the description of each unit, but this does not mean that all the soils of a given series are in the unit. The capability unit designation for each soil in the county can be found in the "Guide to Mapping Units."

#### CAPABILITY UNIT IIe-1, DRYLAND

This unit consists of deep, well-drained soils of the Harney and Richfield series. These soils have slopes of 1 to 3 percent. They formed in loess. The surface layer is silt loam. Available water capacity and fertility are high. Permeability is moderately slow.

These soils are suited to wheat and sorghum. They are well suited to native grasses.

Controlling water erosion and soil blowing is the major concern in management. Unless protected, the surface of these soils tends to seal when wet and to form a crust when dry.

Managing crop residue, terracing (fig. 11), stripcropping, and farming on the contour help in controlling runoff and erosion and in conserving moisture. Management should also include the selection of suitable crops and the use of a flexible cropping system. Grazing of crop residue should be limited so that enough stubble is left to protect the soils.

#### CAPABILITY UNIT IIe-2, DRYLAND

This unit consists of deep, well-drained soils of the Penden, Roxbury, and Uly series. Penden and Uly soils have slopes of 1 to 3 percent, and Roxbury soils slopes of 2 to 5 percent. These soils formed in loess, outwash, or alluvium. The surface layer is silt loam or silty clay loam. Available water capacity and fertility are high. Permeability is moderate or moderately slow.

These soils are suited to wheat and sorghum. They are well suited to native grasses.

Controlling water erosion and soil blowing is the major concern in management. Unless protected, the surface of these soils tends to seal when wet and to form a crust when dry.

Managing crop residue, terracing, stripcropping, and farming on the contour help in controlling runoff and erosion and in conserving moisture. Management should also include the selection of suitable crops and the use of a flexible cropping system. Grazing of crop residue should be limited so that enough stubble is left to protect the soil.

#### CAPABILITY UNIT IIe-3, DRYLAND

Harney silty clay loam, 1 to 3 percent slopes, eroded, is the only soil in this unit. It is a deep, well-drained soil that formed in loess. The surface layer is silty clay loam. Erosion has removed part or all of the original surface layer. The present surface layer is a mixture of the original material and material from the subsoil. Available water capacity and fertility are high. Permeability is moderately slow.

*Figure 11.*—Newly constructed terrace on Richfield silt loam, 1 to 3 percent slopes.

This soil is well suited to wheat, sorghum, and native grasses.

Controlling further water erosion and soil blowing is the major concern in management. Unless protected, the surface of this soil tends to seal when wet and to form a crust when dry.

Managing crop residue, terracing, stripcropping, and farming on the contour help in controlling runoff and erosion and in conserving moisture. Management should also include the selection of suitable crops and the use of a flexible cropping system. Grazing of crop residue should be limited so that enough stubble is left to protect the soil.

#### CAPABILITY UNIT IIs-1, DRYLAND

Spearville silty clay loam, 0 to 1 percent slopes, is the only soil in this unit. This is a deep, well drained or moderately well drained soil that formed in loess. The surface layer is silty clay loam. Available water capacity and fertility are high. Permeability is slow.

Although the available water capacity is high, this soil has a clayey subsoil that takes water slowly and releases it slowly to plants. Conserving moisture and controlling wind erosion are other concerns. Unless protected, the surface of this soil tends to seal when wet and to form a crust when dry.

Management of crop residue improves water infiltration, prevents crusting of the surface, helps control erosion, and improves tilth. Management should also include a flexible cropping system and summmer fallow. Other effective practices are terracing, contour farming, and stripcropping. Because of its clayey subsoil, this soil is better suited to wheat than to sorghum. It is well suited to native grasses.

#### CAPABILITY UNIT IIc-1, DRYLAND

This unit consists of deep, well-drained soils of the Harney, Ost, Penden, and Richfield series. Slopes are 1 percent or less. These soils formed in loess or outwash material. The surface layer is silt loam or silty clay loam. Available water capacity and fertility are high. Permeability is moderate or moderately slow.

These soils are suited to wheat and sorghum. They are well suited to native grasses.

Inadequate rainfall is the main limitation. Conserving moisture and controlling soil blowing are concerns in management. Water erosion is a hazard on long slopes. Unless protected, the surface of these soils tends to seal when wet and to form a crust when dry.

Management of crop residue improves water infiltration, prevents crusting, and helps control erosion. Good management also includes the selection of suitable crops and the use of a flexible cropping system. Other effective practices that are especially needed on long slopes are terracing, contour farming, and stripcropping.

#### CAPABILITY UNIT IIc-2, DRYLAND

This unit consists of deep, well drained and moderately well drained soils of the Bridgeport, Detroit, Hord, and Roxbury series. Slopes are 1 percent or less. These soils formed in alluvium. The surface layer is silt loam or silty clay loam. Available water capacity and fertility are high. Permeability is moderate or slow.

These soils are suited to wheat, sorghum, alfalfa, and native grasses. Wheat and sorghum are the main crops. Grass seed is harvested in some places (fig. 12).

Inadequate rainfall is the main limitation. Conserving moisture and controlling soil blowing are major concerns in management. In places these soils receive runoff from adjacent areas.

Stripcropping and management of crop residue improve the capacity of the soils to take in moisture and help to control erosion. Contour farming and terracing are also desirable if the site is suitable. Good management also includes the selection of suitable crops and the use of a flexible cropping system.

#### CAPABILITY UNIT IIIe-1, DRYLAND

Harney silt loam, 3 to 5 percent slopes, is the only soil in this unit. It is a deep, well-drained soil that formed in loess. The surface layer is silt loam. Available water capacity and fertility are high. Permeability is moderately slow.

The soil is well suited to wheat, sorghum, and native grasses. Controlling water erosion and soil blowing is the major concern in management. Unless protected, the surface of this soil tends to seal when wet and to form a crust when dry.

Managing crop residue, terracing, stripcropping, and farming on the contour help in controlling runoff and erosion and conserving moisture. Management should also include the selection of suitable crops and the use of a flexible cropping system. Grazing of crop residue should be limited so that enough stubble is left to protect the soil.

#### CAPABILITY UNIT IIIe-2, DRYLAND

This unit consists of soils of the Penden, Campus, and Wakeen series. The slope gradient is 1 to 4 percent. These are deep or moderately deep, well-drained soils that formed in outwash, semiconsolidated caliche, or chalky shale. The surface layer is silt loam or clay loam. Available water capacity is low, fertility is medium, and permeability is moderate in the Campus and Wakeen soils. In the Penden soils, available water capacity and fertility are high and permeability is moderate or moderately slow.

These soils are suited to wheat and sorghum. They are well suited to native grasses. Controlling water erosion and soil blowing is the major concern in management. Unless protected, the surface of these soils tends to seal when wet and to form a crust when dry.

Managing crop residue, terracing, stripcropping, and farming on the contour help in controlling runoff and erosion and in conserving moisture. Good management also includes the selection of suitable crops and the use of a flexible cropping system. Grazing of crop residue should be limited so that enough stubble is left to protect the soils.

#### CAPABILITY UNIT IIIe-3, DRYLAND

Only Spearville complex, 1 to 3 percent slopes, eroded, is in this unit. It is a deep, well drained or moderately well drained soil that formed in loess. The surface layer is silty clay loam or light silty clay. Erosion has removed most or all of the original surface layer. The present surface layer is a mixture of the original material and material from the subsoil. Available water capacity and fertility are high. Permeability is slow.

Because the subsoil is clayey, this soil is better suited to wheat than to sorghum. It is well suited to native grasses. Controlling water erosion and soil blowing is the major concern in management. Unless protected, the surface of

*Figure 12.*—**Harvest of western wheatgrass on Detroit silty clay loam. Estimated yield of seed is 150 to 200 pounds per acre.**

this soil tends to seal when wet and to form a crust when dry.

Managing crop residue, terracing, stripcropping, and farming on the contour help to control erosion, improve the capacity of this soil to take in moisture, and help to prevent crusting of the surface. Good management should also include a flexible cropping system and summer fallow.

Grazing of crop residue should be limited so that enough stubble is left to protect the soil.

#### CAPABILITY UNIT IIIe-4, DRYLAND

This unit consists of deep, well-drained soils of the Penden and Uly series. These soils have slopes of 3 to 6 percent. They formed in loess or outwash. The surface layer is silt loam or silty clay loam. Available water capacity and fertility are high. Permeability is moderate or moderately slow.

These soils are suited to wheat and sorghum. They are well suited to native grasses. Controlling water erosion and soil blowing is the major concern in management. Unless protected, the surface of these soils tends to seal when wet and to form a crust when dry.

Managing crop residue, terracing, stripcropping, and farming on the contour help in controlling runoff and erosion and conserving moisture. Management should also include the selection of suitable crops and the use of a flexible cropping system. Grazing of crop residue should be limited so that enough stubble is left to protect the soil.

#### CAPABILITY UNIT IIIe-5, DRYLAND

This unit consists of deep, well-drained, eroded soils of the Harney and Richfield series. Harney soils have slopes of 3 to 5 percent, and Richfield soils slopes of 2 to 5 percent. These soils formed in loess. The surface layer is silty clay loam. Erosion has removed part or all of the original surface layer. The present surface layer is a mixture of the original material and material from the subsoil. Available water capacity and fertility are high. Permeability is moderately slow.

These soils are suited to wheat and sorghum. They are well suited to native grasses. Controlling further water erosion and soil blowing is the major concern in management. Unless protected, the surface of these soils tends to seal when wet and to form a crust when dry.

Managing crop residue, terracing, stripcropping, and farming on the contour help in controlling runoff and erosion and in conserving moisture. Management should also include the selection of suitable crops and the use of a flexible cropping system. Grazing of crop residue should be limited so that enough stubble is left to protect the soil.

#### CAPABILITY UNIT IIIw-1, DRYLAND

Roxbury and Bridgeport soils, channeled, are the only soils in this unit. These are deep, well drained or moderately well drained soils that formed in alluvium. They occupy flood plains of intermittent upland streams. Slopes are 2 percent or less. The surface layer is silt loam or silty clay loam. Available water capacity and fertility are high. Permeability is moderate.

These soils are suited to wheat and sorghum. They are well suited to native grasses.

The soils are subject to frequent flooding. In some years floods only slightly damage crops and soils, but in other years they seriously damage crops and deposit sediment on the soils. Soil blowing is a hazard if these soils are left bare. In some places meandering, uncrossable stream channels or nonarable, adjacent slopes make these soils inaccessible.

Management of crop residue is most effective in improving water infiltration and controlling erosion. Management should also include the selection of suitable crops and the use of a flexible cropping system. Conservation measures in adjacent areas reduce the amount of runoff these soils receive.

#### CAPABILITY UNIT IVe-1, DRYLAND

This unit consists of deep or moderately deep, well-drained soils of the Coly, Kim, Penden, Uly, and Wakeen series. These soils have slopes of 3 to 6 percent. They formed in loess, outwash, or chalky shale. The surface layer is silt loam or silty clay loam. Permeability is moderate or moderately slow. Available water capacity is high, and fertility is medium or high in all but the moderately deep Wakeen soil. This soil has low available water capacity and medium fertility. The Coly, Kim, Penden, and Uly soils are eroded.

These soils are better suited to native grasses than to cultivated crops, but if well managed, they can be cultivated. Wheat and sorghum are the main crops.

Controlling water erosion and soil blowing is the major concern in management. Careful management is needed in eroded areas to prevent further erosion and deterioration. Unless protected, the surface of these soils tends to seal when wet and to form a crust when dry.

Managing crop residue, terracing, stripcropping, and farming on the contour help in controlling runoff and erosion and in conserving moisture. Management should also include the selection of suitable crops and the use of a flexible cropping system. Grazing of crop residue should be limited so that enough stubble is left to protect the soil.

#### CAPABILITY UNIT VIe-1, DRYLAND

Only the Penden complex is in this unit. It consists of deep, well-drained soils that formed in outwash material or alluvium. These soils occupy the sides and the narrow bottom land of drainageways. Penden soils are on the sides and have slopes of 6 to 12 percent. The loamy soils are in the bottoms and have slopes of 0 to 2 percent. The surface layer is silty clay loam. Available water capacity and fertility are high. Permeability is moderate or moderately slow.

These soils are best suited to range. They are not suited to cultivation. On the sides of drainageways, they are highly susceptible to erosion. On narrow bottom land, they are subject to frequent flooding.

Grazing of the range should be managed to encourage growth of the best native forage. A proper stocking rate and deferred grazing or rotation deferred grazing are essential. The distribution of livestock depends on the location of fences, salt, and watering places.

#### CAPABILITY UNIT VIe-2, DRYLAND

This unit consists of soils of the Campus, Canlon, Kipson, and Wakeen series. These soils are very shallow, shallow, or moderately deep and well drained or somewhat excessively drained. Slopes range from 3 to 30 percent. These soils formed in chalky shale or semiconsolidated caliche. The surface layer is loam or silt loam. Available water capacity is low or very low, and fertility is medium or low. Permeability is moderate. Outcrops of caliche or chalky shale are common.

These soils are best suited to range. Erosion is a severe hazard in areas bare of native vegetation. The limited root zone and low to very low available water capacity are concerns in management.

Grazing of the range should be managed to encourage growth of the best native forage. A proper stocking rate and deferred grazing or rotation deferred grazing are essential. The distribution of livestock depends on the location of fences, salt, and watering places. If revegetation is necessary, native grasses should be seeded.

#### CAPABILITY UNIT VIe-3, DRYLAND

Only Otero gravelly complex is in this unit. It consists of well drained to somewhat excessively drained soils that are underlain by sand at a depth of about 30 inches. These soils formed in sandy calcareous outwash material. They occupy sides of drainageways and have slopes of 6 to 12 percent. Available water capacity is low, and fertility is medium to low. Permeability is moderately rapid.

These soils are best suited to range. Erosion is a severe hazard in areas bare of native grasses. The low available water capacity and gravelly soil are concerns in management.

Grazing of the range should be managed to encourage growth of the best native forage. A proper stocking rate and deferred grazing or rotation deferred grazing are essential. The distribution of livestock depends on the location of fences, salt, and watering places.

#### CAPABILITY UNIT VIw-1, DRYLAND

Ness clay is the only soil in this unit. This is a deep, poorly drained soil that formed in loess or clayey alluvium. It occupies depressions in the uplands and valleys. The surface layer is clay about 31 inches thick. Available water capacity and fertility are high. Permeability is very slow.

This soil receives runoff from surrounding areas. It is frequently ponded and too wet for planting. Crops are frequently drowned out. Soil blowing is a hazard in areas where this soil is dry and unprotected.

Ness clay is generally managed in the same way as the surrounding soils. Conserving moisture and controlling erosion on the surrounding areas help in reducing the amount of runoff received by this soil. In some places surface drainage is feasible.

#### CAPABILITY UNIT VIIw-1, DRYLAND

Only Broken alluvial land is in this unit. This is deep, loamy soil material on broken banks of creeks and their deeply incised stream channels. Slopes range from 6 to 40 percent. Available water capacity and fertility are high.

These soils are subject to frequent flooding and, in turn, to erosion and deposition of new material. Vegetation is mainly annual weeds, grasses, and trees.

#### CAPABILITY UNIT VIIs-1, DRYLAND

Only Canlon soils and Rough broken land are in this unit. They are shallow, are somewhat excessively drained, and have slopes of 3 to 40 percent. Rock outcrops are common, especially in Rough broken land. Available water capacity is very low and fertility is low.

The slope, rock outcrops, and other soil limitations make these areas best suited to range. Grazing of the range should be managed to encourage growth of the best native forage. A proper stocking rate and deferred grazing or rotation deferred grazing are essential. The distribution of livestock depends on the location of fences, salt, and watering places.

### *Predicted yields*

Table 2 gives predicted average yields per acre of wheat and grain sorghum for the soils of the county suitable for cultivation. The yields shown in table 2 are those to be expected under a high level of management. Information on which to base precise estimates is limited because no long-term, accurate records are available. Yields fluctuate greatly, mainly as the result of differences in the amount of precipitation. Estimates of yields were based on information obtained from farmers, from branches of the Kansas Agricultural Experiment Station, and on observations of the soil survey party and other agricultural workers.

High level management consists of practices that help in conserving moisture and protecting the soil from erosion. Among these practices are a flexible cropping system that is based on the depth to moisture, seeding rates that are recommended, and other practices, including residue management, terracing, stripcropping and contour tillage, and fallow.

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

[Only the soils suited to cultivation are listed. Yields of wheat reflect the use of summer fallow]

| Soil | Wheat | Sorghum |
|---|---|---|
| | *Bu.* | *Bu.* |
| Bridgeport silt loam, 0 to 1 percent slopes | 25 | 39 |
| Detroit silty clay loam | 26 | 38 |
| Harney silt loam, 0 to 1 percent slopes | 26 | 42 |
| Harney silt loam, 1 to 3 percent slopes | 24 | 38 |
| Harney silt loam, 3 to 5 percent slopes | 22 | 36 |
| Harney silty clay loam, 1 to 3 percent slopes, eroded | 21 | 34 |
| Harney silty clay loam, 3 to 5 percent slopes, eroded | 20 | 32 |
| Hord silty clay loam | 27 | 44 |
| Kim-Penden silty clay loams, 3 to 6 percent slopes, eroded | 16 | 23 |
| Ost silt loam, 0 to 1 percent slopes | 24 | 37 |
| Penden silty clay loam, 0 to 1 percent slopes | 23 | 32 |
| Penden silty clay loam, 1 to 3 percent slopes | 21 | 27 |
| Penden silty clay loam, 3 to 6 percent slopes | 19 | 25 |
| Penden-Campus clay loams, 1 to 4 percent slopes | 19 | 26 |
| Richfield silt loam, 0 to 1 percent slopes | 24 | 37 |
| Richfield silt loam, 1 to 3 percent slopes | 22 | 35 |
| Richfield silty clay loam, 2 to 5 percent slopes, eroded | 19 | 30 |
| Roxbury silt loam | 27 | 40 |
| Roxbury silty clay loam, 2 to 5 percent slopes | 23 | 33 |
| Roxbury and Bridgeport soils, channeled | 22 | 34 |
| Spearville silty clay loam, 0 to 1 percent slopes | 23 | 35 |
| Spearville complex, 1 to 3 percent slopes, eroded | 20 | 27 |
| Uly silt loam, 1 to 3 percent slopes | 22 | 34 |
| Uly silt loam, 3 to 6 percent slopes | 20 | 32 |
| Uly-Coly silt loams, 3 to 6 percent slopes, eroded | 17 | 29 |
| Wakeen silt loam, 1 to 3 percent slopes | 19 | 32 |
| Wakeen silt loam, 3 to 6 percent slopes | 17 | 25 |

## Management of Irrigated Soils

About 9,000 acres of Hodgeman County is irrigated. About 500 acres of the cropland irrigated is in the uplands. The rest is in the valleys of the various creeks, mainly east of Jetmore. About 225 wells produce the water for irrigation, 210 of which are drilled in the alluvium in the valleys. The average depth is about 100 feet. The yield is 300 to 1,500 gallons a minute. In a few places water is pumped directly from creeks.

Most farms have both irrigated and dryfarmed acreages. Corn, sorghum, alfalfa, and wheat are the principal crops under irrigation.

The general method of irrigation in Hodgeman County is surface irrigation. The surface is covered with water in a border or basin-type system, or water is conveyed through furrows or corrugations (fig. 13).

The efficiency of the irrigation system is affected by the soil, the topography, and the crop. The design of the system, the degree of land preparation, and the skill and care of the irrigator probably have the greatest influence on the total amount of water used.

Land leveling is usually needed for efficient, uniform application of water, regardless of the irrigation method. It provides greater efficiency in the application of water, insures more uniform distribution of water, and con-

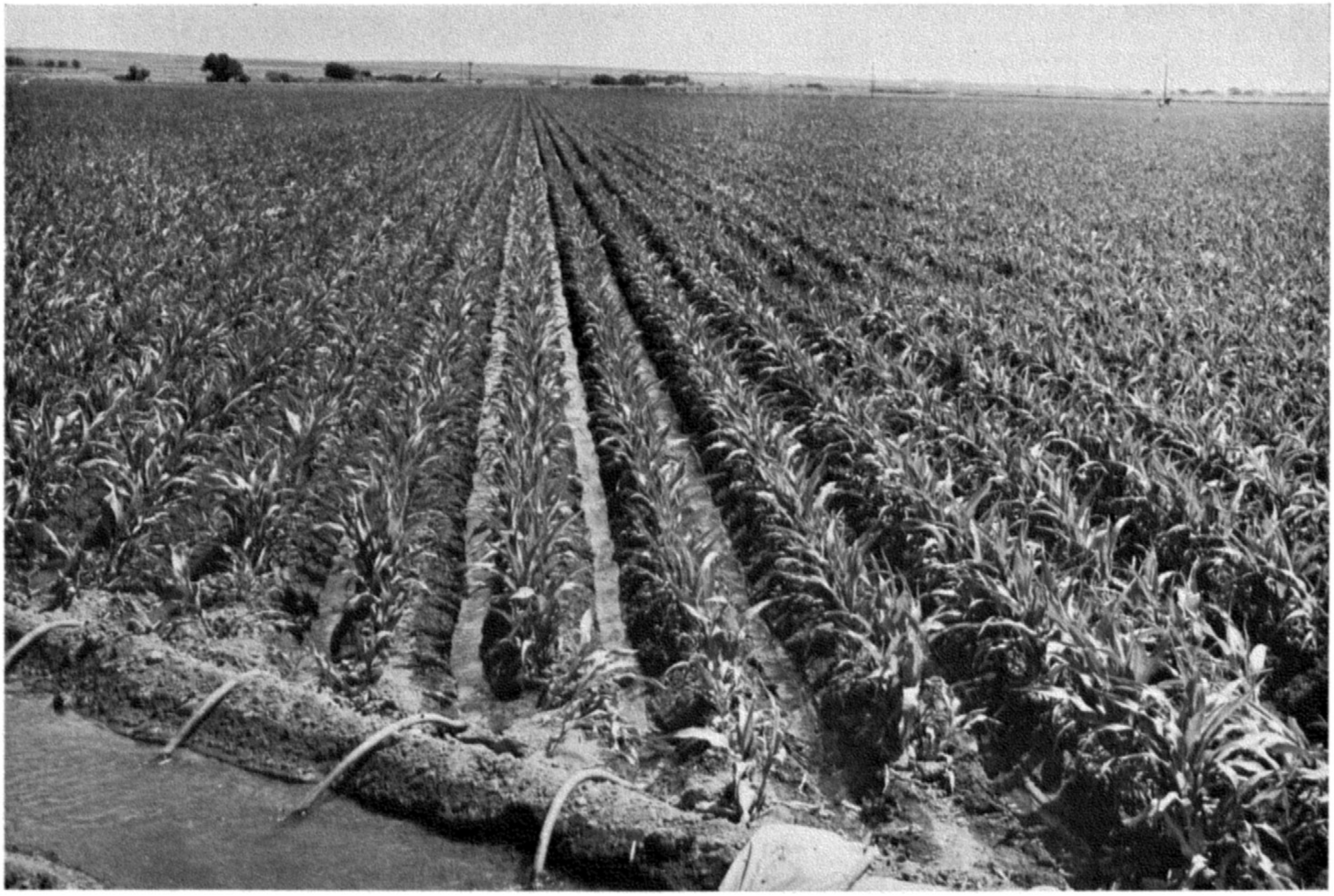

*Figure 13.*—**Furrow irrigation on recently leveled Roxbury silt loam.**

serves soil and water. In some areas land leveling decreases soil productivity by removing valuable topsoil and subsoil. Applying fertilizer and manure in such areas and growing deep-rooted legumes help in restoring productivity.

Drainage is needed along with irrigation to efficiently control water.

The management practices needed to protect irrigated soils are choosing an adequate cropping sequence, leaving crop residue on the surface, adding fertilizer, using sound conservation practices, and using irrigation water efficiently.

A cropping sequence effective in increasing yields and rebuilding and stabilizing soil aggregates should include a sod or legume crop every few years.

Crop residue should be left on the surface to provide a protective cover until a new crop is to be planted, and should then be cultivated under. The residue that is cultivated under improves the structure of the soil, increases the supply of organic matter, and makes the soil easier to work.

The use of commercial fertilizer, particularly nitrogen, has become increasingly important in irrigation management. On some soils other elements, especially phosphorus, are needed. Soil tests and field trials help in determining fertilizer needs.

In some areas contour furrows, drop structures, pipelines, and lined ditches are needed for efficient use of irrigation water. In some, terraces and detention structures are needed to protect irrigated fields against runoff from the uplands.

The following factors should be considered in planning an irrigation system: (1) the suitability of the soil for irrigation, (2) the adequacy, reliability, and quality of the water supply, (3) the control and conveyance of water, (4) the total water requirement, (5) the method of applying water, (6) the preparation of the soil, and (7) the drainage facilities needed to remove excess water.

The irrigated soils of Hodgeman County are deep and have high available water capacity. Most have moderate or moderately slow permeability. Spearville soils have slow permeability.

### *Management by capability unit*

Irrigated crops in Hodgeman County require careful management. This section describes capability units for irrigated soils and gives suggestions on management needed. Soils that are not suitable for irrigation are not considered. For information about irrigation and other associated engineering problems not given in this section, consult a local technician of the Soil Conservation Service.

#### CAPABILITY UNIT I-1, IRRIGATED

This unit consists of deep, well drained and moderately well drained soils of the Bridgeport, Detroit, Harney, Hord, Ost, Penden, Richfield, and Roxbury series. Slopes are mainly 1 percent or less. These soils formed in loess, outwash, or alluvium. The surface layer is silt loam or silty clay loam. Available water capacity and fertility are high. Permeability is moderate, moderately slow, or slow.

Wheat, sorghum, alfalfa, corn, and other adapted crops can be grown under irrigation.

Management that maintains or improves fertility and tilth and conserves irrigation water is needed; for example, including deep-rooted legumes in the cropping sequence, managing crop residue, applying fertilizer as needed, and using irrigation water efficiently. Land leveling is commonly needed.

#### CAPABILITY UNIT IIe-1, IRRIGATED

This unit consists of deep, well-drained soils of the Harney, Penden, Richfield, Roxbury, and Uly series. Roxbury soils have slopes of 2 to 5 percent, and the rest from 1 to 3 percent. These soils formed in loess, outwash, or alluvium. The surface layer is silt loam or silty clay loam. Available water capacity and fertility are high. Permeability is moderate to moderately slow.

Wheat, sorghum, alfalfa, corn, and other adapted crops can be grown under irrigation.

Controlling erosion and using irrigation water efficiently are concerns in management. Management that maintains or improves fertility and tilth is needed; for example, including deep-rooted legumes in the cropping sequence, managing crop residue, and applying fertilizer as needed. Land leveling or contour irrigation minimizes erosion and increases efficiency in use of irrigation water. In places drop structures are needed to help control erosion in the irrigation ditch. Underground pipelines eliminate ditches and reduce the loss of water.

#### CAPABILITY UNIT IIs-1, IRRIGATED

Spearville silty clay loam, 0 to 1 percent slopes, is the only soil in this unit. This is a deep, well drained or moderately well drained soil that formed in loess. The surface layer is silty clay loam. Available water capacity and fertility are high. Permeability is slow.

Under irrigation, this soil is suited to wheat, sorghum, alfalfa, corn, and other adapted crops.

Conserving irrigation water and using it efficiently are concerns in management. This soil takes up water slowly and releases it slowly to plants. Careful management is needed to maintain favorable structure and good tilth and to improve fertility. Working crop residue into the soil and using a cropping sequence that includes deep-rooted legumes are ways to improve tilth. Working organic matter into the surface layer prevents crusting and improves soil-moisture relationships. Land leveling is commonly needed. A disposal system for removing excess irrigation water and runoff is essential.

### *Predicted yields*

Methods of managing irrigated soils vary. Therefore, no predictions of yields from irrigated crops of this county were made. Generally, irrigation farming insures more dependable and higher yields than dryland farming. This increase ranges from 50 to 300 percent above yields obtained under dryland farming. Yields are affected mainly by plant varieties, management, insect damage, and climate.

## Range Management[2]

Native grassland amounts to about 40 percent of the total acreage in Hodgeman County. Most of the rangeland is in the northwestern part, south of Buckner Creek and east of Sawlog Creek. Generally, about half the acreage used as rangeland is suitable for cultivation. Small tracts of rangeland intermingled with larger acreages of cropland and suitable for cultivation occur throughout the county.

Livestock raising is the second largest farm enterprise. Only the growing of wheat and sorghum for grain is more important. Livestock operations consist mostly of the grazing of stockers and feeders. There are several large cowherd operations that use the calves as feeders. Most ranches include cropland that is used for supplemental grazing. Wheat, sudan, and sorghum stubble are the chief crops used for temporary grazing.

The native vegetation is mainly a mixture of mid and short grasses. The more nearly level uplands have a cover of blue grama, buffalograss, side-oats grama, and western wheatgrass. On the rough, broken land, side-oats grama, little bluestem, blue grama, and hairy grama are the principal grasses.

The climate of the county, which is one of extremes, has a marked influence on the production of forage. It is characterized by great fluctuations in precipitation, temperature, humidity, and wind movement. There are often long periods during the growing season when there is little or no rainfall, temperature and wind movement are high, and the relative humidity and available soil moisture are extremely low. Snowfall has little value in replenishing soil moisture on uplands and other exposed areas because most snow cover is swept by high winds into protected places.

Native grasses grow best from May to October. Generally recurrent droughts result in some dormancy in July and August, but if enough moisture is available, the grasses start growing again about the first of September and continue to grow until the first frost. Frequently, early growth is retarded by lack of precipitation in winter and early in spring.

### *Range sites and condition classes*

Range sites are areas of rangeland that differ in their ability to produce different kinds or amounts of native vegetation. The establishment of a range site is based on factors that result in a significant difference in the potential plant community, not on differences in soil or in climate, and it must be great enough to require some change in management, a different rate of stocking, for example. Plants on a native range site are of three main kinds, which respond to grazing in different ways, as explained in the following.

*Decreasers* are species in the potential plant community that tend to decrease in relative amount under

[2] By H. RAY BROWN, range conservationist, Soil Conservation Service.

close grazing. They generally are the tallest and most productive perennial grasses and forbs and the most palatable to livestock.

*Increasers* are species in the potential plant community that increase in relative amount as the more desirable plants are reduced by close grazing. They are commonly shorter than decreasers, and some are less palatable to livestock.

*Invaders* are plants that cannot withstand the competition for moisture, nutrients, and light in the potential plant community. Hence, they invade and grow along with the increasers after the potential vegetation has been reduced by grazing. Many are annual weeds. Some are forbs that have limited grazing value, but others have little value for grazing.

Range condition is the present state of the vegetation compared with that of the potential plant community for the site. The purpose in classifying range condition is to provide an approximate measure of any deterioration that has taken place in the plant cover and thereby provide a basis for predicting the degree of improvement possible. Four condition classes are defined. Range is in *excellent* condition if 76 to 100 percent of the vegetation is characteristic of the climax vegetation on the same site; it is in *good* condition if the percentage is between 51 to 75; in *fair* condition if the percentage is between 26 to 50; and in *poor* condition if the percentage is less than 26.

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

### *Descriptions of range sites*

Most rangeland in Hodgeman County produces approximately one-third to one-half of its potential in kind and amount of forage. Seven range sites are recognized. They are described on the pages that follow. Each description lists the soils and their important characteristics, the composition of the potential plant community, the principal invaders, and estimates of total herbage yields when the site is in excellent condition. Yields are given in air-dry weight, one for favorable years and one for unfavorable years.

The names of the soil series represented are mentioned in the description of each site, but this does not mean that all the soils of a given series are in the site. The range site designation for each soil in the county can be found in the "Guide to Mapping Units."

#### BREAKS RANGE SITE

This site consists of Rough broken land and very shallow and shallow, somewhat excessively drained soils of the Canlon and Kipson series. The landscape is somewhat broken. Slopes range from 3 to 40 percent. The surface layer is loam. The underlying material is caliche, chalky shale, limestone, noncalcareous shale, or sandstone. Barren outcrops of these materials are common. Available water capacity is very low, fertility is low, and permeability is moderate. Water erosion and soil blowing are hazards in unprotected areas.

Decreaser grasses in the potential plant community, such as little bluestem, side-oats grama, big bluestem, switchgrass, and other perennial forbs and grasses, make up at least 65 percent of the total plant composition. Increaser plants, chiefly hairy grama, blue grama, buffalograss, sand dropseed, purple three-awn, and broom snakeweed, make up to 35 percent of the potential composition. Common invaders are ring muhly, tumblegrass, and annual three-awn.



This site is not readily accessible to livestock, but it is generally in good to excellent condition. Little bluestem and side-oats grama carry the grazing load. If the site is in excellent condition, the estimated annual yield of air-dry forage ranges from 800 to 1,800 pounds per acre.

#### CLAY UPLAND RANGE SITE

This site consists of deep, well drained or moderately well drained soils of the Spearville series. Slopes are up to 3 percent. The surface layer is silty clay loam. Available water capacity and fertility are high, and permeability is slow. Water erosion and soil blowing are hazards in unprotected areas.

The potential plant community consists of mid and short grasses. About 30 percent of the total plant composition is made up of such decreasers as western wheatgrass, side-oats grama, tall dropseed, and other perennial forbs and grasses. Increasers can make as much as 60 percent of the potential plant composition. The dominant increaser grasses are blue grama, buffalograss, silver bluestem, and sand dropseed. Other common increasers are western ragweed and pricklypear. The principal invaders are little barley, annual brome, snow-on-the-mountain, windmillgrass, and tumblegrass.

The site is readily accessible to livestock and is a favorite site for grazing early in spring and in fall and winter. Generally it is in good condition. Blue grama and buffalograss carry the grazing load. Side-oats grama is the first species to decrease under continuous overgrazing. It is followed by a decrease in western wheatgrass.

Forage production varies. If the site is in excellent condition, about 25 percent of the forage is western wheatgrass. If precipitation is high in winter and spring, the annual yield of air-dry forage is high, about 6,000 pounds per acre. If winter and spring are droughty, the yield is low, about 500 pounds per acre.

#### GRAVELLY HILLS RANGE SITE

Only Otero gravelly complex is in this site. It consists of well-drained to somewhat excessively drained soils that are underlain by sand at a depth of 30 inches. Slopes are 6 to 12 percent. The surface layer is gravelly sandy loam. Available water capacity is low, fertility is medium to low, and permeability is moderately rapid. Soil blowing and water erosion are hazards in unprotected areas.

Decreaser grasses in the potential plant community, such as sand bluestem, little bluestem, switchgrass, side-oats grama, and other perennial forbs and grasses, make up 65 percent of the total plant composition. Increaser plants, chiefly hairy grama, blue grama, sand dropseed, and buffalograss, can make up to 35 percent of the potential composition. The principal woody plant increasers are sand sagebush and small soapweed. Common invaders are tumblegrass, windmillgrass, and annual three-awn.

Generally, this site is in fair condition. Under present grazing use, blue grama and hairy grama carry the grazing load. If the site is in excellent condition, the estimated annual yield of air-dry forage ranges from 1,200 to 2,200 pounds per acre.

### LIMY UPLAND RANGE SITE

This site consists of moderately deep or deep, well-drained, calcareous soils of the Campus, Coly, Kim, Penden, Uly, and Wakeen series. The slope gradient is up to 12 percent. The surface layer is generally calcareous loam, clay loam, silt loam, or silty clay loam. Permeability is moderate or moderately slow. Available water capacity is low in Campus and Wakeen soils and high in the rest. Fertility is high in Penden and Uly soils and medium in the other soils. Uly soils are moderately eroded. Water erosion and soil blowing are hazards in unprotected areas.

The potential plant community consists of mid and tall grasses (fig. 14). About 50 percent of the total plant composition is made up of such decreasers as little bluestem, side-oats grama, big bluestem, switchgrass, leadplant, Jerseytea, ceanothus, and other perennial forbs and grasses. Increasers can make up as much as 50 percent of the potential plant composition. Important increasers are blue grama, hairy grama, buffalograss, purple three-awn, sand dropseed, and broom snakeweed. Common invaders are windmillgrass, tumblegrass, little barley, and annual brome.

This site is readily accessible to livestock and is a favorite site for grazing late in spring and in summer. Generally it is in fair condition. Continuous overgrazing results in an immediate decrease in big bluestem, followed by decreases in switchgrass and little bluestem. Blue grama and hairy grama carry the grazing load.

If this site is in excellent condition, the estimated annual yield of air-dry forage ranges from 1,000 to 4,200 pounds per acre.

### LOAMY LOWLAND RANGE SITE

Only Roxbury and Bridgeport soils, channeled, is in this site. These are deep, well drained to moderately well drained soils on the flood plains of local intermittent streams. The slope gradient is as much as 2 percent. The surface layer is silt loam or silty clay loam. Available water capacity and fertility are high. Permeability is moderate.

The potential plant community consists of mid and tall grasses. About 60 percent of the total plant composition is made up of such decreasers as big bluestem, switchgrass, indiangrass, Canada wildrye, little bluestem, and other perennial forbs and grasses. Increasers can make up as much as 40 percent of the potential plant composition. Important increasers are western wheatgrass, blue grama, side-oats grama, buffalograss, and western ragweed. Common invaders are little barley, annual brome, windmillgrass, and common pricklypear.

Generally, this site is in fair condition. Under present grazing use, blue grama and western wheatgrass carry the grazing load. If the site is in excellent condition, the estimated annual yield of air-dry forage ranges from 4,000 to 6,000 pounds per acre.

*Figure 14.*—**Area of Penden silty clay loam reseeded to native grasses.**

#### LOAMY TERRACE RANGE SITE

This site consists of deep, well drained and moderately well drained soils of the Bridgeport, Detroit, Hord, and Roxbury series. Slopes generally are less than 1 percent. The surface layer is silt loam or silty clay loam. Available water capacity and fertility are high. Permeability is moderate or slow. These soils receive some runoff. Flooding from streams is infrequent.

Decreaser grasses in the potential plant community, such as switchgrass, big bluestem, little bluestem, side-oats grama, Canada wildrye, and other perennial forbs and grasses, make up about 50 percent of the total plant composition. The dominant increaser grasses are western wheatgrass, blue grama, and buffalograss. Western ragweed and wooly verbena are common forb increasers. The principal invaders are silver bluestem, annual brome, little barley, windmillgrass, and tumblegrass.

This site is more productive than the Loamy Upland site, but less productive than the Loamy Lowland. Generally, it is in fair condition. Under present grazing use, western wheatgrass is the main increaser under heavy grazing. Usually western wheatgrass and blue grama carry the grazing load. If the site is in excellent condition, the estimated annual yield of air-dry forage ranges from 3,000 to 5,000 pounds per acre.

#### LOAMY UPLAND RANGE SITE

This site consists of deep, well-drained soils of the Harney, Ost, Richfield, Roxbury, and Uly series. The slope range is up to 5 percent for Harney, Richfield, and Roxbury soils and up to 6 percent for Ost and Uly soils. The surface layer is silt loam or silty clay loam. Available water capacity and fertility are high. Permeability is moderate or moderately slow. Water erosion and soil blowing are hazards in unprotected areas.

The potential plant community consists of mid and short grasses. About 40 percent of the total plant composition is made up of such decreasers as side-oats grama, little bluestem, a small amount of big bluestem and switchgrass, and other perennial forbs and grasses. Increasers can make up about 60 percent of the potential plant composition. Important species are blue grama, buffalograss, western wheatgrass, silver bluestem, sand dropseed, red three-awn, and western ragweed. Common invaders are little barley, annual brome, and common pricklypear.

This site is readily accessible to livestock and is a favorite site for grazing. Generally it is in good condition. Continuous overgrazing results in an immediate decrease in big bluestem and switchgrass, followed by a decrease in little bluestem. Buffalograss increases rapidly under continuous overgrazing. Buffalograss and blue grama usually carry the grazing load. If the site is in excellent condition, the estimated annual yield of air-dry forage ranges from 1,000 to 4,000 pounds per acre.

## Management of Windbreaks [3]

Woodland in Hodgeman County occurs as narrow fringes of native trees, chiefly mixed stands of ash, hackberry, elm, and cottonwood along the Pawnee River and the major creeks. The growth rate is too slow for economic production of wood crops. Because of the usual midsummer drought and the resulting limited supply of moisture, trees are planted only for windbreaks, shade, or ornamental purposes. They are limited to locations where extra care can be given.

Windbreaks reduce soil blowing and help to protect farmsteads and livestock. They also improve the appearance of the farmstead, increase the value of the property, and provide food and cover for wildlife.

Windbreaks can be established successfully and maintained if they are well planned and well cared for. The following steps should be taken to establish tree plantings for windbreaks: (1) fallow the area and subsoil to help conserve moisture, (2) disk the area before planting to prepare a good seedbed, (3) keep planting stock moist so the roots will not become dry, (4) use good quality planting stock, and (5) avoid a hot windy day for planting. On uplands the growth and longevity of the trees can be increased if runoff is diverted into the windbreak area. The growth of trees in the windbreak can be increased significantly in areas where irrigation water is available, as shown in table 3.

Cultivation as often as necessary to keep weeds under control is important for seedlings. On upland sites cultivation for weed control is needed during the entire lifespan of the windbreak. Trees also need protection from fire, livestock, insects, rabbits, and rodents.

[3] F. DEWITT ABBOTT, State soil conservationist, Soil Conservation Service, helped prepare this section.

TABLE 3.—*Trees and shrubs suitable for windbreaks and estimated height attained in 10 years*

| Suitable trees and shrubs | Windbreak groups | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Deep loamy lowland | | Deep loamy upland | | Moderately deep loamy upland | | Deep loamy upland with clayey subsoil | |
| | Dryland | Irrigated | Dryland | Irrigated | Dryland | Irrigated | Dryland | Irrigated |
| | *Ft.* | *Ft.* | *Ft.* | *Ft.* | *Ft.* | *Ft.* | *Ft.* | *Ft.* |
| Siberian elm | 27 | 32 | 22 | 32 | 14 | 18 | 18 | 28 |
| Mulberry | 17 | 24 | 15 | 20 | 9 | 15 | 11 | 18 |
| Honeylocust | 16 | 23 | 14 | 23 | 12 | 17 | 12 | 20 |
| Eastern redcedar | 13 | 18 | 10 | 18 | 9 | 14 | 10 | 18 |
| Russian-olive | 14 | 22 | 12 | 22 | 10 | 15 | 12 | 22 |

The soils suitable for windbreak plantings have been assigned to four windbreak groups. Each group consists of soils that are similar in potential for tree growth and in management requirements.

Table 3 lists the trees and shrubs suitable for windbreaks and gives the estimated height, by windbreak groups, in 10 years on dryland and irrigated soils.

Drought-resistant species suitable for windbreaks are eastern redcedar, Rocky Mountain juniper, Siberian elm, and Osage-orange.

Kipson-Wakeen complex, Campus-Canlon complex, Otero gravelly complex, Canlon soils, Ness clay, and Rough broken land are not well suited to trees and are not assigned to a windbreak group.

Data in table 3 for the Moderately Deep Loamy Upland group were based on field observations. Data for all other groups were obtained from plot studies of tree growth on key soils in Hodgeman, Ford, Gove, Stevens, Morton, and Edwards Counties.

More information on the planting of trees, the selection of species, and the spacing of windbreak developments can be obtained from a local technician of the Soil Conservation Service or from the county agricultural extension agent.

## Wildlife Management[4]

Animals and plants depend upon sunlight, soil, water, and air as basic essentials necessary to support life. Changes in the soil and the vegetation affected by weather or climate and man's activities have had an impact on wildlife species in Hodgeman County. Habitat that once supported populations of bison, elk, antelope, prairie chickens, and turkeys no longer offers the essentials necessary to maintain these species.

Pheasants are closely associated with cropland on soil associations 1, 2, 4, and 6. Fewer pheasants are produced on association 3, and very few inhabit the more extensive grassland areas on association 5. Soil associations are shown on the General Soil Map at the back of this publication. Pheasant hunting is good throughout the county, and numerous hunters consider the pheasant an excellent game bird.

Bobwhite quail are most numerous on association 6. Recent surveys in the county indicate a population of 0.41 bird per 100 acres, in contrast with a population of 20 to 40 per 100 acres in eastern Kansas.

The grassland in Hodgeman County is chiefly mid and short grasses. Tall grasses grow in scattered areas of bottom land. Attempts to reestablish the prairie chicken within this habitat have not proved successful.

Mourning doves nest throughout the county. Waterfowl utilize the water areas during migration, but very few use these areas for nesting.

Eastern cottontail can be found mainly along stream valleys, desert cottontail largely on short-grass areas above the floor of stream valleys, and fox squirrel in shelterbelts and in wooded areas along streams. The black-tailed jackrabbit is common throughout the county. A few prairie-dog towns are seen in native pastures. Other animals include opossum, ground squirrels, muskrats, raccoons, badgers, and striped and spotted skunks. Beaver have increased in number along the Pawnee River and Buckner and Sawlog Creeks on association 6. Coyotes, although under a bounty in the county, are numerous and offer good sport for hunters. The number of deer, both white-tailed and mule, appear to be increasing. Deer are mainly on association 6.

Approximately 135 farm ponds have been constructed in the county. Some of these have been stocked with largemouth black bass, bluegill, and channel catfish. The Forestry, Fish, and Game Commission maintains the Hodgeman County State Lake 1 mile east, 2 miles south, and 3 miles east of Jetmore. The lake when full is 85 surface acres of water.

## Use of the Soils in Engineering[5]

This section provides information of special interest to engineers, contractors, farmers, and others who use soil as structural material or as foundation material upon which structures are built.

Some soil properties are of special interest to engineers because they affect the construction and maintenance of roads, airports, pipelines, building foundations, facilities for water storage, erosion control structures, drainage systems, and sewage disposal systems. Among the properties most important are permeability, strength, compaction characteristics, soil drainage, shrink-swell potential, grain size, plasticity, and pH. Also important are topography and depth to the water table and to bedrock.

Information concerning these and related soil properties is given in tables 4 and 5. The estimates and interpretations in these tables can be used to—

1. Make studies that will aid in selecting and developing industrial, commercial, residential, and recreational sites.
2. Make preliminary estimates of the engineering properties of soils in planning drainage systems, farm ponds, terraces, waterways, dikes, diversion terraces, and irrigation systems.
3. Make preliminary evaluations that will aid in selecting sites for highways, airports, pipelines, and cables, and in planning detailed investigations at the selected location.
4. Locate probable sources of gravel, sand, and other construction material.
5. Correlate performance of soil mapping units to develop information that will be useful in planning engineering practices and in designing and maintaining engineering structures.
6. Determine the suitability of soils for cross-country movement of vehicles and construction equipment.
7. Supplement other publications, such as maps, reports, and aerial photographs, that are used in preparation of engineering reports for a specific area.
8. Develop other preliminary estimates for construction purposes pertinent to the particular area.

The engineering interpretations reported here do not eliminate the need for sampling and testing at the site of

[4] By JACK WALSTROM, biologist, Soil Conservation Service.

[5] FRED MEYER, JR., civil engineer, Soil Conservation Service, assisted in preparing this section.

specific engineering works involving heavy loads of excavations deeper than the depths reported, ordinarily about 5 feet. Even in these situations, however, the soil map is useful in planning more detailed field investigations and in indicating the kinds of problems that may be expected.

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

### *Engineering classification systems*

The two systems most commonly used in classifying soils for engineering are the systems approved by the American Association of State Highway Officials (AASHO) (*1*) and the Unified system (*14*). Estimated classifications of the soils according to these systems are shown in table 4.

The AASHO system is used to classify soils according to those properties that affect use in highway construction. In this system all soil material is classified in seven principal groups. The groups range from A–1, which consists of soils that have the highest bearing strength and are the best soils for subgrade, to A–7, which consists of soils that have the lowest strength when wet. Within each group, the relative engineering value of the soil material is indicated by a group index number. The numbers range from 0, for the best material, to 20, for the poorest.

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

In the Unified system soils are classified according to particle-size distribution, plasticity, and liquid limit. The soil material is identified as coarse grained, that is, gravel (G) and sand (S); fine grained, silt (M) and clay (C); and highly organic (Pt). There are no highly organic soils in Hodgeman County. Clean sands are identified by the symbols SW or SP; sands that have fines of silt and clay, by SM and SC; silts and clays that have a low liquid limit, by ML and CL; and silts and clays that have a high liquid limit, by MH and CH.

Soil scientists use the USDA textural classification (*11*). In this, the texture of the soil is determined according to the proportion of soil particles smaller than 2 millimeters in diameter, that is, the proportion of sand, silt, and clay. Modifiers such as gravelly, stony, shaly and cobbly are used as needed.

### *Soil properties significant in engineering*

Table 4 shows estimates of the soil properties to be considered in engineering. The estimates are for major horizons in a representative profile. They are based on the results of tests on similar soils in Ford, Logan, and Morton Counties, Kansas; on tests made by the State Highway Commission; and on information in other sections of the survey, particularly the section "Descriptions of the Soils."

No estimates are shown in table 4 on the depth to the water table and the depth to bedrock. The depth to the water table in the valleys of the Pawnee River and Buckner and Sawlog Creeks ranges from 15 to 50 feet. On uplands it ranges from 50 to 150 feet. The depth to bedrock is more than 5 feet in all but the Campus, Canlon, Kipson, and Wakeen soils, and in the mapping unit Rough broken land. Localized outcrops of caliche, of the Ogallala Formation, and outcrops of Cretaceous material are mainly the only rock formations within a depth of 5 feet. Outcrops occur in the Canlon soils, the Campus-Canlon complex, and the Kipson-Wakeen complex, and in Rough broken land. The depth to caliche (semiconsolidated outwash) in Canlon soils is 10 to 20 inches, and in Campus soils, 20 to 36 inches. The depth to chalky shale in Kipson soils is 7 to 20 inches, and in Wakeen soils, 20 to 40 inches. The depth to rock in Rough broken land is less than 20 inches. The rock includes chalky shale, limestone, and noncalcareous shale and sandstone. Information on the depth to bedrock and the kind of bedrock for all soils is given under the heading "Descriptions of the Soils."

The textural classes designated by the U.S. Department of Agriculture and the classification according to the Unified and AASHO systems are estimated in table 4.

The estimated percentage of material passing sieve numbers 4, 10, and 200 reflects the normal range in texture for a soil series. Most soils are within the range given, but the grain size of any soil varies.

The column headed "Permeability" refers to the quality that enables the soil to transmit water or air. It is expressed in the number of inches per hour at which water moves downward through saturated soil.

The available water capacity is the capacity of a soil to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Reaction is the degree of acidity or alkalinity of a soil, expressed as a pH value. The estimates are given as a range of values.

Shrink-swell potential is an indication of the volume change to be expected of the soil material with changes in moisture content. In general, soils that have high shrink-swell potential present hazards to the maintenance of engineering structures constructed in, on, or with such materials.

### *Engineering interpretations*

Table 5 shows specific features of the soils that affect their use for various engineering purposes. The first four columns rate the soils according to the suitability of the material as a source of topsoil, sand and gravel, road subgrade, and road fill. The next several columns show soil features that affect use of the soils for highway location, engineering structures, and foundations for low buildings. The last two columns show the degree and kind of limitations that affect use of the soils for sewage disposal.

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TABLE 4.—*Estimates of soil*

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

| Soil series and map symbols | Depth from surface (representative profile) | Classification | | |
|---|---|---|---|---|
| | | USDA texture (dominant) | Unified | AASHO |
| | *In.* | | | |
| Bridgeport: Be. | 0–60 | Silt loam | ML or CL | A–4 or A–6 |
| Broken alluvial land: Br. No valid estimates can be made. | | | | |
| *Campus: Cc. For Canlon part of Cc, refer to Canlon series. | 0–8 | Loam | CL | A–6 |
| | 8–16 | Clay loam | CL | A–6 |
| | 16–30 | Loam | CL | A–6 |
| | 30 | Caliche. | | |
| Canlon: Cn. | 0–13 | Loam | CL | A–6 |
| | 13 | Caliche. | | |
| Coly. Mapped only with Uly soils. | 0–60 | Silt loam | ML or CL | A–6 |
| Detroit: Dt. | 0–12 | Silty clay loam | CL | A–6 |
| | 12–25 | Silty clay | CH | A–7 |
| | 25–60 | Silty clay loam | CL | A–6 |
| Harney: | | | | |
| Ha, Hb, Hc. | 0–7 | Silt loam | ML or CL | A–4 or A–6 |
| | 7–17 | Silty clay loam | CL | A–6 |
| | 17–40 | Silty clay | CH | A–7 |
| | 40–60 | Silty clay loam | CL | A–6 |
| Hd, He. | 0–12 | Silty clay loam | CL | A–6 |
| | 12–35 | Silty clay | CH | A–7 |
| | 35–60 | Silty clay loam | CL | A–6 |
| Hord: Ho. | 0–60 | Silty clay loam | CL | A–6 |
| *Kim: Kp. For Penden part of Kp, refer to Penden series. | 0–4 | Silty clay loam | CL | A–6 |
| | 4–60 | Clay loam | CL | A–6 |
| *Kipson: Kw. For Wakeen part of Kw, refer to Wakeen series. | 0–10 | Loam | ML or CL | A–4 or A–6 |
| | 10–15 | Clay loam | CL | A–6 |
| | 15 | Chalky shale. | | |
| Ness: Ne. | 0–31 | Clay | CH | A–7 |
| | 31–60 | Silty clay loam | CL | A–6 |
| Ost: Om. | 0–7 | Silt loam | ML or CL | A–4 or A–6 |
| | 7–10 | Silty clay loam | CL | A–6 |
| | 10–60 | Clay loam | CL | A–6 |
| Otero: Ox. | 0–25 | Gravelly sandy loam | SM-SC | A–4 or A–3 |
| | 25–60 | Loamy sand to sand and gravel | SM or SP-SM | A–1 |
| *Penden: | | | | |
| Pd, Pe, Pf, Pn. | 0–16 | Silty clay loam | CL | A–6 |
| | 16–60 | Clay loam | CL | A–6 |
| Pu. For Campus part of Pu, refer to Campus series. | 0–60 | Clay loam | CL | A–6 |
| Richfield: | | | | |
| Rm, Rn. | 0–7 | Silt loam | ML or CL | A–4 or A–6 |
| | 7–33 | Silty clay loam | CL | A–6 |
| | 33–60 | Silt loam | ML or CL | A–4 or A–6 |
| Ro. | 0–30 | Silty clay loam | CL | A–6 |
| | 30–60 | Silt loam | ML or CL | A–4 or A–6 |

See footnote at end of table.

*properties significant in engineering*

in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions table. Symbol > means more than. Symbol < means less than]

| Percentage passing sieve— | | | Permeability | Available water capacity | Reaction | Shrink-swell potential |
|---|---|---|---|---|---|---|
| No. 4 | No. 10 | No. 200 | | | | |
| | | | *In./hr.* | *In./in. of soil* | *pH* | |
| 100 | 100 | 70–90 | 0. 63–2. 0 | 0. 17–0. 19 | 7. 4–8. 4 | Low to moderate. |
| 100 | 100 | 60–75 | 0. 63–2. 0 | . 18–. 20 | 7. 9–8. 4 | Moderate. |
| 100 | 90–100 | 70–80 | 0. 63–2. 0 | . 17–. 19 | 7. 9–8. 4 | Moderate. |
| 90–100 | 85–90 | 60–75 | 0. 63–2. 0 | . 18–. 20 | 7. 9–8. 4 | Moderate. |
| 95–100 | 85–95 | 60–75 | 0. 63–2. 0 | . 18–. 20 | 7. 9–8. 4 | Low. |
| 100 | 100 | 70–90 | 0. 63–2. 0 | . 17–. 19 | 7. 9–8. 4 | Moderate. |
| 100 | 100 | 90–95 | 0. 2–0. 63 | . 18–. 20 | 7. 4–7. 8 | High. |
| 100 | 100 | 90–95 | 0. 06–0. 20 | . 19–. 21 | 7. 4–7. 8 | High. |
| 100 | 100 | 90–95 | 0. 2–0. 63 | . 18–. 20 | 7. 4–8. 4 | High. |
| 100 | 100 | 70–90 | 0. 63–2. 0 | . 17–. 19 | 6. 1–6. 5 | Low to moderate. |
| 100 | 100 | 90–100 | 0. 2–0. 63 | . 18–. 20 | 6. 6–7. 3 | High. |
| 100 | 100 | 90–100 | 0. 2–0. 63 | . 19–. 21 | 7. 4–8. 4 | High. |
| 100 | 100 | 90–100 | 0. 2–0. 63 | . 18–. 20 | 7. 9–8. 4 | Moderate. |
| 100 | 100 | 90–100 | 0. 2–0. 63 | . 18–. 20 | 6. 6–7. 8 | High. |
| 100 | 100 | 90–100 | 0. 2–0. 63 | . 19–. 21 | 7. 4–8. 4 | High. |
| 100 | 100 | 90–100 | 0. 2–0. 63 | . 18–. 20 | 7. 9–8. 4 | Moderate. |
| 100 | 100 | 90–95 | 0. 63–2. 0 | . 18–. 20 | 6. 6–8. 4 | Moderate. |
| 100 | 100 | 90–95 | 0. 63–2. 0 | . 18–. 20 | 7. 9–8. 4 | Moderate. |
| 100 | 100 | 70–80 | 0. 2–2. 0 | . 18–. 20 | 7. 9–8. 4 | Moderate. |
| 100 | 100 | 60–75 | 0. 63–2. 0 | . 17–. 19 | 7. 9–8. 4 | Low. |
| 100 | 90–100 | 70–80 | 0. 63–2. 0 | . 18–. 20 | 7. 9–8. 4 | Low. |
| 100 | 100 | 75–95 | <0. 06 | . 20–. 22 | 7. 4–7. 8 | High. |
| 100 | 100 | 90–100 | 0. 2–0. 63 | . 18–. 20 | 7. 9–8. 4 | Moderate. |
| 100 | 100 | 70–90 | 0. 63–2. 0 | . 17–. 19 | 6. 6–7. 3 | Low to moderate. |
| 100 | 100 | 90–95 | 0. 2–0. 63 | . 18–. 20 | 6. 6–7. 3 | High. |
| 100 | 100 | 70–80 | 0. 2–0. 63 | . 17–. 19 | 7. 4–8. 4 | Moderate |
| 90–95 | 80–85 | 30–40 | 2. 0–6. 3 | . 13–. 15 | 7. 4–8. 4 | Low. |
| 85–90 | 75–80 | 10–20 | >6. 3 | (1) | 7. 9–8. 4 | None. |
| 100 | 100 | 90–95 | 0. 63–2. 0 | . 18–. 20 | 7. 4–8. 4 | Moderate. |
| 100 | 100 | 70–80 | 0. 2–2. 0 | . 17–. 19 | 7. 9–8. 4 | Moderate. |
| 100 | 100 | 70–80 | 0. 2–2. 0 | . 17–. 19 | 7. 9–8. 4 | Moderate. |
| 100 | 100 | 70–90 | 0. 63–2. 0 | . 17–. 19 | 7. 4–7. 8 | Low to moderate. |
| 100 | 100 | 90–100 | 0. 20–0. 63 | . 18–. 20 | 7. 4–8. 4 | High. |
| 100 | 100 | 70–90 | 0. 63–2. 0 | . 17–. 19 | 7. 9–8. 4 | Low to moderate. |
| 100 | 100 | 90–100 | 0. 20–0. 63 | . 18–. 20 | 7. 4–8. 4 | High. |
| 100 | 100 | 70–90 | 0. 63–2. 0 | . 17–. 19 | 7. 9–8. 4 | Low to moderate. |

TABLE 4.—*Estimates of soil properties*

| Soil series and map symbols | Depth from surface (representative profile) | Classification | | |
|---|---|---|---|---|
| | | USDA texture (dominant) | Unified | AASHO |
| | *In.* | | | |
| Rough broken land: Rr. No valid estimates can be made. | | | | |
| *Roxbury: Rx, Ry. For Bridgeport part of Ry, refer to Bridgeport series. | 0–22 | Silt loam | ML or CL | A–4 or A–6 |
| | 22–42 | Silty clay loam | CL | A–6 |
| | 42–60 | Clay loam | CL | A–6 |
| Rz. | 0–60 | Silty clay loam | CL | A–6 |
| Spearville: Sp, Sr. | 0–7 | Silty clay loam | CL | A–6 |
| | 7–18 | Silty clay | CH | A–7 |
| | 18–25 | Silty clay loam | CL | A–6 |
| | 25–60 | Silt loam | ML or CL | A–4 or A–6 |
| *Uly: Ub, Uc, Um. For Coly part of Um, refer to Coly series. | 0–8 | Silt loam | ML or CL | A–4 or A–6 |
| | 8–21 | Silty clay loam | CL | A–6 |
| | 21–60 | Silt loam | ML or CL | A–4 or A–6 |
| Wakeen: Wa, Wb. | 0–10 | Silt loam | ML or CL | A–4 or A–6 |
| | 10–20 | Silty clay loam | CL | A–6 |
| | 20–28 | Clay loam | CL | A–6 |
| | 28 | Chalky shale. | | |

[1] Very low available water capacity.

TABLE 5.—*Engineering*

[C. W. HECKATHORN, field soils engineer, and HERBERT E. WORLEY, soils research engineer, Kansas State Highway Commission, helped asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in referring to other series that appear in the first column of this table]

| Soil series and map symbols | Suitability as source of— | | | | Soil features affecting— | | |
|---|---|---|---|---|---|---|---|
| | Topsoil | Sand and gravel | Road subgrade | Road fill | Highway location | Dikes and levees | Farm ponds |
| | | | | | | | Reservoir area |
| Bridgeport: Be | Good | Not suitable. | Good | Good | Good to moderately good drainage; fair to good stability. | Fair to good compaction; good to moderately good drainage. | Moderate permeability. |
| Broken alluvial land: Br. No interpretations. Material variable. | | | | | | | |

See footnotes at end of table.

*significant in engineering*—Continued

| Percentage passing sieve— | | | Permeability | Available water capacity | Reaction | Shrink-swell potential |
|---|---|---|---|---|---|---|
| No. 4 | No. 10 | No. 200 | | | | |
| | | | *In./hr.* | *In./in. of soil* | *pH* | |
| 100 | 100 | 70–90 | 0. 63–2. 0 | 0. 17–0. 19 | 6. 6–7. 8 | Low to moderate. |
| 100 | 100 | 90–95 | 0. 63–2. 0 | . 18–. 20 | 7. 4–7. 8 | Moderate. |
| 100 | 100 | 70–80 | 0. 63–2. 0 | . 18–. 20 | 7. 9–8. 4 | Moderate. |
| 100 | 100 | 90–95 | 0. 63–2. 0 | . 18–. 20 | 7. 4–8. 4 | Moderate. |
| 100 | 100 | 90–95 | 0. 2 –0. 63 | . 18–. 20 | 6. 6–7. 3 | Moderate. |
| 100 | 100 | 90–95 | 0. 06–0. 2 | . 19–. 21 | 7. 4–7. 8 | High. |
| 100 | 100 | 90–100 | 0. 2 –0. 63 | . 18–. 20 | 7. 9–8. 4 | High. |
| 100 | 100 | 70–90 | 0. 63–2. 0 | . 17–. 19 | 7. 9–8. 4 | Moderate. |
| 100 | 100 | 70–90 | 0. 63–2. 0 | . 17–. 19 | 7. 4–7. 8 | Low to moderate. |
| 100 | 100 | 90–100 | 0. 63–2. 0 | . 18–. 20 | 7. 9–8. 4 | Moderate. |
| 100 | 100 | 70–90 | 0. 63–2. 0 | . 17–. 19 | 7. 9–8. 4 | Low to moderate. |
| 100 | 100 | 70–90 | 0. 63–2. 0 | . 17–. 19 | 7. 9–8. 4 | Moderate. |
| 100 | 100 | 90–95 | 0. 63–2. 0 | . 18–. 20 | 7. 9–8. 4 | Moderate. |
| 100 | 90–100 | 70–80 | 0. 63–2. 0 | . 18–. 20 | 7. 9–8. 4 | Moderate. |

*interpretations*

prepare columns headed "Road subgrade" and "Road fill," under a cooperative agreement with the Bureau of Public Roads. An such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for

| Soil features affecting—Continued | | | | | Suitability as foundations for low buildings | Degree and kind of limitation for— | |
|---|---|---|---|---|---|---|---|
| Farm ponds—Con. | Agricultural drainage | Irrigation | Terraces and diversions | Grassed waterways | | Septic tank filter field | Sewage lagoons |
| Embankment | | | | | | | |
| Fair to good compaction. | Good to moderately good drainage; moderate permeability. | Deep; moderate permeability; high available water capacity. | Slopes 1 percent or less on low terraces and bottom lands. | Deep; high fertility; moderate erodibility. | Fair to poor: poor to fair shear strength; low to moderate shrink-swell potential. | Moderate to slight: moderate permeability.[1] | Moderate: moderate permeability.[1] |

TABLE 5.—*Engineering*

| Soil series and map symbols | Suitability as source of— | | | | Soil features affecting— | | |
|---|---|---|---|---|---|---|---|
| | Topsoil | Sand and gravel | Road subgrade | Road fill | Highway location | Dikes and levees | Farm ponds: Reservoir area |
| *Campus: Cc. For Canlon part of Cc, refer to Canlon series. | Good in surface layer; not suitable below a depth of 16 inches. | Not suitable for sand; good as source of caliche below a depth of 30 inches. | Poor | Good | Caliche at a depth of 20 to 36 inches. | Fair shear strength and stability. | Moderate permeability; caliche at a depth of 20 to 36 inches. |
| Canlon: Cn | Poor | Fair to poor for sand or gravel; good for caliche. | Fair | Fair | Caliche at a depth of 10 to 20 inches; broken landscape. | Borrow material limited. | Caliche at a depth of 10 to 20 inches; moderate permeability. |
| Coly. Mapped only with Uly soils. | Good | Not suitable. | Good | Good | Good drainage; moderate erodibility. | Fair to good compaction; stable slopes. | Moderate permeability. |
| Detroit: Dt | Good in surface layer. | Not suitable. | Poor | Good | Good to moderately good drainage. | Poor to good compaction; moisture and compaction control needed. | Slow permeability. |
| Harney: Ha, Hb, Hc, Hd, He | Good | Not suitable. | Poor | Good | Good drainage. | Fair to good compaction; good drainage. | Moderately slow permeability. |
| Hord: Ho | Good | Not suitable. | Fair | Good | Good drainage. | Fair to good compaction; moisture and compaction control needed. | Moderate permeability. |
| *Kim: Kp. For Penden part of Kp, refer to Penden series. | Good | Not suitable. | Fair | Good | Good drainage. | Fair to good compaction; good drainage. | Moderate to moderately slow permeability. |

See footnote at end of table.

*interpretations*—Continued

| Soil features affecting—Continued | | | | | Suitability as foundations for low buildings | Degree and kind of limitation for— | |
|---|---|---|---|---|---|---|---|
| Farm ponds—Con.: Embankment | Agricultural drainage | Irrigation | Terraces and diversions | Grassed waterways | | Septic tank filter field | Sewage lagoons |
| Fair to good compaction; good drainage. | Good drainage. | Moderately deep; moderate permeability; low available water capacity; 1 to 12 percent slope. | Caliche at a depth of 20 to 36 inches; moderate erodibility. | Caliche at a depth of 20 to 36 inches; highly calcareous. | Fair to poor: moderate shrink-swell potential; fair shear strength. | Severe: caliche at a depth of 20 to 36 inches. | Severe: caliche at a depth of 20 to 36 inches. |
| Shallow over caliche; excavation difficult and material variable. | Somewhat excessive drainage. | Shallow over caliche; moderate permeability; very low available water capacity; 3 to 40 percent slope. | Caliche at a depth of 10 to 20 inches. | Caliche at a depth of 10 to 20 inches; difficult to construct and to establish vegetation. | Fair to good: poor to fair shear strength. | Severe: caliche at a depth of 10 to 20 inches; 3 to 40 percent slope. | Severe: caliche at a depth of 10 to 20 inches. |
| Fair to good compaction; fair shear strength and stability; moderate plasticity. | Good drainage; moderate permeability. | Deep; moderate permeability; high available water capacity. | Deep; moderate erodibility. | Deep; medium fertility; moderate erodibility. | Fair to poor: moderate shrink-swell potential; fair shear strength. | Moderate to slight: moderate permeability. | Moderate: 3 to 6 percent slope; moderate permeability. |
| Poor to good compaction; moisture and compaction control needed. | Good to moderately good drainage; slow permeability. | Deep; slow permeability; high available water capacity. | Low to moderate erodibility. | Deep; high fertility; slow permeability. | Fair to poor: high shrink-swell potential; fair to poor shear strength. | Severe: slow permeability. | Slight.[1] |
| Fair to good compaction; moisture and compaction control needed. | Good drainage; moderately slow permeability. | Deep; moderately slow permeability; high available water capacity. | Low to moderate erodibility. | Deep; high fertility; low to moderate erodibility. | Fair to poor: fair to poor shear strength; moderate to high shrink-swell potential. | Severe: moderately slow permeability. | Slight if slope is less than 2 percent, moderate if more than 2 percent. |
| Fair to good compaction; moisture and compaction control needed. | Good drainage; moderate permeability. | Deep; moderate permeability; high available water capacity. | Low to moderate erodibility. | Deep; high fertility; low to moderate erodibility. | Fair to poor: moderate shrink-swell potential; fair shear strength. | Slight to moderate: moderate permeability.[1] | Moderate: moderate permeability.[1] |
| Fair to good compaction; stable slopes. | Good drainage; moderate to moderately slow permeability. | Deep; moderate to moderately slow permeability; high available water capacity. | Moderate erodibility. | Deep; medium fertility; moderate erodibility. | Fair to poor: moderate shrink-swell potential; fair shear strength. | Moderate to severe: moderate to moderately slow permeability; 3 to 6 percent slope. | Moderate: moderate to moderately slow permeability; 3 to 6 percent slope. |

TABLE 5.—*Engineering*

| Soil series and map symbols | Suitability as source of— | | | | Soil features affecting— | | |
|---|---|---|---|---|---|---|---|
| | Topsoil | Sand and gravel | Road subgrade | Road fill | Highway location | Dikes and levees | Farm ponds<br>Reservoir area |
| *Kipson: Kw<br>For Wakeen part of Kw, refer to Wakeen series. | Poor | Not suitable. | Fair | Fair | Chalky shale at a depth of 7 to 20 inches; broken landscape. | Borrow material limited. | Chalky shale at a depth of 7 to 20 inches; moderate permeability. |
| Ness: Ne | Poor | Not suitable. | Poor | Poor | Poor drainage; depressions; subject to ponding. | Poor compaction; high shrink-swell potential; cracks when dry. | Very slow permeability. |
| Ost: Om | Good | Not suitable. | Fair | Good | Good drainage. | Fair to good compaction; good drainage. | Moderately slow permeability. |
| Otero: Ox | Poor | Fair: localized deposits. | Good | Good | Good to somewhat excessive drainage. | Sand at a depth of about 30 inches; moderately rapid permeability; moderate to high erodibility. | Moderately rapid permeability; sand and gravel pockets. |
| *Penden: Pd, Pe, Pf, Pn, Pu<br>For Campus part of Pu, refer to Campus series. | Good | Not suitable. | Fair | Good | Good drainage. | Fair to good compaction; stable slopes. | Moderate to moderately slow permeability. |
| Richfield: Rm, Rn, Ro | Good | Not suitable. | Fair to poor. | Fair to good. | Good drainage. | Fair to good compaction; fair shear strength; fair to good stability. | Moderately slow permeability. |

See footnote at end of table.

*interpretations*—Continued

| Soil features affecting—Continued | | | | | Suitability as foundations for low buildings | Degree and kind of limitation for— | |
|---|---|---|---|---|---|---|---|
| Farm ponds—Con. Embankment | Agricultural drainage | Irrigation | Terraces and diversions | Grassed waterways | | Septic tank filter field | Sewage lagoons |
| Fill material limited; very shallow to shallow. | Somewhat excessive drainage. | Very shallow or shallow over chalky shale; moderate permeability; very low available water capacity; 3 to 25 percent slope. | Chalky shale at a depth of 7 to 20 inches. | Chalky shale at a depth of 7 to 20 inches; difficult to establish vegetation. | Fair to good: fair to poor shear strength. | Severe: chalky shale at a depth of 7 to 20 inches; 3 to 25 percent slope. | Severe: chalky shale at a depth of 7 to 20 inches. |
| Poor compaction; high shrink-swell potential; poor shear strength; cracks when dry. | Poor drainage; depressions subject to ponding. | Deep; very slow permeability; high available water capacity; depressions; poor drainage. | Depressions; slope is 1 percent or less. | Deep; high fertility; depressions subject to ponding; difficult to establish vegetation. | Poor: poor shear strength; high shrink-swell potential. | Severe: very slow permeability. | Slight if protected from flooding. |
| Fair to good compaction; moderate to high shrink-swell potential. | Good drainage; moderately slow permeability. | Deep; moderately slow permeability; high available water capacity. | Moderate erodibility. | Deep; high fertility; moderate erodibility. | Fair to poor: moderate to high shrink-swell potential; fair shear strength. | Severe: moderately slow permeability. | Slight. |
| Fair stability; susceptible to piping. | Good to somewhat excessive drainage. | Moderately deep over sand; moderately rapid permeability; low available water capacity; 6 to 12 percent slope. | Sand at a depth of about 30 inches; moderate to high erodibility; subject to excessive siltation. | Low fertility; moderate to high erodibility; sand at a depth of about 30 inches. | Fair to good: fair to good shear strength; low shrink-swell potential. | Moderate: 6 to 12 percent slope. | Severe: moderately rapid permeability. |
| Fair to good compaction; stable slopes. | Good drainage; moderate to moderately slow permeability. | Deep; moderate to moderately slow permeability; high available water capacity; 0 to 12 percent slope. | Moderate erodibility. | Deep; high fertility; moderate erodibility. | Fair to poor: moderate shrink-swell potential; fair shear strength. | Moderate to severe: moderate to moderately slow permeability. | Moderate: moderate to moderately slow permeability; more than 2 percent slope in most places. |
| Fair to good compaction; stable slopes. | Good drainage; moderately slow permeability. | Deep; moderately slow permeability; high available water capacity. | Low to moderate erodibility. | Deep; high fertility; low to moderate erodibility. | Fair to poor: moderate to high shrink-swell potential; fair shear strength. | Severe: moderately slow permeablility. | Slight if slope is less than 2 percent, moderate if more than 2 percent. |

TABLE 5.—*Engineering*

| Soil series and map symbols | Suitability as source of— | | | | Soil features affecting— | | |
|---|---|---|---|---|---|---|---|
| | Topsoil | Sand and gravel | Road subgrade | Road fill | Highway location | Dikes and levees | Farm ponds: Reservoir area |
| Rough broken land: Rr. No interpretations. Material variable. | | | | | | | |
| *Roxbury: Rx, Ry, Rz. For Bridgeport part of Ry, refer to Bridgeport series. | Good | Not suitable. | Fair | Good | Good to moderately good drainage. | Fair to good compaction; fair shear strength and stability. | Moderate permeability. |
| Spearville: Sp, Sr | Good in surface layer; poor in subsoil. | Not suitable. | Poor | Fair | Good to moderately good drainage. | Poor to fair compaction; high shrink-swell potential. | Slow permeability. |
| *Uly: Ub, Uc, Um. For Coly part of Um, refer to Coly series. | Good | Not suitable. | Good | Good | Good drainage. | Fair to good compaction; stable slopes. | Moderate permeability. |
| Wakeen: Wa, Wb | Good in surface layer. | Not suitable. | Fair to good. | Fair to good. | Good drainage; chalky shale at a depth of 20 to 40 inches. | Fair to good compaction; fair shear strength and stability; moderate plasticity. | Moderate permeability; chalky shale at a depth of 20 to 40 inches. |

[1] Severe if flooded.

*interpretations*—Continued

| Soil features affecting—Continued | | | | | Suitability as foundations for low buildings | Degree and kind of limitation for— | |
|---|---|---|---|---|---|---|---|
| Farm ponds—Con.: Embankment | Agricultural drainage | Irrigation | Terraces and diversions | Grassed waterways | | Septic tank filter field | Sewage lagoons |
| Fair to good compaction. | Good to moderately good drainage; moderate permeability. | Deep; moderate permeability; high available water capacity; Ry subject to frequent flooding. | Low to moderate erodibility; Ry subject to frequent flooding. | Deep; high fertility; low to moderate erodibility. | Fair to poor: low to moderate shrink-swell potential; fair shear strength; Ry subject to frequent flooding. | Slight to moderate in Rx and Rz: moderate permeability. [1] Severe in Ry: frequent flooding. | Moderate in Rx and Rz: moderate permeability. [1] Severe in Ry: frequent flooding. |
| Poor to fair compaction; high shrink-swell potential. | Good to moderately good drainage; slow permeability. | Deep; slow permeability; high available water capacity. | Moderate erodibility; high shrink-swell potential. | Deep; high fertility; moderate erodibility. | Fair to poor: high shrink-swell potential; fair to poor shear strength. | Severe: slow permeability. | Slight. |
| Fair to good compaction; fair shear strength and stability; moderate plasticity. | Good drainage; moderate permeability. | Deep; moderate permeability; high available water capacity. | Moderate erodibility. | Deep; high fertility; moderate erodibility. | Fair to poor: low to moderate shrink-swell potential; fair shear strength. | Slight to moderate: moderate permeability. | Moderate: moderate permeability. |
| Fair to good compaction; fair shear strength and stability; moderate plasticity. | Good drainage; moderate permeability. | Chalky shale at a depth of 20 to 40 inches; moderate permeability; low available water capacity; 1 to 12 percent slope. | Moderate erodibility; chalky shale at a depth of 20 to 40 inches. | Chalky shale at a depth of 20 to 40 inches; highly calcareous. | Fair to poor: moderate shrink-swell potential; fair shear strength. | Moderate to severe: chalky shale at a depth of 20 to 40 inches. | Severe: chalky shale at a depth of 20 to 40 inches. |

Topsoil is needed to help control erosion and for growing plants on embankments, on the shoulders of roads, in ditches, and on cut slopes. Each layer of the soil was considered as a possible source of topsoil, though only one estimate is shown in the table. Some suitability ratings for the surface and the subsurface layers differ because of caliche or clayey or chalky materials. Normally, cut slopes on loamy soils can be seeded without adding a layer of topsoil.

Some soils rated *good* as sources of sand and gravel require extensive exploring to find material that will meet requirements. Sand and gravel in amounts of commercial value are in pockets of Otero gravelly complex.

The suitability of soils for material that can be excavated from a borrow pit and used for road subgrade and road fill is rated in table 5. The properties considered in determining these ratings are workability, shrink-swell potential, and compaction characteristics.

Some soils have impounded surface water that adversely affects the location of highways. For example, Ness soils, which occupy depressions, have very slow permeability and poor surface drainage and are subject to ponding during periods of heavy rainfall. Roads that cross these soils must be constructed on embankments and must be provided with adequate subdrains.

Dikes or levees can be constructed on such soils as the Bridgeport, Hord, and Roxbury soils. These soils have fair to good compaction characteristics and can be used for construction material.

In places the Campus-Canlon complex is not suitable as a site for a farm pond, because of stratified sand and gravel or pockets of sand in the bottom of the drainage channel.

Agricultural drainage is a concern in managing such soils as Ness clay. These soils are difficult to drain because they are in depressions, the topography is flat, and possible outlets are remote.

The features that affect the suitability of soils for irrigation are shown in the column "Irrigation." Limitations that affect the management of a soil for irrigation are mentioned in the section "Management of Irrigated Soils."

Terraces and diversions usually are not constructed on Bridgeport soils, because these soils are in the stream valleys where slopes are mainly 1 percent or less.

# *Formation and Classification of the Soils*

This section tells how the factors of soil formation have affected the development of soils in Hodgeman County. It also explains the system of soil classification currently used and classifies each soil series in the county according to that system.

## Factors of Soil Formation

Soil is produced by the action of soil-forming processes on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief, or lay of the land, and (5) the length of time the forces of soil development have acted on the soil material.

Climate and vegetation are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil profile. Usually, a long time is required for the development of distinct horizons.

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

### *Parent material*

The soils of Hodgeman County formed mainly from deposits of loess, outwash material, and alluvium. In some places these deposits were reworked. In areas where surface deposits of loess, outwash, or alluvium were absent, the soils generally formed in material weathered from semiconsolidated caliche or chalky shale interbedded with thin layers of limestone (fig. 15).

Throughout much of the Paleozoic era, the area that is now Hodgeman County was alternately submerged and elevated. During periods of submergence, marine sediments accumulated and were subsequently eroded during periods when the area was above sea level. Near the end of the Permian period, continental deposition became predominant and formed the red beds that are below Cretaceous and younger deposits. By the close of the Paleozoic era, the sea withdrew completely from the area and the land surface was eroded. Erosion probably continued in the area throughout the Triassic and Jurassic periods, for sediments of these periods are not known to occur in Hodgeman County.

Cretaceous deposits were laid down on the long eroded, deeply weathered Permian deposits. During the Lower Cretaceous period, the sea again invaded this area. Sand and some finer materials were deposited. These sediments made up the Cheyenne Sandstone. Later, the sea deposited dark fossiliferous clay that formed the Kiowa Shale. After a general withdrawal of the sea, marking the end of the Lower Cretaceous period, continental deposits of clay and sand accumulated in stream channels, on flood plains, and in lagoons, and thus made the Dakota Formation the oldest formation exposed in Hodgeman County (7). The area was again covered by a shallow sea, and great thicknesses of clay and limestone sediments were deposited on the Dakota Formation. These sediments formed the Graneros Shale, Greenhorn Limestone, Carlile Shale, and Niobrara Formation. Shale members of the Greenhorn Limestone Formation are the parent materials of the Wakeen and Kipson soils. This formation is the parent material for about 4 percent of the soils in the county.

The sea withdrew at the close of the Cretaceous period, and since then the area has been continually above sea level. During most of the Tertiary period, the land surface was subjected to erosion that truncated the Cretaceous rocks.

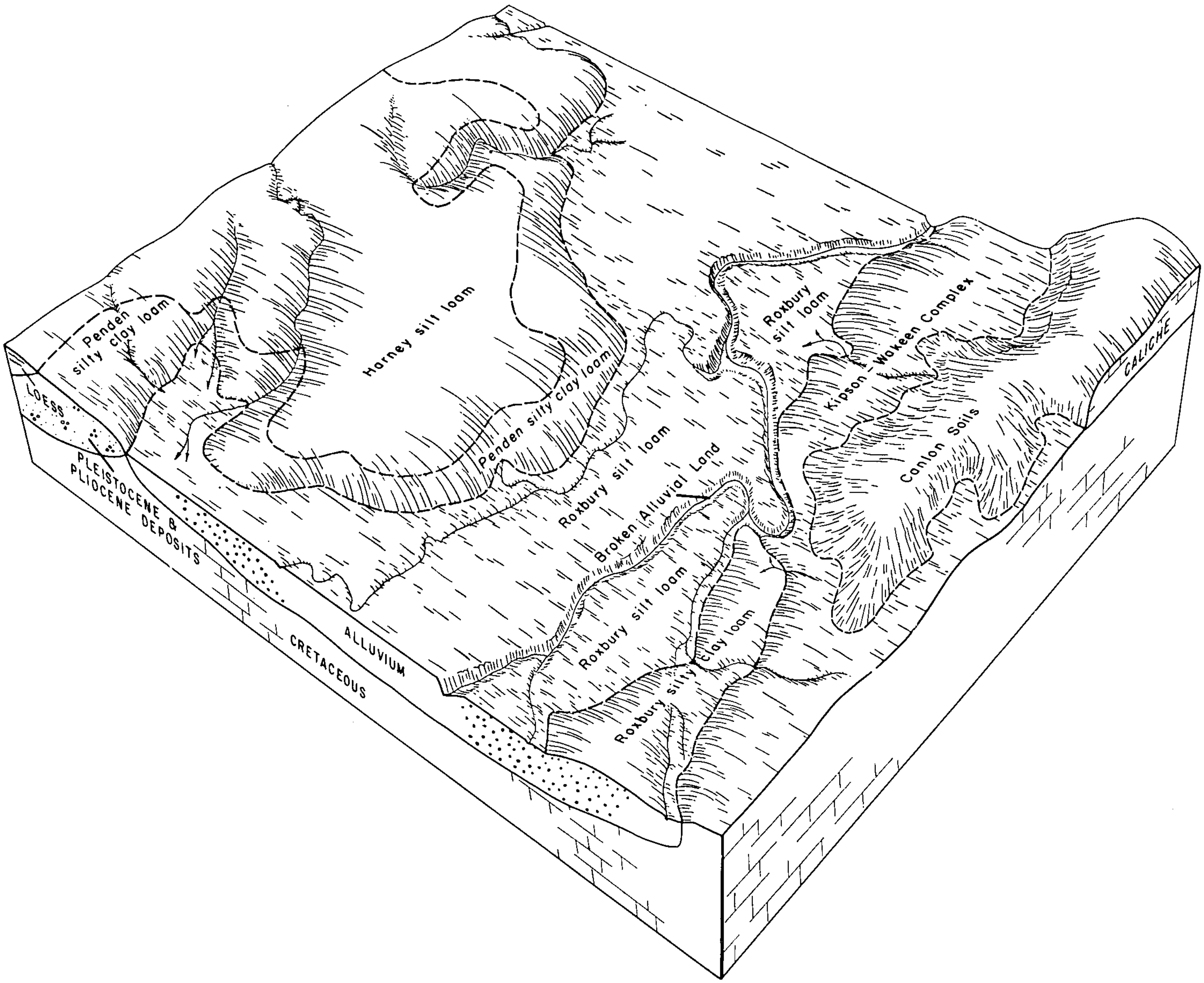


*Figure 15.*—**Typical pattern of soils and parent materials across the Sawlog Valley, about 4 miles north of the Hodgeman-Ford County line.**

After the Rocky Mountains were uplifted, the Ogallala Formation, of middle Pliocene age, was deposited by streams that carried debris from these mountains. These deposits mantled the bedrock in Hodgeman County. Much of this material was removed by subsequent erosion, particularly in the northern half of the county during early Pleistocene. In the western half of the county, the Ogallala Formation is about 100 feet thick. Later, sedimentation was resumed and the valleys cut in the Ogallala, and the areas where the formation was eroded away were filled with sediments that make up the Meade Formation and the lower Sanborn Formations. Penden soils formed in this outwash. Soils developed from materials laid down by streams of Pleistocene and Pliocene ages make up about 26 percent of the county.

Late in the Pleistocene age, the valleys of the Pawnee River and of Buckner and Sawlog Creeks were eroded and cut somewhat below their present depth. This was followed by the deposition of stream-laid silt, sand, and gravel in the valleys. Probably during this time and into Recent time there was a climatic change and the wind velocity became very strong. A layer of windblown silt, Peorian loess, was deposited over most of the county. About 55 percent of the soils in the county formed in loess, principally Harney, Richfield, Spearville, and Uly soils.

Alluvium deposited in Recent time is the youngest parent material in Hodgeman County. About 15 percent of the soils in the county formed in alluvium. Roxbury is the dominant soil that formed in this material.

Much of the present topography is the result of erosion and deposition that started during the latter part of the Pleistocene age and has continued until the present (fig. 16).

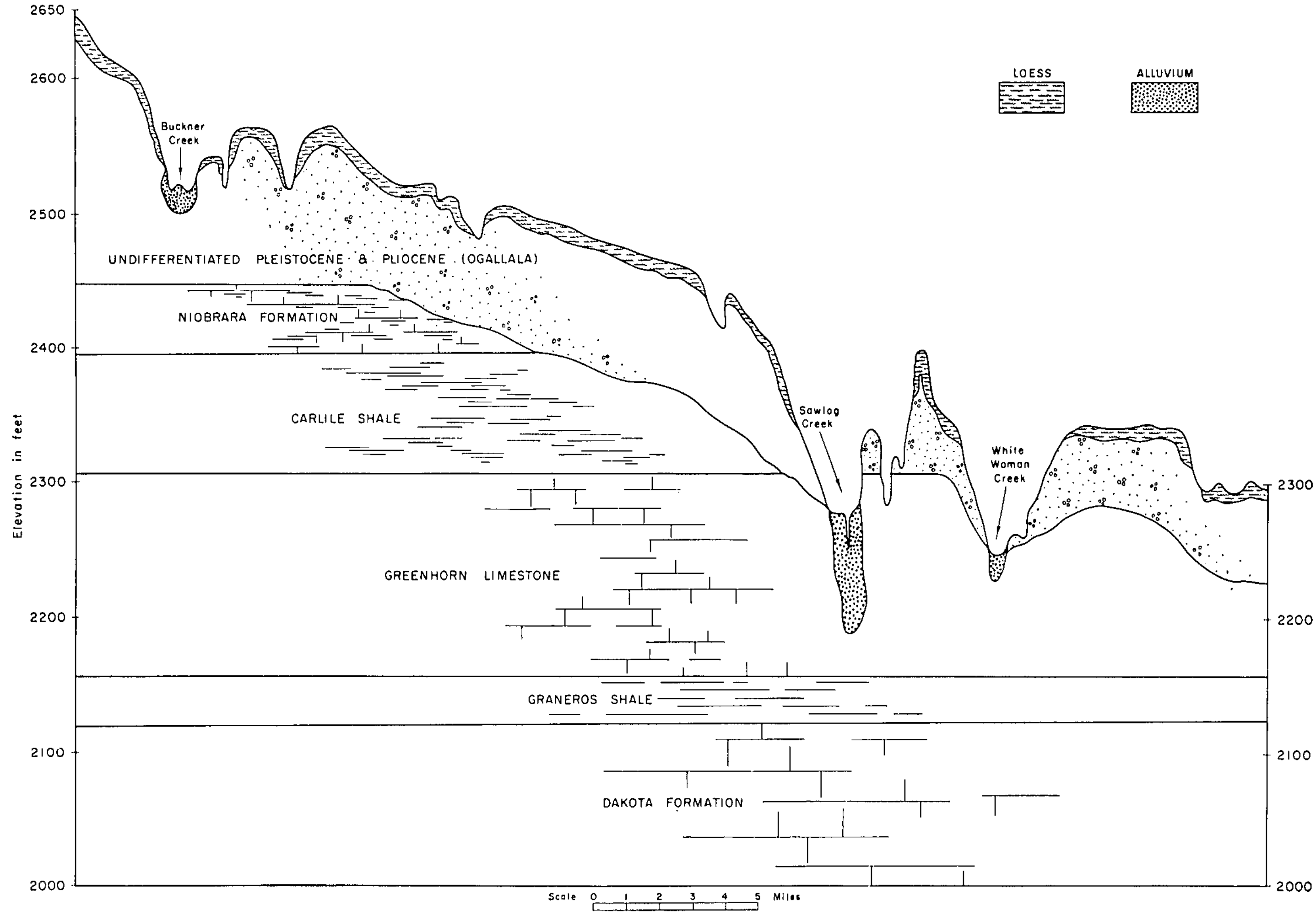


*Figure 16.*—**Geologic cross section of Hodgeman County, west to east, 4 miles north of the south county line.**

### *Climate*

Hodgeman County has a temperate, semiarid climate. The average annual temperature is about 55.3° F., and the average annual precipitation is about 20.38 inches. A large part of the precipitation falls during the growing season. Evaporation is high because of the warm temperature and strong wind. The amount of moisture available for plants and for soil leaching is limited.

The effect of climate on the soils of this county varies according to the kind of parent material, the lay of the land, and the length of time the forces of soil formation have been acting on the parent material. The downward movement of water is one of the main factors in transforming the parent material into a soil that has distinct horizons. Few soils have been leached of lime to a depth greater than 26 inches.

The Harney soil is an example of the influence of climate on the formation of soil. This soil formed in pale-brown, calcareous loess that is about 20 to 25 percent clay and is high in weatherable minerals. It has a well developed profile and is mature. The factors of soil formation have had sufficient time to exert full influence on the profile of this soil. Leaching and the weathering of minerals have formed a dark grayish-brown eluvial horizon about 8 to 15 inches thick and an illuvial horizon about 20 to 30 inches. The illuvial horizon has a clay content of about 35 to 42 percent. The Harney soil is leached of free carbonates to a depth of 18 to 30 inches.

### *Plant and animal life*

Plants and animals are important in the formation of soil. Plants largely determine the kind and amount of organic matter in the soil. They also affect the way organic matter is added, whether as leaves and twigs on the surface or as fibrous roots below the surface.

All the soils in the county formed under grass, and the upper few inches contained many fibrous roots. Decomposed organic matter darkened the soils and influenced the development of soil structure. The accumulation of organic matter is greater in nearly level areas where the most benefit is derived from the available moisture. As a result, the soils in such areas are dark colored to a greater depth than those in areas where slopes are more than 1 percent.

Bacteria and fungi live mainly on plant and animal residue. They break down complex compounds into simpler forms, as in the decay of organic matter. The simpler compounds supply nutrients for the growth of plants. Burrowing animals and earthworms have influenced the formation of soils by mixing the organic and mineral parts of the soil. Uly and Bridgeport soils are examples of soils that have many worm casts in the profile.

### *Relief*

Relief affects runoff and drainage, and in turn, modifies the effect of climate on the parent material. On the stronger slopes, runoff is more rapid, less moisture enters the soil, and erosion is greater. As a result, soil development is less rapid.

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

Ness soils are in undrained depressions that receive runoff from adjacent areas. Their clayey texture and gray color show the effects of additional moisture and poor drainage. The Harney soils have smooth, gentle slopes and neither restricted nor excessive surface drainage. They are less clayey and are better drained than Ness soil. They are more clayey throughout than Uly soils and are leached of lime to a greater depth. The more strongly sloping Uly soils are generally in weakly convex areas. Runoff is more rapid on these soils, and erosion has been greater than on the soils that have gentle, smoother slopes. The weakly developed profile of Uly soils reflects the influence of relief.

### *Time*

Time is necessary for the factors of soil formation to develop soil horizons through their action on parent material. The parent material of the Bridgeport soil, which formed in alluvium, was deposited in Recent time. As a result, these soils have weakly developed horizons. At the other extreme are the Harney and Spearville soils, which have parent material that has been in place long enough for the formation of distinct soil horizons.

Differences in the soils of several series in this county have been caused mainly by differences in the length of time that the factors of soil formation have acted on the parent material. For example, the parent material of the Detroit and Bridgeport soils is nearly uniform, but the more mature Detroit soils reflect the longer time that the parent material has been subject to soil-forming factors.

Soils develop slowly in a dry climate and under sparse vegetation such as exist in Hodgeman County, but they develop much more rapidly in a moist climate and under dense vegetation.

## Classification of the Soils

Classification consists of an orderly grouping of soils according to a system designed to make it easier to remember soil characteristics and interrelationships. Classification is useful in organizing and applying the results of experience and research. Soils are placed in narrow classes for discussion in detailed soil surveys and for application of knowledge within farms and fields. The many thousands of narrow classes are then grouped into progressively fewer and broader classes in successively higher categories, so that information can be applied to large geographic areas.

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (*2*) and revised later (*10*). The system currently used by the National Cooperative Soil Survey was developed in the early sixties (*9*) and adopted in 1965 (*12*). It is under continual study.

The current system of classification has six categories. Beginning with the most inclusive, these categories are the order, the suborder, the great group, the subgroup, the family, and the series. The criteria for classification are soil properties that are observable or measurable, but the properties are selected so that soils of similar genesis are grouped together. The placement of some soil series in the current system of classification, particularly in families, may change as more precise information becomes available.

Table 6 shows the classification of each soil series of Hodgeman County by family, subgroup, and order, according to the current system.

ORDER.—Ten soil orders are recognized. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate these soil orders are those that tend to give broad climatic groupings of soils. The two exceptions are the Entisols and Histosols, both of which occur in many different kinds of climate. The three soil orders in Hodgeman County are Entisols, Mollisols, and Vertisols.

Entisols are light-colored soils that do not have natural genetic horizons or that have only very weakly expressed beginnings of such horizons. These soils do not have traits that reflect soil mixing caused by shrinking and swelling.

Mollisols formed under grass and have a thick, dark-colored surface horizon containing colloids dominated by bivalent cations. The material in these soils has not been mixed by shrinking and swelling.

Vertisols are clay soils that shrink and swell enough to cause cracking, shearing, and mixing of the soil material when climatic and topographic conditions allow alternate wetting and drying of the soil mass.

SUBORDER.—Each order is divided into suborders, primarily on the basis of soil characteristics that seem to produce classes having the greatest genetic similarity. Climatic range is narrower than that of the order. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging or soil differences resulting from the climate or vegetation.

GREAT GROUP.—Suborders are divided into great groups on basis of uniformity in the kind and sequence of genetic horizons and major soil features. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those in which a pan interferes with the growth of roots or movement of water. The features used are the self-mulching properties of clays, soil temperature, and major differences in chemical composition, mainly differences in calcium, magnesium, sodium, and potassium. The great group is not shown in table 6.

SUBGROUP.—Great groups are divided into subgroups, one representing the central (typic) segment of the group, and others, called intergrades, that have properties of one great group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or

TABLE 6.—*Soil series classified according to the current system of classification*

| Series | Family | Subgroup | Order |
|---|---|---|---|
| Bridgeport | Fine-silty, mixed, mesic | Fluventic Haplustolls | Mollisols. |
| Campus | Fine-loamy, mixed, mesic | Typic Calciustolls | Mollisols. |
| Canlon | Loamy, mixed, calcareous, mesic | Lithic Ustorthents | Entisols. |
| Coly | Fine-silty, mixed, calcareous, mesic | Typic Ustorthents | Entisols. |
| Detroit | Fine, montmorillonitic, mesic | Pachic Argiustolls | Mollisols. |
| Harney [1] | Fine, montmorillonitic, mesic | Typic Argiustolls | Mollisols. |
| Hord | Fine-silty, mixed, mesic | Pachic Haplustolls | Mollisols. |
| Kim | Fine-loamy, mixed, calcareous, mesic | Ustic Torriorthents | Entisols. |
| Kipson [2] | Loamy, mixed, mesic, shallow | Udorthentic Haplustolls | Mollisols. |
| Ness | Fine, montmorillonitic, mesic | Udic Pellusterts | Vertisols. |
| Ost [3] | Fine-loamy, mixed, thermic | Typic Argiustolls | Mollisols. |
| Otero | Coarse-loamy, mixed, calcareous, mesic | Ustic Torriorthents | Entisols. |
| Penden | Fine-loamy, mixed, mesic | Typic Calciustolls | Mollisols. |
| Richfield [4] | Fine, montmorillonitic, mesic | Aridic Argiustolls | Mollisols. |
| Roxbury | Fine-silty, mixed, mesic | Cumulic Haplustolls | Mollisols. |
| Spearville | Fine, montmorillonitic, mesic | Typic Argiustolls | Mollisols. |
| Uly | Fine-silty, mixed, mesic | Typic Haplustolls | Mollisols. |
| Wakeen | Fine-silty, carbonatic, mesic | Typic Haplustolls | Mollisols. |

[1] The Harney soils in units Hd and He in Hodgeman County are taxadjuncts to the Harney series because the A horizon is thinner and the depth to lime is less than the range defined for the Harney series.

[2] The Kipson soil in Hodgeman County is a taxadjunct to the Kipson series because the mean annual precipitation is less than the range defined for the Kipson series.

[3] The Ost soil in Hodgeman County is a taxadjunct to the Ost series because the soil temperature is a few degrees lower than the range defined for the Ost series.

[4] The Richfield soil in unit Ro in Hodgeman County is a taxadjunct to the Richfield series because the A horizon is thinner and the depth to lime is less than the range defined for the Richfield series.

order. The names of subgroups are derived by placing one or more adjectives before the great group.

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

## Climate [6]

Hodgeman County has a semiarid, continental climate characterized by low annual rainfall, abundant sunshine, dry atmospheric air, moderate to occasionally strong surface winds, and large daily and annual variations in temperature. The county is on the High Plains of Western Kansas. The average elevation is about 2,300 feet above sea level. Facts about temperature and precipitation are given in table 7.

### PRECIPITATION

Hodgeman County, not far removed from the driest area in the State, receives about 20½ inches of precipitation annually. The Rocky Mountains and the Gulf of Mexico are significant climatic controls. The mountains effectively produce a rain shadow and contribute to the low annual precipitation. Atmospheric air of eastward-moving Pacific weather systems is lifted as it passes over the mountain ranges. Consequently, much of the moisture in these systems condenses and falls over the higher elevations to the west of Kansas. The drier air currents then descend, and winds blow downslope in arriving at Hodgeman County. The Gulf of Mexico is the principal source of moisture for precipitation in western Kansas (*4*), but Hodgeman County is not often in the path of moist air that flows northward from the Gulf.

Insufficient rainfall is the most frequent limiting factor in the production of farm crops on dryland farms. This deficiency can be partly overcome by summer fallowing. It is significant that about three-fourths of the annual precipitation, 20.38 inches, falls during April through September. Much of this moisture falls during showers and thundershowers. Heavy downpours occur at times and erode cultivated fields, especially where the slope is more than 1 percent (*6*).

The peaks in rainfall are in May and June. Precipitation averages more than 3 inches for each of these months. Thereafter, it gradually declines to a minimum of 0.38 inch for January. Precipitation is very light in winter. December, January, and February account for only 8 percent of the annual average precipitation.

The annual precipitation varies. Records at Jetmore for the period 1901 to 1966 show that precipitation has ranged from 8.18 inches in 1952 to 34.52 inches in 1958 (fig. 17). A series of dry years is not uncommon. Droughts were very severe during the 1930's, and again from 1952 to 1956. Palmer (*8*) has developed a system for determining the intensity and duration of meteorological drought. Data obtained from this system show that the drought of the 1930's was the longest of any in 30 years. Drought conditions were continuous in west-central Kansas from July 1932 through October 1940. Of the 103 months of dry weather during that period, 55 months had either severe or extreme drought. The drought of the 1950's, although of shorter duration, was even more severe than the one of the 1930's.

The cultivated soils in the county are subject to blowing (*6*). During a period of drought soil blowing can be severe, especially in spring when winds are usually the

[6] By MERLE J. BROWN, State climatologist, National Weather Service.

strongest. Strong surface wind and unstable air can move soil particles and carry some of them to great heights. Soil blowing was not so much of a problem in the drought of the 1950's as it was in the 1930's because management, including methods of tillage, had improved.

Table 7 shows, by months, the average precipitation for Hodgeman County. It can be noted that in 1 year out of 10, on the average, precipitation in November measures less than 0.01 inch. At the other extreme, precipitation in June, on the average, exceeds 6.27 inches in 1 year out of 10.

TABLE 7.—*Temperature and precipitation*

[Data from Jetmore, Hodgeman County, Kans.]

| Month | Temperature | | | | Precipitation | | |
|---|---|---|---|---|---|---|---|
| | Average daily maximum [1] | Average daily minimum [1] | Two years in 10 will have at least 4 days with—[2] | | Average total [3] | One year in 10 will have— | |
| | | | Maximum temperature equal to or higher than | Minimum temperature equal to or lower than | | Less than | More than |
| | °F. | °F. | °F. | °F. | In. | In. | In. |
| January | 45. 1 | 17. 4 | 64 | 0 | 0. 38 | 0. 01 | 1. 06 |
| February | 49. 4 | 20. 7 | 70 | 7 | . 74 | . 04 | 1. 70 |
| March | 58. 6 | 28. 5 | 77 | 11 | 1. 06 | . 09 | 2. 47 |
| April | 67. 8 | 39. 2 | 88 | 25 | 1. 97 | . 27 | 3. 80 |
| May | 77. 1 | 50. 1 | 93 | 38 | 3. 12 | 1. 04 | 5. 75 |
| June | 87. 7 | 60. 0 | 102 | 49 | 3. 12 | . 70 | 6. 27 |
| July | 93. 9 | 65. 4 | 103 | 58 | 2. 80 | . 59 | 5. 31 |
| August | 92. 8 | 64. 3 | 103 | 55 | 2. 46 | . 80 | 4. 78 |
| September | 85. 2 | 55. 6 | 98 | 40 | 1. 75 | . 28 | 3. 37 |
| October | 73. 0 | 42. 7 | 89 | 30 | 1. 55 | . 09 | 3. 70 |
| November | 58. 1 | 28. 3 | 73 | 13 | . 87 | . 01 | 2. 20 |
| December | 46. 9 | 19. 8 | 65 | 7 | . 56 | . 01 | 1. 39 |
| Year | 69. 6 | 41. 0 | [4] 106 | [5] −10 | 20. 38 | [6] 13. 93 | [7] 28. 79 |

[1] Period 1908–60.
[2] Period 1936–60.
[3] Period 1901–60.
[4] Average annual maximum.
[5] Average annual minimum.
[6] Yearly value equal to or less than 13.93 inches.
[7] Yearly value equal to or less than 28.79 inches.

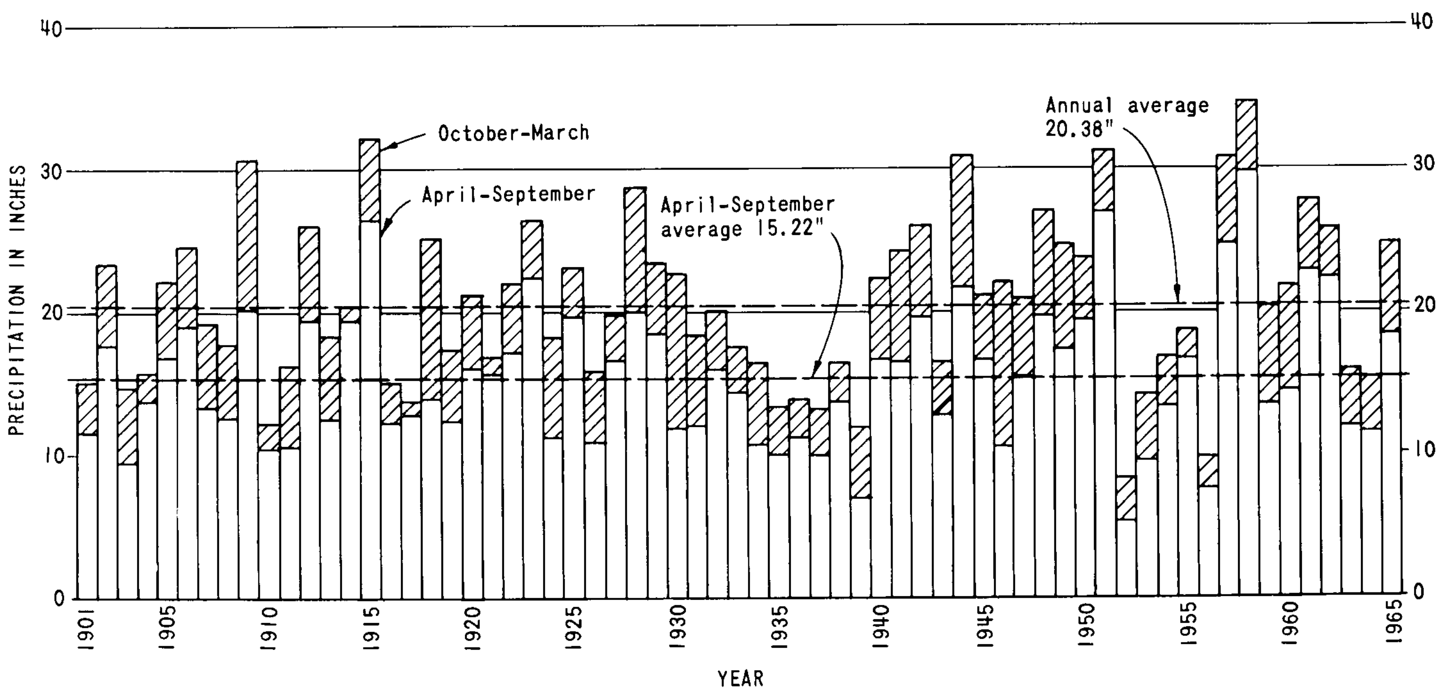


***Figure 17.***—**Annual precipitation and precipitation from April through September at Jetmore, Kans., for the period 1901 through 1965. White part of bar represents precipitation from April through September. White part plus shaded part represents annual precipitation.**

Figure 18 shows the probability, in percent, of receiving specified amounts of precipitation in any week of the year. It also shows the normal weekly precipitation. The percentages are based on data recorded at Larned (*5*). It can be noted in the figure that the best chances of receiving significant amount of moisture, that is, 0.20 inch or more in 1 week, are late in May and early in June. In summer the probability of significant rainfall is least late in July.

Table 8 gives the frequency, in years, of specified amounts of rainfall for durations of one-half hour to 24 hours (*13*).

Snowfall is generally light. It averages about 20 inches annually and is usually heaviest in March. Blizzards and heavy snowstorms occur, but they are relatively infrequent. Snowfall may accumulate to a depth of several inches, but seldom remains on the ground for long.

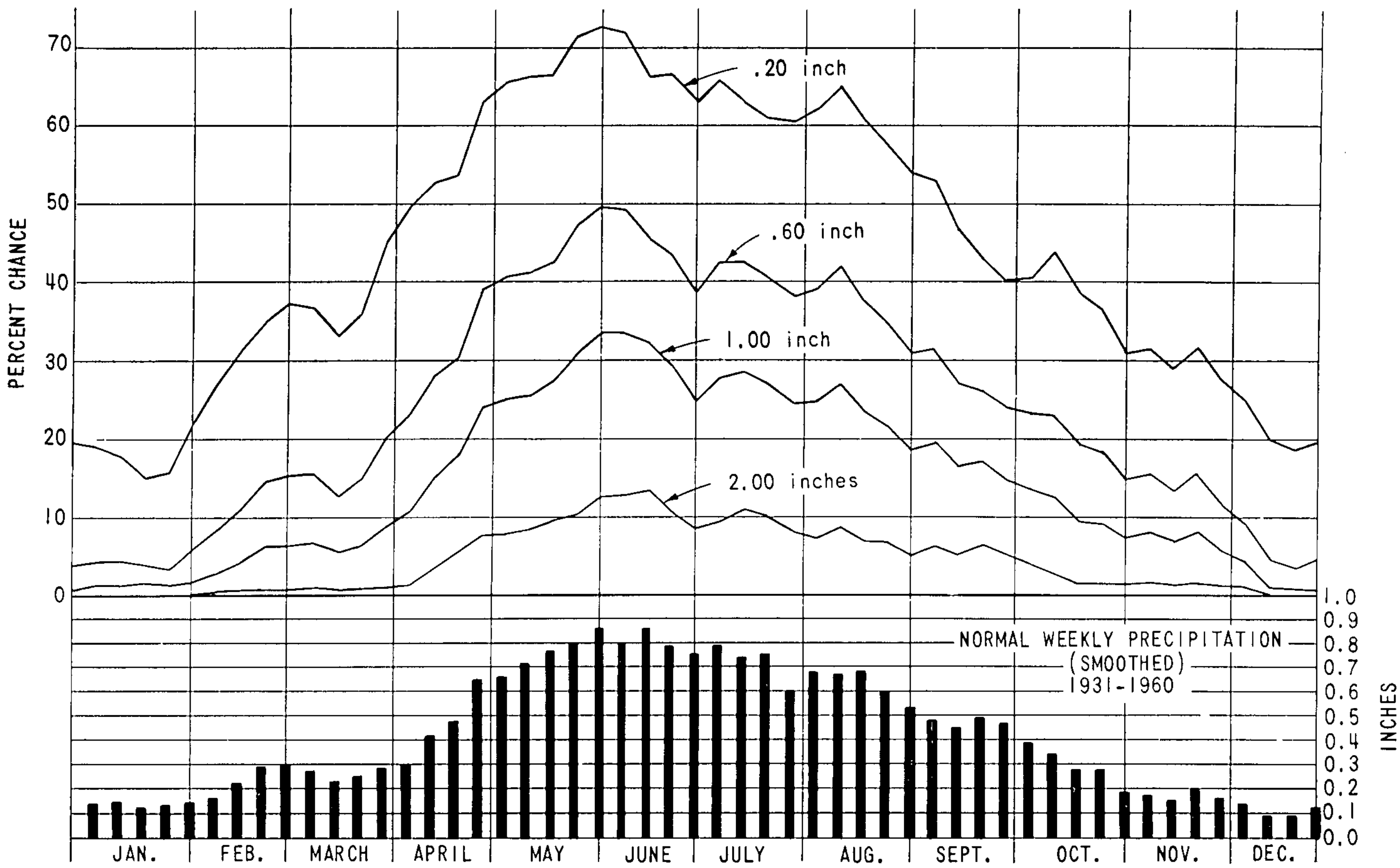


***Figure 18.*—Probabilities, in percent, of receiving at least the specified amount of precipitation by weeks. The normal amount of weekly precipitation is shown at the bottom of this figure.**

TABLE 8.—*Frequency of specified amounts of rainfall during stated time intervals*

| Frequency [1] | Inches of rainfall for duration of— | | | | | | |
|---|---|---|---|---|---|---|---|
| | One-half hour | 1 hour | 2 hours | 3 hours | 6 hours | 12 hours | 24 hours |
| Once in | | | | | | | |
| 1 year | 0.9 | 1.2 | 1.4 | 1.4 | 1.8 | 1.7 | 2.0 |
| 2 years | 1.2 | 1.5 | 1.7 | 1.8 | 2.1 | 2.3 | 2.5 |
| 5 years | 1.6 | 2.1 | 2.4 | 2.5 | 2.7 | 3.2 | 3.5 |
| 10 years | 1.9 | 2.5 | 2.8 | 2.9 | 3.3 | 3.8 | 4.2 |
| 25 years | 2.3 | 2.9 | 3.3 | 3.5 | 3.9 | 4.3 | 5.0 |
| 50 years | 2.6 | 3.3 | 3.7 | 4.0 | 4.5 | 5.0 | 5.8 |
| 100 years | 3.0 | 3.7 | 4.2 | 4.5 | 5.0 | 5.8 | 6.0 |

[1] Frequency of specified number of inches of rainfall at given time intervals. For example, 2.4 inches of rainfall in 2 hours can be expected once in 5 years, and 1.9 inches in one-half hour can be expected once in 10 years.

### Temperature

Frequent cloudless skies and dry atmospheric air result in warm days and cool nights. Daily and annual temperatures vary greatly. A daily range of 30 degrees is not uncommon, and variations of more than 40 degrees are recorded at times, particularly in fall.

The transition from winter to spring is rapid. In March, for example, the mean temperature is 43.5° F.; in April, it is 53.5°. The change is even more rapid between October and November. The mean temperature in October is 58°, and in November 43°.

The temperature extremes at Jetmore have ranged from a low of 24° below zero to a high of 114° (fig. 19). The average daily maximum during July and August is in the nineties. On an average of 78 days during the year, the maximum temperature is 90° or higher. At the other extreme, on an average of 137 days the minimum temperature is 32° or lower. Table 7 gives the average daily maximum and minimum temperatures, by months, and also gives the probability of very high or very low temperatures.

The freeze-free period ranges from about 170 days per year in the northwestern corner of the county to 180 days in the southeastern corner (*3*). At Jetmore, the latest date in spring of a temperature of 32° or below was May 27, 1907. The earliest date of a 32° temperature in fall was September 20, 1918. Crops grown in the area are usually not damaged severely by freezing weather.

Probabilities for the last freeze in spring and the first in fall are given for five freeze thresholds in table 9. Data in this table indicate that in half the years, on the average, the last 32° temperature in spring occurs after April 27, and the first in fall before October 19.

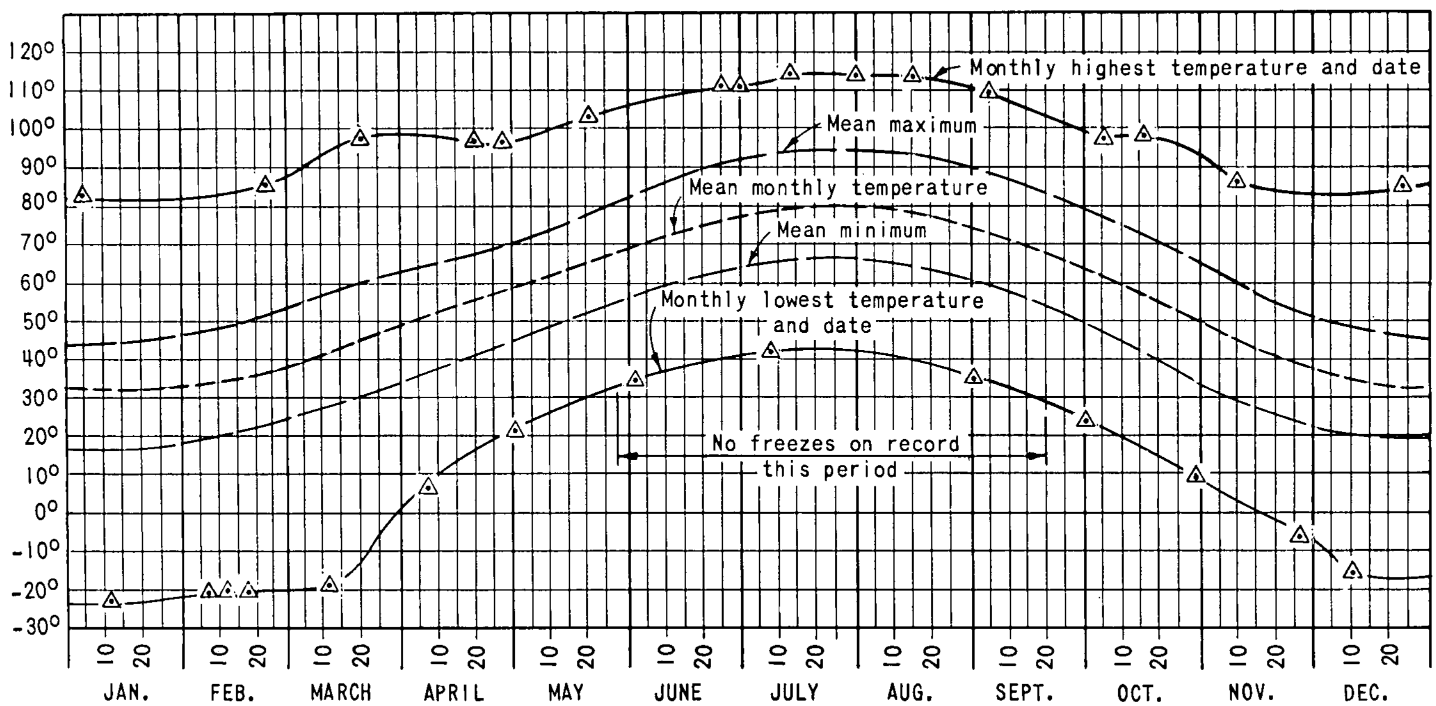


***Figure 19.*—Means and extremes of temperature at Jetmore, Kans.**

Table 9.—*Probability of last freezing temperature in spring and first in fall*

| Probability | Dates for given probability and temperature | | | | |
|---|---|---|---|---|---|
| | 16° F. or lower | 20° F. or lower | 24° F. or lower | 28° F. or lower | 32° F. or lower |
| Spring: | | | | | |
| 1 year in 10 later than | April 4 | April 11 | April 14 | April 29 | May 12 |
| 2 years in 10 later than | March 29 | April 5 | April 9 | April 24 | May 7 |
| 5 years in 10 later than | March 17 | March 26 | March 31 | April 14 | April 27 |
| Fall: | | | | | |
| 1 year in 10 earlier than | November 5 | October 29 | October 21 | October 16 | October 5 |
| 2 years in 10 earlier than | November 11 | November 3 | October 25 | October 21 | October 9 |
| 5 years in 10 earlier than | November 23 | November 14 | November 4 | October 30 | October 19 |

Surface winds are moderate to occasionally strong. The strongest winds are in March and April when hourly velocities average 16 to 17 miles per hour. The prevailing wind direction is northerly in February, March, and December, and southerly in other months.

Tornadoes occur occasionally, but generally affect only small local areas. Hail, accompanied by strong winds, probably causes more damage than any other type of storm. In the wettest years, when conditions are favorable for bumper crops, damage may be especially severe.

# *Additional Facts About the County*

Hodgeman County was organized in 1879. The population was about 1,500. It increased steadily to 3,825 in 1930. Then it decreased and fluctuated during the 1950's. In 1960, it was 3,115.

In 1949, farmers and landowners organized the county into a soil conservation district to promote proper land use and the conservation of soil and water. Hodgeman County was the 97th county in the State to form a district.

The following pages tell about the physiography, relief, and drainage in the county, the water supply, markets and transportation, industries, and farming.

## Physiography, Relief, and Drainage

Hodgeman County lies within the Central High Tableland and the Rolling Plains and Breaks sections of the Central Great Plains Winter Wheat and Range Region.

All of the county drains into the Pawnee River except the southeast corner, which drains into Little Coon Creek. The Pawnee River, which originates in Finney County and joins the Arkansas River at Larned in Pawnee County, about 25 miles east of the east Hodgeman County line, flows generally through the northern part of Hodgeman County. Its largest tributary, Buckner Creek, originates in the northeastern part of Gray County and flows northeastward to join the Pawnee River about 5 miles south and one-fourth mile east of the northeast corner of Hodgeman County. The largest tributary of Buckner Creek is Sawlog Creek, which originates in the northwest corner of Ford County and joins Buckner Creek at Hanston in the eastern part of the county. Hackberry Creek, a small tributary, originates in Lane County and joins the Pawnee River in the northwestern part of the county. Little Coon Creek originates in Ford County, flows through the southeast corner of Hodgeman County into Edwards County, and drains into the Arkansas River about 3 miles northeast of Kinsley.

The central parts of the divides between the major streams are flat and undissected. The major drainage of the areas is to the east; the divides, therefore, slope eastward. South-facing slopes of the divides slope gently to the streams. The soils are deep. Rock outcrops are rare. In contrast are the north-facing slopes, which are generally short, steep, rough, and broken. The soils on these slopes are mostly moderately deep to shallow over rock and there are many rock outcrops. The valleys of streams that trend northward or southward have nearly symmetrical cross sections (*7*). All the major streams have developed flood plains, some of which are more than 2 miles wide.

Elevations in Hodgeman County range from 2,090 feet where Buckner Creek and the Pawnee River leave the county to about 2,660 feet in the southwest corner. The elevation at Hanston is about 2,140 feet, and at Jetmore about 2,280 feet.

## Water Supply

Ground water is obtained from the alluvium of the larger streams, from the Ogallala Formation, and from the Dakota Sandstone. Some water comes from springs, but most comes from wells.

Water for domestic use is obtained from wells. Most water for livestock also comes from wells, but some comes from springs, creeks, and small ponds. Wells for domestic use and for livestock can be drilled almost anywhere in the county.

Water in sufficient quantity to irrigate field crops is pumped from the alluvium of the major streams, and in local areas from the Ogallala Formation and the Dakota Sandstone.

## Markets and Transportation

Jetmore and Hanston, two towns in Hodgeman County, are along Buckner Creek. Jetmore is in the center of the county. Hanston is about midway between Jetmore and the east county line. Both are on U.S. Highway 156.

U.S. Highway 156 crosses the center of Hodgeman County, generally from east to west. U.S. Highway 283 crosses from north to south and intersects Highway 156 at Jetmore. A bus line traveling north and south operates on a schedule through Jetmore. Practically all the county is accessible by graded county and township roads.

## Industries

Petroleum and natural gas production is second only to farming in Hodgeman County. There is a natural gas plant in the northeast corner of the county. Fields opening north of Hanston sharply increased petroleum production in 1962.

Sand and gravel, used mainly for road surfacing, are obtained from deposits on Sand and White Woman Creeks. Limestone for fenceposts, culverts, bridges, and other structures has been quarried (*7*). At present there are no active quarries.

## Farming

Farming in Hodgeman County is based mainly on wheat and grain sorghum. Dryland farming is predominant. Farming operations are on a large scale and are highly mechanized. About 9,000 acres is irrigated. The raising and production of cattle is the principal livestock industry in the county.

*Crops.*—Wheat and grain sorghum are the crops best suited to the dryland farming and the climate of Hodgeman County. Wheat is the main cash crop. It is usually grown on acreages that have been fallowed. During the fallow period, the soil is kept free of weeds and volunteer wheat so that moisture is stored for the crop that follows.

In 1960, according to the Kansas State Board of Agriculture, 153,000 acres was in wheat, 26,000 in grain sorghum, 18,000 in forage sorghum, 11,000 in barley, 1,000 in alfalfa, 800 in oats, and 200 in corn.

Wheat and grain sorghum are also the major crops under irrigation. Small acreages are used for alfalfa, corn, and forage sorghum.

*Range.*—About 40 percent of the county is in native grass and is used as range. About half the rangeland is nonarable. Most of the rangeland is on the more sloping soils south of Buckner Creek, in the northwest quarter of the county, and on the east side of Sawlog Creek. These soils support mainly mid and short grasses. Tall grass grows in bottom lands that are frequently flooded.

*Livestock.*—Large numbers of cattle and some sheep are brought into the county in fall when wheat pasture and sorghum stubble are available for grazing.

In 1960, according to the Kansas State Board of Agriculture, there were 370 horses and mules, 1,700 milk cows, 38,300 cattle other than milk cows, 5,840 sheep, 1,400 hogs, and 29,000 chickens in Hodgeman County.

*Size, type, and tenure of farms.*—The 1964 United States Census of Agriculture reported 507 farms in Hodgeman County. The average size of farms was 1,000 acres. Dryland farms numbered about 405 and averaged about 967 acres. All or part of the cropland on the other 102 farms, 115,635 acres, was irrigated. Average size per farm was 1,134 acres. The estimated numbers of farms classified according to major source of income are as follows: 128 cash grain, 20 dairy, 280 livestock other than poultry or dairy, 23 general farms, and 56 miscellaneous and unclassified.

The 1964 census shows approximately 20 percent of the operators are full owners, 52 percent are part owners, and 28 percent are tenants.

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## Glossary

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

**Available water capacity** (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

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

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

**Chlorosis.** Yellowing or blanching of green portions of a plant, particularly the leaves. May be caused by disease organisms, unavailability of nutrients, or other factors.

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

**Complex, soil.** A mapping unit consisting of different kinds of soils that occur in such small individual areas or in such an intricate pattern that they cannot be shown separately on a publishable soil map.

**Concretions.** Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

**Consistence, soil.** The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

*Loose.*—Noncoherent when dry or moist; does not hold together in a mass.

*Friable.*—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

*Firm.*—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

*Plastic.*—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

*Sticky.*—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

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

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

*Cemented.*—Hard and brittle; little affected by moistening.

**Depth classes, soil.** The upper limit and the lower limit of a depth class, applied to any one soil, are fixed in definite figures. These limits need to vary somewhat among soils depending on the other soil characteristics. In this survey, the approximate upper and lower limits of depth classes are as follows.

| | *Inches* |
|---|---|
| Very shallow | 0 to 10 |
| Shallow | 10 to 20 |
| Moderately deep | 20 to 40 |
| Deep | 40 to 60 |

**Flood plain.** Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

**Gravel.** Individual rock or mineral fragments having diameters ranging from 2.0 millimeters to 3 inches. As a textural class modifier, gravelly is used when the soil mass contains above 15 to 20 percent by volume of the fragments, depending on the other soil characteristics.

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

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

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

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

*C horizon.*—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

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

**Leached, soil.** A soil from which most of the soluble materials have been removed from the entire profile or have been removed from one part of the profile and have accumulated in another part.

**Loam.** As a soil textural class, a soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand.

**Loess.** Fine-grained material, dominantly of silt-sized particles, that has been deposited by wind.

**Parent material.** Disintegrated and partly weathered rock from which soil has formed.

**Permeability.** The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

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

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

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

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

**Relief.** The elevations or inequalities of a land surface, considered collectively.

**Sand.** Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

**Series, soil.** A group of soils developed from a particular type of parent material and having genetic horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the profile.

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

**Soil.** A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

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

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

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

**Substratum.** Technically, the part of the soil below the solum.

**Surface soil.** The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

**Terrace** (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, or lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

**Texture, soil.** The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

**Tilth, soil.** The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

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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).