SOIL SURVEY OF

HARPER COUNTY, Kansas

U. S. Department of Agriculture
Soil Conservation Service
In Cooperation With
Kansas
Agricultural Experiment Station

Issued December 1971

Major fieldwork for this soil survey was done in the period 1960 to 1963. Soil names and descriptions were approved in 1965. Unless otherwise indicated, statements in this 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 Harper 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, USDA, Washington, D.C. 20250

HOW TO USE THIS SOIL SURVEY

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

Locating Soils

All the soils of Harper County are shown 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 windbreak group and range site 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 ranchers and those who work with farmers can learn about use and management of the soils from the soil descriptions, from the section "Management of Soils for Crops," from the discussions of the range sites, and from the section "Management of Windbreaks.

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

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

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

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

Newcomers in Harper County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given in the beginning of the publication and in the section "Additional Facts about the County."

Cover: Terraces and contour farming on gently sloping Grant and Pond Creek soils. Breaks-Alluvial land complex is in the drainageways.

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SOIL SURVEY OF HARPER COUNTY, KANSAS

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

Harper County is in the south-central part of Kansas (fig. 1). It occupies about 512,640 acres, or 801 square miles. Anthony is the county seat.

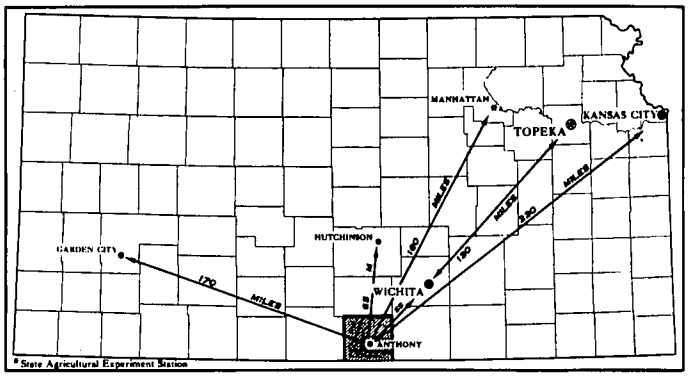

Figure 1.--Location of Harper County in Kansas.

Much of the farm income in this county comes from the sale of wheat, grain sorghum, and cattle. The soils are used mainly for dryland farming and range. Areas used for range consist mainly of sandy soils and of shallow and moderately deep soils.

Harper County is in three physiographic provinces (6) 1/. About 51 percent of the county is in the Red Hills province, and about 45 percent, in the southern and eastern parts of the county, is in the Wellington lowland province. The remaining 4 percent, in the northwest corner of the county, is in the High Plains province.

Drainage in the county is generally to the east and south. The northeastern part is drained by the Chikaskia River and its main tributaries, Spring and Sand Creeks. Bluff Creek and its tributaries drain the central and southeastern parts of the county, and Big and Little Sandy Creeks and their tributaries, the southwestern part.

HOW THIS SURVEY WAS MADE

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

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

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Nashville and Grant, 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, Kirkland silt loam, 0 to 1 percent slopes, is one of several phases within the Kirkland series.

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

1/ Underscored numbers in parentheses refer to Literature cited, p. 77

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 Harper 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 of the names of the dominant soils, joined by a hyphen. An example is Case-Clark complex, 2 to 6 percent slopes.

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." Shellabarger and Albion soils, 7 to 15 percent slopes, 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. Slickspots is a land type in Harper 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 soils 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 soils. Yields under defined management are estimated for all the soils.

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

GENERAL SOIL MAP

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

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, 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.

The terms for texture used in the title for several of the associations apply to the surface layer. For example, in the title for association 1, the term "silt loam" refers to texture of the surface layer.

The soil associations in Harper County are discussed in the following pages.

1. Grant-Nashville-Pond Creek Association

Deep and moderately deep, nearly level to sloping silt loams; on uplands

This association is in the central and south-central parts of the county. It consists of nearly level and gently sloping soils in broad areas and of sloping soils in relatively narrow areas. Intermittent major drainageways occur about every three-fourths of a mile to 1 mile. These drainageways are entrenched into bedrock and have steep side slopes. The bottoms range from 50 to 300 feet wide.

This association makes up about 31 percent of the county. It is 35 percent Grant soils, 25 percent Nashville soils, and 25 percent Pond Creek soils. Minor soils make up the remaining 15 percent.

Grant soils typically are on side slopes and are gently sloping, but small areas are nearly level or sloping. These soils are deep and are well drained. They have a surface layer of silt loam about 11 inches thick. The subsoil, about 32 inches thick, is light silty clay loam and silt loam. The underlying material is silt loam.

Nashville soils typically are on convex side slopes and are gently sloping. Small areas, however, are on ridgetops and are nearly level or are on short side slopes and are sloping. These moderately deep, well-drained soils have a surface layer

of silt loam about 12 inches thick. The subsoil is silt loam about 18 inches thick. The underlying material is soft siltstone.

Pond Creek soils are mostly nearly level. Some areas, however, are on broad side slopes and are gently sloping, and small areas on short side slopes are sloping. These deep, well-drained soils have a surface layer of silt loam about 13 inches thick. The subsoil is silty clay loam about 36 inches thick. The underlying material is silty clay loam.

Most of the acreage in minor soils consists of Breaks-Alluvial land complex, though small areas are occupied by Kirkland, Minco, and Ruella soils.

Much of this association is in small grains and sorghums. Some of the more sloping soils, however, are used for pasture or range. The Grant and Pond Creek soils are suited to alfalfa. Natural fertility is high in Grant and Pond Creek soils, and moderate in Nashville soils.

Crops on soils of this association respond to fertilizer, good management, and proper tillage. Runoff causes sheet, rill, and gully erosion on the gently sloping and sloping soils. In these areas terracing and contour farming are used for controlling water erosion.

2. Shellabarger-Farnum Association

Deep and moderately deep, nearly level to sloping loams and sandy loams; on uplands

This association consists of nearly level soils on ridge tops in relatively narrow areas; of gently sloping soils on convex side slopes in broad areas; and of sloping soils on complex side slopes in narrow areas. The largest area extends north and west of Harper. Smaller areas are in the northern half of the county.

This association makes up about 21 percent of the county. It is about 55 percent Shellabarger soils, about 40 percent Farnum soils, and about 5 percent minor soils.

Shellabarger soils typically are gently sloping and are on convex side slopes. Some of these soils are sloping, however, and occupy areas on side slopes that are irregular in shape, and a few of the soils are nearly level and are at the base of side slopes. Shellabarger soils are deep and moderately deep and are well drained. They have a surface layer of fine sandy loam about 13 inches thick. The subsoil, about 25 inches thick, is sandy clay loam. The underlying material is coarse sandy loam, except in the shale substratum phase, where shale is at a depth between 24 to 45 inches.

Farnum soils generally are nearly level and are the principal soils on ridgetops. Some of these soils, however, are gently sloping and occupy broad areas on convex side slopes. Others are sloping and occur in small areas on side slopes. Farnum soils are well drained. They have a surface layer of loam about 11 inches thick. The subsoil, about 30 inches thick, is clay loam, and is underlain by clay loam.

Minor soils in this association are in the Albion, Case, Clark, and Norge series. The land type Wet alluvial land also occupies small areas.

Most of this association is in small grains and sorghums. Crops on these soils respond to fertilizer, good management, and proper tillage. On the gently sloping and sloping soils, practices are needed for control of water erosion. On the Shellabarger soils, soil blowing is a moderate hazard, and practices for control of wind and water erosion are needed.

3. Crisfield-Port-Zenda Association

Deep, nearly level fine sandy loams and silt loams; on flood plains and low terraces

In this association are nearly level soils along some of the major streams. The flood plains and low terraces range from a few hundred feet to 4 miles in width. The largest continuous area is along Bluff Creek northwest and southeast of Anthony. Smaller areas are along Sand Creek and the Chikaskia River in the northeastern part of the county, and along West Sandy Creek and Little Sandy Creek and their tributaries in the southwestern part.

This association makes up about 14 percent of the county. About 70 percent is made up of Crisfield and Port soils in equal parts, and about 10 percent is Zenda soils. Minor soils make up the remaining 20 percent.

Crisfield soils are well drained. They have a surface layer of fine sandy loam about 18 inches thick. The subsoil is fine sandy loam about 27 inches thick. The underlying material is loamy fine sand.

Port soils also are well drained. They have a surface layer of silt loam about 22 inches thick. Below this is silt loam about 18 inches thick. The underlying material is stratified silt loam and silty clay loam.

Zenda soils are somewhat poorly drained. Their surface layer is fine sandy loam about 15 inches thick. The upper part of the subsoil is sandy clay loam about 7 inches thick. The lower part of the subsoil is about 11 inches thick. It is mottled sandy clay loam. The underlying material is mottled sandy clay loam.

The minor soils in this association are the Brazos, Gerlane, Minco, and Shellabarger, and areas of the Port-Slickspots complex. Gerlane soils make up about 10 percent of the association.

Most of this association is in small grains. The soils are well suited to alfalfa, and more alfalfa is grown in this association than in any other in the county.

Most crops on soils of this association respond to fertilizer. Lime generally is not required for wheat or sorghums, but it may be required locally for alfalfa. Good management is needed for maintaining fertility, tilth, and organic matter. The

hazard of soil blowing is slight to moderate in the Crisfield and Zenda soils, and practices are needed that control soil blowing.

4. Kirkland-Renfrow Association

Deep and moderately deep, nearly level and gently sloping silt loams and clay loams; on uplands

This association is in the southeast corner of the county. It consists of nearly level soils on broad plains and of gently sloping soils on long side slopes.

This association makes up about 4 percent of the county. It is 60 percent Kirkland soils and 35 percent Renfrow soils. Minor soils make up the remaining 5 percent.

Kirkland soils are deep and moderately well drained. Some of these soils are nearly level and are on broad plains; others are gently sloping and occupy long slopes. Kirkland soils are slowly permeable. Their surface layer is silt loam about 12 inches thick. The subsoil is silty clay and clay about 40 inches thick. The underlying material is clayey sediment that contains a few lime concretions.

Renfrow soils are deep and moderately deep and are well drained. They are gently sloping and are on long slopes. The surface layer is clay loam about 9 inches thick. The subsoil is clay about 33 inches thick. Below this is clay about 18 inches thick that typically is underlain by calcareous shale. In some places the third layer is absent, and the subsoil is underlain by shale. Depth to shale ranges from 24 to 70 inches.

The minor soils in this association are in the Bethany, Pond Creek, and Vernon series.

About 70 percent of this association is in small grains and sorghums. The rest is used for pasture and range. Most crops on these soils respond to fertilizer. Proper tillage done at optimum moisture content is effective in maintaining soil structure. Water erosion is a serious hazard on the gently sloping soils. Terraces and other measures are needed for controlling water erosion.

5. Bethany-Corbin-Tabler Association

Deep, nearly level and gently sloping silt loams and clay loams; on uplands

This association is in the east-central part of the county. It consists principally of nearly level soils on broad plains, though in a small acreage the soils are gently sloping. The gently sloping soils generally occur along slopes to intermittent drainageways.

This association makes up about 7 percent of the county. It is 30 percent Bethany soils, and about 30 percent consists of Corbin and Tabler soils in equal parts. Minor soils make up the remaining 40 percent.

Bethany soils are mainly nearly level and are on broad plains, but some areas are gently sloping. These soils are well drained. They have a surface layer of silt loam about 13 inches thick, and a transitional silty clay loam layer about 4 inches thick. The upper part of the subsoil is clay about 21 inches thick, and the lower part is silty clay loam.

Corbin soils are mainly nearly level and are on broad plains, but some of the soils are gently sloping. These soils are deep and are well drained. They have a surface layer of silt loam about 16 inches thick. The upper part of the subsoil is silty clay loam about 14 inches thick, and the lower part is clay about 25 inches thick. The underlying material is silty clay loam that is similar to the upper part of the subsoil.

Tabler soils are nearly level and are on broad plains or in slightly concave areas. They are deep, moderately well drained, and very slowly permeable. Their surface layer is clay loam about 10 inches thick. The subsoil is clay and is about 23 inches thick. The underlying material is calcareous clay.

Minor soils in this association are in the Grant, Kirkland, Nashville, Pond Creek, and Renfrow series. The land types Alluvial land and Broken alluvial land also occupy small areas.

Most of this association is in small grains. Crops on these soils generally respond to fertilizer. In places water ponds on the Tabler soils and damages crops. On the nearly level soils, practices are needed that maintain fertility, tilth, and the content of organic matter. The hazard of water erosion is slight on the gently sloping soils, and it can be controlled by use of conservation measures.

6. Farnum-Norge Association

Deep, nearly level and gently sloping loams; on uplands

This association is in the northeastern part of the county near Danville. It consists of nearly level and gently sloping soils on broad plains and side slopes.

This association makes up about 6 percent of the county. It is about 60 percent Farnum soils and 30 percent Norge soils. Minor soils make up the remaining 10 percent.

Farnum soils are nearly level and gently sloping and are on broad plains on the north side of Sand Creek. The nearly level areas extend from 1 to 3 miles north of the stream, and the gently sloping areas extend from this distance 1 to 3 miles further north. Then another fairly broad plain of nearly level Farnum soils occurs. Farnum soils are well drained and have a surface layer of loam about 11 inches thick. The subsoil is clay loam about 30 inches thick. The underlying material is clay loam.

Norge soils are well drained and are gently sloping. They have a surface layer of loam about 10 inches thick and a transitional clay loam layer about 5 inches thick. The subsoil is clay loam about 33 inches thick. The underlying material is clay loam similar to that of the subsoil, but it is less clayey and contains more sand and gravel.

Minor soils in this association are chiefly in the Kaski, Shellabarger, and Zavala series.

Most of this association is in wheat and sorghums. Most crops on these soils respond to fertilizer, good management, and proper tillage. On the gently sloping soils, practices are necessary for controlling of water erosion.

7. Pratt-Brazos-Tivoli Association

Deep and moderately deep, nearly level, undulating and hummocky loamy fine sands and fine sands; on low terraces and uplands

In this association are undulating or hummocky soils on uplands and nearly level soils on low terraces. The largest area is in the southwestern part of the county north and west of Waldron. A smaller area is in the northeastern part of the county along the Chikaskia River.

This association makes up about 8 percent of the county. It is 35 percent Pratt soils, 30 percent Brazos soils, and 15 percent Tivoli soils. Minor soils make up the remaining 20 percent.

Pratt soils are undulating and hummocky, deep and moderately deep, and well drained. These soils are on uplands. Their surface layer is loamy fine sand about 12 inches thick. The subsoil is loamy fine sand that is more clayey than the surface layer and is about 24 inches thick. Except that the siltstone substratum phase has siltstone at a depth between 24 and 50 inches, the underlying material is light loamy fine sand.

Brazos soils are nearly level, low terrace soils above the flood plain. These deep, somewhat excessively drained soils have a surface layer of loamy fine sand about 4 inches thick. Below this is a layer of loamy sand about 17 inches thick. Except that the clayey subsoil variant has a clay layer at a depth between 20 and 36 inches, the underlying material is fine sand.

Tivoli soils are hummocky, deep, excessively drained soils on uplands. They have a surface layer of fine sand about 5 inches thick, which is underlain by fine sand.

Minor soils in this association are in the Carwile, Crisfield, Kanza, Ruella, and Shellabarger series.

About 50 percent of the soils of this association is cultivated. The rest is used for range. Pratt soils and the minor soils are the principal cultivated soils, and small grains and grain sorghums are the principal crops.

Soil blowing is a moderate to severe hazard on these soils. Management is needed that prevents soil blowing in cultivated areas. Proper use is required on areas in range.

8. Minco-Pond Creek Association

Deep, nearly level, gently sloping and sloping silt loams; on uplands

This association is in the southwest corner of the county. It consists mainly of gently sloping soils on broad side slopes. Small areas of nearly level soils, however, are at the base of side slopes and at the crests of ridges, and some sloping soils are on short side slopes (pl. I).

This association makes up about 1 percent of the county. About 90 percent consists of Minco and Pond Creek soils in equal parts. Minor soils make up the remaining 10 percent.

Minco soils typically are gently sloping and occur on side slopes. Some of the soils, however, are nearly level and are at the base of side slopes, and others are sloping and are on irregular side slopes. Minco soils are deep and are well drained. Their surface layer is silt loam about 15 inches thick. The subsoil is silt loam about 27 inches thick, and the underlying material also is silt loam.

Pond Creek soils typically are on side slopes and are gently sloping. Some of the soils, however, are nearly level and are at the crests of ridges. Others are sloping and are on short side slopes. Pond Creek soils are deep and are well drained. Their surface layer is silt loam about 13 inches thick. The subsoil is silty clay loam about 40 inches thick, and the underlying material also is silty clay loam.

Minor soils in this association are the Bethany, Farnum, and Port.

Much of this association is in small grains, grain sorghums, and alfalfa. Some small sloping areas are used for range.

Most crops on soils of this association respond to fertilizer, good management, and proper tillage. Good management is needed for maintaining fertility, tilth, and structure. The gently sloping and sloping soils have a slight to moderate hazard of water erosion that can be controlled by use of proper conservation practices.

9. Quinlan-Woodward Association

Shallow and moderately deep, nearly level, gently sloping and sloping loams; on uplands

This association consists of nearly level soils on broad ridges and at the foot of side slopes; of gently sloping soils on broad side slopes; and of sloping soils in relatively narrow areas on side slopes. The largest area extends from about 2 miles south of Attica to about 3 miles north of Waldron. Smaller areas are chiefly in the western half of the county.

This association makes up about 8 percent of the county. It is 45 percent Quinlan soils, 25 percent Woodward soils, and 30 percent minor soils.

Quinlan soils typically are on side slopes and are sloping or gently sloping. Some of the soils, however, are nearly level to slightly concave and are at the base of side slopes, and others are gently sloping and are on broad plains. The sloping soils occupy relatively narrow areas that are irregular in shape.

Quinlan soils are shallow to bedrock and are well drained. They have a surface layer of loam that is about 9 inches thick. The underlying material is calcareous siltstone or very fine sandstone.

Woodward soils typically are on broad side slopes and are gently sloping. Small areas, however, are nearly level and are on ridges and others are sloping and are on side slopes. Woodward soils are mapped only in a complex with Quinlan soils. They are moderately deep over siltstone or very fine sandstone. These well-drained soils have a surface layer of calcareous loam about 10 inches thick. The next layer is calcareous loam about 14 inches thick. The underlying material is soft, calcareous, very fine sandstone.

Minor soils in this association are in the Brazos, Crisfield, Gerlane, Ruella, and Shellabarger series. Small areas of Wet alluvial land also are in this association.

About 70 percent of this association is cultivated. The remaining 30 percent is used for range. Cultivated crops are principally wheat, barley, and rye. Sorghums and alfalfa are poorly suited to these soils.

Limited soil depth and low available water capacity make these soils droughty and restrict the choice of crops that can be grown. The hazard of water erosion is moderate to severe on the gently sloping and sloping soils, and measures for control of water erosion are needed when these soils are cultivated.

DESCRIPTIONS OF THE SOILS

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

The procedure is first to describe the soil series, and then the mapping units in that series. Thus, to get full information on any one mapping unit, it is necessary to read the description of that unit and also the description of the soil series to which it belongs. As mentioned in the section "How this Survey Was Made," not all mapping units are members of a soil series. Alluvial land and Slickspots, for example, are miscellaneous land types that do not belong to a soil series. They are listed, nevertheless, in alphabetic order along with the soil series.

In comparing a mapping unit with a soil series, many will prefer to read the short description in paragraph form. It precedes the technical description that identifies layers by A, B, and C horizons and depth ranges. The technical profile descriptions are mainly for soil scientists and others who want detailed information about soils. Unless otherwise indicated, the colors given in the descriptions are those of a dry soil. Some of the terms used to describe the soils are defined in the Glossary at the back of this soil survey.

Following the name of each mapping unit, there 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 are the capability unit, range site, and windbreak group in which the mapping unit has been placed. The pages on which each of these are described can be found by referring to the "Guide to Mapping Units" at the back of this survey.

Albion Series

The Albion series consists of well-drained sandy loams on uplands. These soils are moderately deep over sand and gravel. They formed in noncalcareous, old alluvial outwash. Slopes range from 7 to 15 percent.

In a representative profile the surface layer is brown sandy loam about 7 inches thick that contains coarse sand and fine gravel. The subsoil is yellowish-red sandy loam about 14 inches thick. It is hard when dry and friable when moist. The substratum is reddish-yellow sand and gravel that is loose when moist and when dry.

These soils have low available water capacity. Permeability of the subsoil is moderate, but permeability of the substratum is moderately rapid to rapid.

Albion soils are better suited to range than to other uses. Most areas are in native grass.

In this county Albion soils are mapped only in an undifferentiated unit with Shellabarger soils. A description of the mapping unit is given under the Shellabarger series.

Representative profile of an Albion sandy loam on 7 to 15 percent slopes in an area of Shellabarger and Albion soils (600 feet east and 900 feet south of the northwest corner of sec. 17, T. 31 S., R. 9 W.):

A1--0 to 7 inches, brown (7.5YR 5/2) sandy loam, dark brown (7.5YR 3/2) when moist; many small pebbles; weak, medium, granular structure; slightly hard when dry, friable when moist; medium acid; clear, smooth boundary.

B2t--7 to 21 inches, yellowish-red (5YR 4/6) sandy loam, yellowish red (5YR 3/6) when moist; weak, coarse, subangular blocky structure; hard when dry, friable when moist; medium acid; gradual, smooth boundary.

IIC--21 to 60 inches, reddish-yellow (5YR 6/6) fine, medium, and coarse sand and gravel, yellowish red (5YR 5/6) when moist; structureless; loose dry and moist; medium acid.

The A horizon ranges from 5 to 9 inches in thickness, and from sandy loam to gravelly sandy loam in texture. Color ranges from brown to dark brown in the 7.5YR hue. The B2t horizon is dark reddish brown to yellowish red in the 5YR hue, and it is sandy loam to light sandy clay loam in texture. Structure ranges from granular to subangular blocky. The IIC horizon is at a depth of 20 to 30 inches. It is sand and gravel in most places, but it ranges to loamy sand and light sandy loam.

Albion soils have a C horizon at a shallower depth than Shellabarger soils. Their Bt horizon contains less clay and more sand than that of Farnum soils.

Alluvial Land

Alluvial land (0 to 2 percent slopes) (An) consists of loamy soils on flood plains of intermittent and perennial streams. In most places all layers of the soil are loam, but they range from heavy sandy loam to clay loam. Sandy and clayey material is at a depth of 36 to 60 inches. Alluvial land lacks the steep broken banks that occur in the mapping unit Broken alluvial land.

Alluvial land is flooded frequently. A few small areas are cultivated, but most areas are used for range or pasture. Capability unit VIw-1; Loamy Lowland range site; windbreak group 7.

Attica Series

In the Attica series are deep, well-drained fine sandy loams on uplands. These soils formed in fine sandy loam material laid down by wind. Slopes range from 1 to 3 percent.

In a representative profile the surface layer is brown fine sandy loam about 13 inches thick. The subsoil is brown fine sandy loam, about 35 inches thick, that is slightly more clayey than

TABLE 1.--APPROXIMATE ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Soil	Area	Extent	Soil	Area	Extent
	Acres	Percent		Acres	Percent
Alluvial land	3,030	0.6	Pond Creek silt loam, 3 to 6 percent slopes	701	0.1
Attica fine sandy loam, 1 to 3 percent slopes	1,337	.3	Pond Creek silt loam, 3 to 6 percent slopes, eroded	1,775	.3
Bethany silt loam, 0 to 1 percent slopes	9,878	1.9	Port silt loam	21,162	4.1
Bethany silt loam, 1 to 3 percent slopes	1,706	.3	Port-Slickspots complex	3,615	.7
Brazos loamy fine sand	11,381	2.2	Pratt loamy fine sand, undulating	4,953	1.0
Brazos loamy fine sand, clayey subsoil variant	1,558	.3	Pratt loamy fine sand, siltstone substratum, undulating	1,797	.4
Breaks-Alluvial land complex	21,825	4.3	Pratt-Carwile complex	10,086	2.0
Broken alluvial land	1,055	.2	Pratt-Tivoli loamy fine sands	7,272	1.4
Carwile fine sandy loam	1,355	.3	Quinlan loam, 0 to 1 percent slopes	2,832	.6
Case-Clark complex, 2 to 6 percent slopes	234	(1/)	Quinlan loam, 1 to 3 percent slopes	1,982	.4
Corbin silt loam, 0 to 1 percent slopes	4,810	.9	Quinlan loam, 3 to 6 percent slopes	3,154	.6
Corbin silt loam, 1 to 3 percent slopes	1,153	.2	Renfrow-Vernon clay loams, 1 to 3 percent slopes	1,541	.3
Crisfield fine sandy loam	23,837	4.7	Ruella loam, 0 to 1 percent slopes	416	.1
Farnum clay loam, 3 to 6 percent slopes, eroded	983	.2	Ruella loam, 1 to 3 percent slopes	3,068	.6
Farnum loam, 0 to 1 percent slopes	28,910	5.6	Ruella loam, 3 to 6 percent slopes	599	.1
Farnum loam, 1 to 3 percent slopes	22,160	4.3	Saline alluvial land	895	.2
Farnum loam, 3 to 6 percent slopes	3,020	.6	Shellabarger fine sandy loam, 0 to 1 percent slopes	3,014	.6
Gerlane fine sandy loam	6,725	1.3	Shellabarger fine sandy loam, 1 to 3 percent slopes	32,525	6.3
Grant silt loam, 0 to 1 percent slopes	6,201	1.2	Shellabarger fine sandy loam, 3 to 6 percent slopes	10,212	2.0
Grant silt loam, 1 to 3 percent slopes	47,690	9.3	Shellabarger fine sandy loam, 3 to 6 percent slopes, eroded	3,318	.7
Grant silt loam, 3 to 6 percent slopes	5,941	1.2	Shellabarger fine sandy loam, shale substratum, 1 to 3 percent slopes	4,579	.9
Kanza loamy fine sand	1,505	.3	Shellabarger fine sandy loam, shale substratum, 3 to 6 percent slopes	1,171	.2
Kaski loam	1,077	.2	Shellabarger fine sandy loam, shale substratum, 3 to 6 percent slopes, eroded	272	.1
Kirkland silt loam, 0 to 1 percent slopes	4,850	.9	Shellabarger loamy fine sand, undulating	527	.1
Kirkland-Renfrow clay loams, 1 to 3 percent slopes	18,318	3.6	Shellabarger and Albion soils, 7 to 15 percent slopes	9,050	1.8
Kirkland-Renfrow soils, 1 to 3 percent slopes, eroded	2,919	.6	Slickspots	2,256	.4
Minco silt loam, 0 to 1 percent slopes	372	.1	Tabler clay loam	5,957	1.2
Minco silt loam, 1 to 3 percent slopes	4,427	.9	Tivoli fine sand, hummocky	2,678	.5
Minco silt loam, 3 to 6 percent slopes	855	.2	Vernon-Renfrow complex, 2 to 6 percent slopes, eroded	367	.1
Nashville silt loam, 0 to 1 percent slopes	3,557	.7	Wet alluvial land	9,603	1.9
Nashville silt loam, 1 to 3 percent slopes	25,848	5.0	Woodward-Quinlan loams, 0 to 1 percent slopes	6,373	1.2
Nashville silt loam, 3 to 6 percent slopes	4,252	.8	Woodward-Quinlan loams, 1 to 3 percent slopes	14,762	2.9
Nashville silt loam, 3 to 6 percent slopes, eroded	5,581	1.1	Woodward-Quinlan loams, 3 to 6 percent slopes	668	.1
Norge loam, 1 to 3 percent slopes	8,809	1.7	Zavala fine sandy loam	2,710	.5
Pond Creek silt loam, 0 to 1 percent slopes	17,605	3.4	Zenda fine sandy loam	6,553	1.3
Pond Creek silt loam, 1 to 3 percent slopes	24,618	4.8	Ponds	170	(1/)
			Anthony Lake	118	(1/)
			Chikaskia River	527	.1
			Total	512,640	100.0

1/ Less than 0.1 percent.

the surface layer. The subsoil is soft when dry and friable when moist. The substratum is light-brown light fine sandy loam.

These soils have moderate available water capacity. Permeability is moderately rapid.

Representative profile of Attica fine sandy loam, 1 to 3 percent slopes (400 feet west and 100 feet north of the southeast corner of sec. 16, T. 32 S., R. 8 W.):

A1--0 to 13 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) when moist; weak, fine, granular structure; soft when dry, very friable when moist; slightly acid; clear, smooth boundary.

B1--13 to 19 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) when moist; weak, fine and medium, granular structure; soft when dry, very friable when moist; slightly acid; clear, smooth boundary.

B21t--19 to 29 inches, brown (7.5YR 5/3) fine sandy loam that has a slightly higher clay content than the B1 horizon, dark brown (7.5YR 3/3) when moist; weak, medium, granular structure; soft when dry, friable when moist; slightly acid; gradual, smooth boundary.

B22t--29 to 48 inches, brown (7.5YR 5/4) fine sandy loam, brown (7.5YR 4/4) when moist; weak, fine, granular structure; soft when dry, friable when moist; slightly acid; gradual, smooth boundary.

C--48 to 60 inches, light-brown (7.5YR 6/4) light fine sandy loam, brown (7.5YR 5/4) when moist; massive; soft when dry, very friable when moist; slightly acid.

The A1 horizon ranges from 6 to 15 inches in thickness. Color ranges from brown to dark brown in the 10YR hue. The B1 horizon is 6 to 12 inches thick. The B2t horizon ranges from reddish brown to reddish yellow in the 5YR hue, and from brown to reddish yellow in the 7.5YR hue. The C horizon is light fine sandy loam to loamy sand. It is at a depth of 30 to 48 inches.

Attica soils are not so coarse textured as Pratt and Tivoli soils. Their Bt horizon is more sandy than that of Shellabarger soils.

Attica fine sandy loam, 1 to 3 percent slopes (At).--This is the only Attica soil mapped in the county. Slopes are short. Included in mapping are small areas of Pratt loamy fine sand and of Shellabarger fine sandy loam.

This soil is moderately fertile. If it is cultivated and left unprotected, the hazard of soil blowing is moderate. The hazard of water erosion is slight.

This soil is suited to pasture and hay and to all crops commonly grown in the county. Wheat and sorghum are the chief crops. Capability unit IIe-4; Sandy range site; windbreak group 3.

Bethany Series

The Bethany series consists of deep, well-drained silt loams on uplands. These soils formed in old alluvium and loess. Slopes range from 0 to 3 percent.

In a representative profile the surface layer is dark grayish-brown silt loam about 13 inches thick. The subsoil is very dark grayish-brown silty clay loam in the upper 4 inches and dark-brown clay in the lower 21 inches. It is very hard when dry and very firm when moist. Lime concretions occur in this layer.

These soils have high available water capacity and slow permeability.

Representative profile of Bethany silt loam, 0 to 1 percent slopes (1,320 feet east and 150 feet north of the southwest corner of sec. 16, T. 33 S., R. 5 W.):

A1--0 to 13 inches, dark grayish-brown (10YR 4/2) heavy silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium and coarse, granular structure; soft when dry, very friable when moist; slightly acid; gradual, smooth boundary.

B1--13 to 17 inches, very dark grayish brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) when moist; moderate, medium and fine, subangular blocky structure; hard when dry, firm when moist; slightly acid; gradual, smooth boundary.

B2t--17 to 38 inches, dark-brown (7.5YR 4/2) light clay, dark brown (7.5YR 3/2) when moist; moderate, medium, blocky structure; very hard when dry, very firm when moist; neutral; diffuse, smooth boundary.

B3--38 to 60 inches, reddish-brown (5YR 4/4) heavy silty clay loam, dark reddish brown (5YR 3/2) when moist; weak, coarse, blocky structure to massive; very hard when dry, firm when moist; mildly alkaline; calcareous; a few, hard, calcareous concretions.

The combined thickness of the A1 and B1 horizons ranges from 14 to 19 inches. Their color ranges from dark brown to dark grayish brown in the 7.5YR and 10YR hues. The B2t horizon ranges from 20 to 40 inches in thickness. It is brown to dark brown in the 7.5YR hue. Structure is blocky or subangular blocky. Texture ranges from heavy clay loam to light clay. In places the lower part of the B2t horizon contains calcareous concretions. The B3 horizon ranges from reddish brown to dark brown in the 5YR and 7.5YR hues. It is calcareous to non-calcareous and lacks calcareous concretions in places.

Bethany soils have a thicker A1 horizon than that in Tabler or Kirkland soils. Their Bt horizon is browner and less gray than that in Tabler soils.

Bethany silt loam, 0 to 1 percent slopes (Be).--This soil has the profile described as representative of the series. Slopes are smooth. Included in mapping are small areas of Kirkland silt loam and Corbin silt loam.

Natural fertility is high in this soil. The hazard of erosion is slight to none.

Most of this soil is cultivated. All crops common to the county can be grown, but the principal crop is wheat. Capability unit I-1; Loamy Upland range site; windbreak group 1.

Bethany silt loam, 1 to 3 percent slopes (Bh).--This soil has smooth, gentle slopes. Included in mapping are small areas of Kirkland clay loam and Renfrow clay loam.

This soil has high natural fertility. If it is cultivated and left unprotected, the hazard of water erosion is moderate.

Most of this soil is cultivated. All crops common to the county can be grown, but wheat is the principal crop. Capability unit IIe-2; Loamy Upland range site; windbreak group 1.

Brazos Series

The Brazos series consists of deep, somewhat excessively drained loamy fine sands on the first terrace above the flood plain along perennial and intermittent streams. These soils formed in alluvium. Slopes range from 0 to 1 percent.

In a representative profile the brown loamy fine sand surface layer and the loamy sand transitional layer have a combined thickness of about 21 inches. Below is reddish-brown, loose sand.

These soils have low to moderate available water capacity. Permeability is rapid.

Representative profile of Brazos loamy fine sand (700 feet south and 50 feet east of the northwest corner of sec. 4, T. 34 S., R. 9 W.):

A1--0 to 4 inches, brown (7.5YR 5/4) loamy fine sand, brown (7.5YR 4/4) when moist; structureless; loose, dry and moist; slightly acid; abrupt, smooth boundary.

AC--4 to 21 inches, brown (10YR 5/3) light loamy sand, brown (10YR 4/3) when moist; a few, thin layers of sandy loam; single grain; loose, dry and moist; slightly acid; gradual, smooth boundary.

C--21 to 60 inches, reddish-brown (5YR 5/4) sand, reddish brown (5YR 4/4) when moist; single grain; loose, dry and moist; slightly acid.

The A1 and AC horizons range from loamy fine sand to fine sand in texture. Their color ranges from dark brown to brown in the 7.5YR and 10YR hues. The combined thickness ranges from 15 to 25 inches. Depth to the water table ranges from 4 to 8 or more feet.

Brazos soils have less clay and more sand in the profile than Gerlane and Crisfield soils. Their AC and C horizons contain coarser sand than that of the Pratt and Tivoli soils.

Brazos loamy fine sand (0 to 1 percent slopes) (Bm).--This soil has the profile described as representative of the series. Included in mapping are small areas of Gerlane and Crisfield fine sandy loams and of Brazos loamy fine sand, clayey subsoil variant. This soil has low available water capacity.

If this soil is cultivated, the hazard of soil blowing is very severe. Most of the acreage is used for pasture and range. Capability unit VIe-2; Sandy Lowland range site; windbreak group 4.

Brazos loamy fine sand, clayey subsoil variant (0 to 1 percent slopes) (Bo).--This soil is like Brazos loamy fine sand to a depth of 20 to 36 inches. Below this depth is dark brown to gray, mottled, clayey material that is calcareous in most places. This layer is slowly permeable to water. Available water capacity is moderate in this soil.

Included with this soil in mapping are small areas of Brazos loamy fine sand. Also included are small areas of Gerlane fine sandy loam and of Crisfield fine sandy loam.

If this soil is cultivated, the hazard of soil blowing is very severe. Most of the acreage is used for pasture and range. Capability unit VIe-2; Sandy Lowland range site; windbreak group 4.

Breaks-Alluvial Land Complex

Breaks-Alluvial land complex (Bp) consists of broken side slopes and of narrow valley floors of upland drainageways. The areas range from about 50 to 750 feet in width. Depth from the top of the side slopes to the valley floor is between 10 and 30 feet.

The Breaks part of this complex, which consists of the side slopes, makes up 50 to 75 percent of the complex. These irregular slopes range from a minimum of 6 percent to nearly vertical banks. The soils are loamy and are moderately deep over siltstone, very fine sandstone, and shaly clay. In places rock outcrops are present. Some small areas of shallow soils are included in mapping.

The Alluvial land part of this complex, which consists of deep loamy soils on the valley floors, makes up 25 to 50 percent of the complex. The valley floors range from 20 to 150 feet in width. Slopes are 0 to 3 percent.

Unlike Broken alluvial land, this mapping unit has rock outcrops and shallow to moderately deep soils on the side slopes.

Nearly all of the Breaks-Alluvial land complex is used for range. The Alluvial land part is cultivated in places where the valley floor is widest. The Breaks part is not cultivated because of the slope and the hazard of erosion. Both parts, Capability unit VIe-5; Breaks part, Loamy Upland range site, windbreak group not assigned; Alluvial land part, Loamy Lowland range site, windbreak group not assigned.

Broken Alluvial land

Broken alluvial land (Br) consists of the channels, the immediate flood plains, and the steep, broken banks of deeply entrenched streams. The width from bank to bank ranges from 50 to 300 feet. Depth from the top of the bank to the bottom of the channel ranges from 20 to 50 feet. The loamy soils on the narrow flood plains are flooded frequently. During each flood, material is deposited in some areas and removed from other areas.

Broken alluvial land characteristically has steep broken banks. It lacks the rock outcrops and the shallow to moderately deep soils on the side slopes that are characteristic of the Breaks-Alluvial land complex.

Most areas of this mapping unit are idle, but some areas are used for limited grazing. Trees and shrubs make up most of the vegetation. Capability unit VIIw-1; range site and windbreak group not assigned.

Carwile Series

The Carwile series consists of deep, somewhat poorly drained fine sandy loams on uplands. These soils formed in old alluvium or in material laid down by wind. They have plane to slightly concave slopes that range from 0 to 1 percent.

In a representative profile the surface layer is brown fine sandy loam about 14 inches thick. The subsoil is about 28 inches thick. Its upper part is gray heavy sandy clay loam that has yellowish brown mottles and is hard when dry and firm when moist. The lower part is dark-gray clay that has yellowish-brown mottles and is very hard when dry and firm when moist. The substratum is gray clay that has distinct light olive-brown mottles.

These soils have high available water capacity. Permeability is slow.

Representative profile of Carwile fine sandy loam in an area of Pratt-Carwile complex (75 feet west and 60 feet south of the northeast corner of sec. 2, T. 34 S., R. 9 W.):

Ap--0 to 10 inches, brown (7.5YR 5/2) fine sandy loam, dark brown (7.5YR 3/2) when moist; weak, granular structure; soft when dry, friable when moist; medium acid; clear, smooth boundary.

A1--10 to 14 inches, brown (7.5YR 5/3) fine sandy loam, dark brown (7.5YR 4/3) when moist; weak, medium, granular structure; soft when dry, friable when moist; medium acid; clear, smooth boundary.

IIB1--14 to 20 inches, gray (10YR 5/1) heavy sandy clay loam, dark gray (10YR 4/1) when moist; a few, fine, distinct mottles of yellowish brown (10YR 5/4); weak, medium, subangular blocky structure; hard when dry, firm when moist; neutral; gradual, smooth boundary.

IIB2t--20 to 42 inches, dark-gray (10YR 4/1) light clay, very dark gray (10YR 3/1) when moist; common, fine, distinct mottles of yellowish brown (10YR 5/6); moderate, medium and coarse, subangular blocky structure; very hard when dry, firm when moist; neutral; diffuse, smooth boundary.

IIC--42 to 60 inches, gray (N 6/0) light clay, gray (N 5/0) when moist; common, coarse, distinct mottles of light olive brown (2.5Y 5/4); weak, medium and coarse, subangular blocky structure; hard when dry, firm when moist; neutral, a few, small calcareous concretions.

The A horizon ranges from 9 to 24 inches in thickness. Its color ranges from dark brown to brown in the 7.5YR and 10YR hues. In places the lower part of the A horizon is mottled. The combined thickness of the B horizons ranges from 20 to 40 inches. Texture of these horizons ranges from heavy sandy clay loam to light clay. The color ranges from dark gray to light gray through dark brown to brown in hues of 7.5YR and 10YR. Structure of the IIB2t horizon ranges from subangular blocky to blocky, and in places this horizon is nearly massive. This horizon is noncalcareous, but in places it contains some hard calcareous concretions.

Carwile fine sandy loam (0 to 1 percent slopes) (Ca).--This soil has slopes that are plane to slightly concave. Included in mapping are small areas of Pratt loamy fine sand and of Shellabarger fine sandy loam.

This soil has moderate fertility. In some areas water is frequently ponded on the surface and damages growing crops. Soil blowing is also a hazard.

Most of this soil is in wheat and sorghums. The soil is poorly suited to alfalfa. Capability unit IIw-1; Sandy range site; windbreak group 2.

Case Series

The Case series consists of deep, well-drained, calcareous clay loams on uplands. These soils formed in calcareous old alluvium. Slopes range from 2 to 6 percent.

In a representative profile the surface layer is grayish-brown clay loam about 7 inches thick. It is calcareous and contains small, hard, calcareous concretions. The next layer, to a depth of about 60 inches, is brownish-yellow and light-gray clay loam that is very hard when dry and firm when moist.

These soils have high available water capacity. Permeability is moderate.

Representative profile of Case clay loam on 2 to 6 percent slopes in an area of Case-Clark complex (1,320 feet south and 200 feet east of the northwest corner of sec. 16, T. 31 S., R. 8 W.):

Ap--0 to 7 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, granular structure;

slightly hard when dry, friable when moist; mildly alkaline; calcareous and contains many, fine and very fine, calcareous concretions; gradual, smooth boundary.

Cca--7 to 60 inches, brownish-yellow (10YR 6/6) and light-gray (10YR 7/2) clay loam in about equal parts, yellowish brown (10YR 5/6) and light brownish gray (10YR 6/2) when moist; weak, medium and coarse, subangular blocky structure; very hard when dry, firm when moist; moderately alkaline; calcareous; about 25 percent of the mass is soft and hard calcareous masses of calcium carbonate.

The A horizon ranges from 2 to 10 inches in thickness. Its color ranges from brown to light gray in hues of 10YR and 7.5YR. The Cca horizon is mixed in color. It ranges from yellowish brown to light gray in hue of 10YR and strong brown to pinkish gray in hue of 7.5YR. This horizon is 20 to 40 percent calcium carbonate.

Case soils have a lighter colored A horizon than soils of the Clark series.

Case-Clark complex, 2 to 6 percent slopes (Cc).--These soils have the profile described as representative of their respective series. Case soils make up about 70 percent of the complex, and Clark soils about 30 percent. Slopes are irregular. Included in mapping are small areas of Farnum and Shellabarger soils.

These soils are low in natural fertility. If they are cultivated and left unprotected, the hazard of water erosion is severe.

About 30 percent of this complex is in wheat and sorghums. The remaining 70 percent is in native grass. Sorghum on the Case soils is subject to chlorosis. Capability unit IVe-3; Limy Upland range site; windbreak group 1.

Clark Series

The Clark series consists of deep, well-drained, calcareous loams on uplands. These soils formed in calcareous old alluvium. Slopes range from 2 to 6 percent.

In a representative profile, the surface layer is very dark grayish-brown calcareous loam about 8 inches thick. Just below is grayish-brown clay loam about 10 inches thick that is hard when dry and firm when moist. The substratum is brownish-yellow and light-gray clay loam that is very hard when dry and firm when moist. This layer is calcareous, and about 25 percent, by volume, is masses of lime.

These soils have high available water capacity. Permeability is moderate.

In this county Clark soils are mapped only in a complex with Case soils. A description of the mapping unit is given under the Case series.

Representative profile of Clark loam in an area of Case-Clark complex, 2 to 6 percent slopes (1,350 feet south and 300 feet east of the northwest corner of sec. 16, T. 31 S., R. 8 W.):

A1--0 to 8 inches, very dark grayish brown (10YR 3/2) loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; mildly alkaline; calcareous; clear, smooth boundary.

AC--8 to 18 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) when moist; moderate to strong, medium, granular structure; hard when dry, firm when moist; moderately alkaline; calcareous; gradual, smooth boundary.

Cca--18 to 60 inches, brownish-yellow (10YR 6/6) and light-gray (10YR 7/2) clay loam in about equal parts, yellowish brown (10YR 5/6) and light brownish gray (10YR 6/2) when moist; weak, medium and coarse, subangular blocky structure; very hard when dry, firm when moist; moderately alkaline; calcareous, about 25 percent of the mass is hard and soft masses of calcium carbonate.

The A1 horizon ranges from 6 to 10 inches in thickness and from loam to clay loam in texture. It ranges from very dark grayish brown to brown in the 10YR hue or from dark brown to brown in the 7.5YR hue. In some places calcareous concretions are on the surface and in the A1 horizon. The AC horizon is calcareous heavy loam to clay loam 5 to 15 inches thick. It is dark grayish brown to pale brown in the 10YR hue or dark brown to light brown in the 7.5YR hue. The Cca horizon is 20 to 40 percent calcium carbonate.

Clark soils have a darker colored A1 horizon than that of Case soils. Unlike the Farnum soils, Clark soils have calcareous A1 and AC horizons.

Corbin Series

In the Corbin series are deep, well-drained silt loams on uplands. These soils formed in old alluvium and loess. Slopes range from 0 to 3 percent.

In a representative profile the surface layer is brown silt loam about 16 inches thick. The upper part of the subsoil is brown silty clay loam about 14 inches thick. It is hard when dry and friable when moist. Below this is dark grayish-brown, light clay about 11 inches thick. The lower part of the subsoil is brown clay about 14 inches thick. The two lower layers of the subsoil are hard when dry and firm when moist. The substratum is brown silty clay loam.

These soils have high available water capacity. Permeability is moderate in the upper part of the subsoil, but it is slow in the clay layer.

Representative profile of Corbin silt loam, 0 to 1 percent slopes (1,320 feet west and 40 feet south of the northeast corner of sec. 28, T. 33 S., R. 5 W.):

A1--0 to 16 inches, brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) when moist; moderate, medium and fine, granular structure; soft

when dry, very friable when moist; medium acid; gradual, smooth boundary.

B21t--16 to 30 inches, brown (7.5YR 4/3) silty clay loam, dark brown (7.5YR 3/3) when moist; moderate, fine, subangular blocky structure; hard when dry, friable when moist; neutral; clear, smooth boundary.

IIB22t-30 to 41 inches, dark grayish-brown (10YR 4/2) light clay, very dark grayish brown (10YR 3/2) when moist; moderate, medium, blocky structure; hard when dry, firm when moist; neutral; clear, smooth boundary.

IIB23t--41 to 55 inches, brown (7.5YR 4/2) clay, dark brown (7.5YR 3/2) when moist; moderate, medium, blocky structure; hard when dry, firm when moist; neutral; gradual, smooth boundary.

IIC--55 to 60 inches, brown (7.5YR 4/3) silty clay loam, dark brown (7.5YR 3/3) when moist; massive; very hard when dry, friable when moist; neutral.

The A1 horizon ranges from 12 to 20 inches in thickness. It ranges from very dark grayish brown to brown in the 10YR hue and from dark brown to brown in the 7.5YR hue. The upper part of the B horizon is silty clay loam that is as much as 33 percent clay. It ranges from dark brown to brown in the 7.5YR hue. The upper boundary of the IIB22t horizon is at a depth of 26 to 40 inches. The IIB22t and IIB23t horizons range in texture from heavy silty clay loam to clay. These horizons range from dark grayish brown to brown in the 10YR hue and from dark brown to brown in the 7.5YR hue. The combined thickness of the two horizons is 20 to 40 inches. The color and texture of the IIC horizon is similar to that of the B21t horizon.

Corbin soils have less clay in the upper part of the Bt horizon than that of Kirkland and Tabler soils. They have more clay in the lower part of the Bt horizon than Pond Creek soils.

Corbin silt loam, 0 to 1 percent slopes (Ce).--This soil has the profile described as representative of the series. Slopes are smooth. Included in mapping are small areas of Kirkland and Pond Creek soils.

Natural fertility is high in this soil. The hazard of erosion is slight to none.

This soil is suited to all crops commonly grown in the county. Nearly all of the acreage is in wheat, sorghums, and alfalfa. Capability unit I-1; Loamy Upland range site; windbreak group 1.

Corbin silt loam, 1 to 3 percent slopes (Cf).--This soil has smooth slopes. Included in mapping are small areas of Bethany, Pond Creek, and Kirkland soils.

Natural fertility is high in this soil. If this soil is cultivated and not protected, the hazard of water erosion is moderate.

This soil is suited to all crops commonly grown in the county. Nearly all of the acreage is in wheat, sorghums, and alfalfa. Capability unit IIe-1; Loamy Upland range site; windbreak group 1.

Crisfield Series

The Crisfield series consists of deep, well-drained fine sandy loams on first and second terraces. These soils formed in alluvium. Slopes range from 0 to 2 percent.

In a representative profile the surface layer is brown fine sandy loam about 18 inches thick. The subsoil is reddish-brown fine sandy loam about 27 inches thick. It is soft when dry and very friable when moist. The substratum is yellowish-red loamy fine sand.

These soils have low to moderate available water capacity. Permeability is moderately rapid.

Representative profile of Crisfield fine sandy loam (2,640 feet east and 150 feet south of the northwest corner of sec. 8, T. 34 S., R. 6 W.):

A1--0 to 18 inches, brown (7.5YR 4/2) fine sandy loam, dark brown (7.5YR 3/2) when moist; moderate, medium and fine, granular structure; soft when dry, very friable when moist; slightly acid; gradual, smooth boundary.

B2--18 to 45 inches, reddish-brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) when moist; moderate, medium and coarse, granular structure; soft when dry, very friable when moist; slightly acid; diffuse, smooth boundary.

C--45 to 60 inches, yellowish-red (5YR 5/6) loamy fine sand, yellowish red (5YR 4/6) when moist; single grain; loose; slightly acid.

The A1 horizon ranges from 12 to 24 inches in thickness. It is brown to dark grayish brown in the 7.5YR and 10YR hues. The B2 horizon ranges from fine sandy loam to light sandy clay loam in texture. It ranges from dark reddish brown to yellowish red in the 5YR hue and from dark brown to reddish yellow in the 7.5YR hue. The C horizon is at a depth of 36 to 60 inches. In most places it ranges from light sandy loam to loamy sand or sand. It is clay in a few places.

Crisfield soils lack the calcareous B horizon of the Gerlane soils, and lack a water table within rooting depth that is typical of those soils. They are less frequently flooded than Kaski soils, which are on flood plains.

Crisfield fine sandy loam (0 to 2 percent slopes) (Ch).--This is the only Crisfield soil mapped in the county.

Included in mapping with this soil are small areas of Gerlane, Shellabarger, Zavala, and Zenda soils. Also included are a few small areas of soils similar to Crisfield soils that have slopes of 5 percent.

Natural fertility is moderate in Crisfield fine sandy loam. The hazard of soil blowing is slight. In some areas the hazard of water erosion is slight because of runoff from adjacent, more sloping soils.

Most of the acreage of this soil is in wheat. Capability unit IIe-4; Sandy Lowland range site; windbreak group 7.

Farnum Series

The Farnum series consists of deep, well-drained loams and clay loams on uplands. These soils formed in old alluvium. Slopes range from 0 to 6 percent.

In a representative profile the surface layer is dark grayish-brown loam about 11 inches thick. The subsoil is brown clay loam about 30 inches thick. It is hard when dry and firm when moist. The substratum is brown clay loam.

These soils have high available water capacity. Permeability is moderately slow.

Representative profile of Farnum loam, 1 to 3 percent slopes (1,320 feet south and 100 feet east of the northwest corner of sec. 17, T. 31 S., R. 8 W.):

A1--0 to 11 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, granular structure; soft when dry, friable when moist; slightly acid; clear, smooth boundary.

B1--11 to 16 inches, brown (10YR 4/3) light clay loam, dark brown (10YR 3/3) when moist; moderate, medium and coarse, granular structure; slightly hard when dry, friable when moist; neutral; clear, smooth boundary.

B2t--16 to 41 inches, brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) when moist; much coarse sand and many pebbles; moderate, medium and coarse, subangular blocky and blocky structure; hard when dry, firm when moist; neutral; gradual, smooth boundary.

C--41 to 60 inches, brown (7.5YR 4/4) clay loam, dark brown (7.5YR 3/3) when moist; moderate, medium, subangular blocky structure; hard when dry, firm when moist; neutral.

The A1 horizon ranges mainly from 7 to 18 inches in thickness. In the mapping unit Farnum clay loam, 3 to 6 percent slopes, eroded, however, the thickness of the surface layer ranges from 4 to 7 inches. Color of the A1 horizon ranges from brown to dark grayish brown in the 7.5YR and 10YR hues. Texture is loam or clay loam. In some places pebbles are on the surface and throughout the A1 horizon. The B2t horizon ranges from about 20 inches to more than 40 inches in thickness. Its color ranges from dark brown to brown in the 7.5YR and 10YR hues with values from 3 to 5 and chromas from 2 to 4. The upper part of the B2t horizon typically is medium clay loam, but the lower 10 inches ranges from medium clay loam to heavy clay loam. The C horizon consists of brown or reddish-brown sandy clay loam or clay loam. In some places a few lime concretions are in this horizon.

Farnum soils have more clay in the Bt horizon than Shellabarger soils. They have a less red Bt horizon than Norge soils.

Farnum clay loam, 3 to 6 percent slopes, eroded (Fa).--This soil has irregular slopes. It has a surface layer of clay loam about 4 to 7 inches thick, but its profile otherwise is similar to that described as representative of the series. The original surface layer has been thinned by erosion, and material from the subsoil has been mixed into the plow layer. Shallow gullies and rills are common.

Included in mapping are small areas of Shellabarger fine sandy loam, eroded.

This Farnum soil has moderate natural fertility. If it is cultivated and left unprotected, the hazard of water erosion is very severe.

About half the acreage of this soil is cultivated. The remaining half has been reseeded to grass and is used for pasture and range. This soil is suited to close-growing crops that help to protect the soils from erosion. Capability unit IIIe-4; Loamy Upland range site; windbreak group 1.

Farnum loam, 0 to 1 percent slopes (Fm).--This soil has smooth slopes. Included in mapping are small areas of Shellabarger and Norge soils.

Natural fertility is high in this soil. The hazard of erosion is slight to none.

This soil is suited to all crops common to the county. Most areas are cultivated. Capability unit I-1; Loamy Upland range site; windbreak group 1.

Farnum loam, 1 to 3 percent slopes (Fn).--This soil has the profile described as representative of the series. Slopes are smooth. Included in mapping are small areas of Shellabarger and Norge soils.

Natural fertility is high in this soil. If this soil is cultivated and left unprotected, the hazard of water erosion is moderate.

This soil is suited to all crops common to the county. Most of the acreage is cultivated. Capability unit IIe-1; Loamy Upland range site; windbreak group 1.

Farnum loam, 3 to 6 percent slopes (Fu).--Except that the surface layer is 2 to 5 inches thinner, the profile of this soil is similar to that described as representative of the series. This soil has smooth slopes. Included in mapping are small areas of Shellabarger soils.

Natural fertility is high in this soil. If this soil is cultivated and left unprotected, runoff is rapid and the hazard of water erosion is severe.

This soil is suited to all crops adapted to the climate. Most of the acreage is cultivated. Capability unit IIIe-1; Loamy Upland range site; windbreak group 1.

Gerlane Series

The Gerlane series consists of deep, moderately well drained fine sandy loams on low terraces that are flooded occasionally. These soils formed in alluvium. Slopes range from 0 to 1 percent.

In a representative profile the surface layer is brown fine sandy loam about 17 inches thick. The reddish-brown subsoil is fine sandy loam about 23 inches thick. It is slightly hard when dry and very friable when moist. The substratum is reddish-brown, stratified loamy sand and clay loam.

These soils have moderate available water capacity. Permeability is moderately rapid.

Representative profile of Gerlane fine sandy loam (2,640 feet south and 150 feet east of the northwest corner of sec. 33, T. 33 S., R. 9 W.):

A1--0 to 17 inches, brown (7.5YR 5/3) fine sandy loam, dark brown (7.5YR 3/3) when moist; weak, fine, granular structure; soft when dry, very friable when moist; neutral; clear, smooth boundary.

B2--17 to 40 inches, reddish-brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) when moist; weak, fine, granular structure; slightly hard when dry, very friable when moist; mildly alkaline; calcareous below a depth of 21 inches; clear, smooth boundary.

C1--40 to 48 inches, reddish-brown (5YR 5/3) loamy sand; reddish brown (5YR 4/3) when moist; single grain; loose; mildly alkaline; calcareous; abrupt, smooth boundary.

IIC2--48 to 60 inches, reddish-brown (5YR 4/3) clay loam, dark reddish brown (5YR 3/3) when moist; massive; hard when dry, firm when moist; mildly alkaline; calcareous; small, calcareous concretions.

The A1 horizon ranges from 10 to 20 inches in thickness. It ranges from dark brown to brown in the 7.5YR hue. The B2 horizon ranges from sandy loam to light sandy clay loam. Its color ranges from dark reddish brown to yellowish red in the 5YR hue and from dark brown to reddish yellow in the 7.5YR hue. Depth to calcareous material ranges from 14 to 30 inches, and depth to the C1 horizon ranges from 40 to 60 inches. The C horizon is stratified and ranges from sand to clay loam. During the spring and winter seasons, a fluctuating water table rises to within 2 feet of the surface in most places. During summer and fall, the water table is at a depth below 6 feet in most places.

Gerlane soils are similar to Crisfield soils, but they have calcareous material at a depth between 14 and 30 inches and a fluctuating water table. They are more red and are coarser textured than Kaski soils. Unlike Zavala soils, Gerlane soils are calcareous in the uppermost 30 inches.

Gerlane fine sandy loam (0 to 1 percent slopes) (Ge).--This is the only Gerlane soil mapped in the county. It is on low terraces that are flooded occasionally.

Included in mapping with this soil are small areas of Crisfield, Zavala, and Zenda soils.

This soil has high natural fertility. If it is cultivated and left unprotected, the hazard of soil blowing is slight to moderate.

Nearly all of this soil is cultivated. The soil is suited to the crops commonly grown in the county. Wheat is the principal crop, but alfalfa also is grown. Capability unit IIe-4; Subirrigated range site; windbreak group 7.

Grant Series

The Grant series consists of deep, well-drained silt loams on uplands. These soils formed in material weathered from silty redbeds. Slopes range from 0 to 6 percent.

In a representative profile the surface layer is silt loam about 11 inches thick. The next layer is brown silt loam about 7 inches thick. The yellowish-red subsoil is about 32 inches thick. It is slightly hard, light silty clay loam in the upper part and soft silt loam in the lower part. The substratum is yellowish-red silt loam.

These soils have high available water capacity and moderate permeability.

Representative profile of Grant silt loam, 1 to 3 percent slopes (400 feet north and 40 feet east of the southwest corner of sec. 11, T. 34 S., R. 7 W.):

A1--0 to 11 inches, brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; slightly acid; clear, smooth boundary.

A3--11 to 18 inches, brown (7.5YR 4/4) silt loam, dark brown (7.5YR 3/4) when moist; weak, fine and medium, granular structure; soft when dry, very friable when moist; neutral; gradual, smooth boundary.

B2t--18 to 33 inches, yellowish-red (5YR 5/6) light silty clay loam; reddish brown (5YR 4/4) when moist; moderate, medium and fine, granular structure; slightly hard when dry, friable when moist; many worm casts; thin, continuous clay films; neutral; diffuse, smooth boundary.

B3--33 to 50 inches, yellowish-red (5YR 5/6) heavy silt loam, yellowish red (5YR 4/6) when moist; weak, medium and fine, subangular blocky structure; soft when dry, friable when moist; thin continuous clay films; neutral; diffuse, smooth boundary.

C--50 to 60 inches, yellowish-red (5YR 5/6) silt loam, yellowish red (5YR 4/6) when moist; massive; soft when dry, friable when moist; mildly alkaline.

The combined thickness of the A1 and A3 horizons ranges from 10 to 24 inches. These horizons are brown to dark brown in the 7.5YR hue, dark reddish brown to reddish brown in the 5YR hue, or very dark grayish brown in the 10YR hue. The B2t horizon ranges from reddish brown to yellowish red in the 5YR hue, and from dark brown to strong brown in the 7.5YR hue. Texture ranges from heavy silt loam to

light silty clay loam. Calcareous silty redbeds are at a depth of 36 to 60 inches or more.

Grant soils, unlike the shallower less well developed Nashville soils, have a Bt horizon. Also, depth to bedrock is greater. Their Bt horizon contains less clay than that of Pond Creek soils.

Grant silt loam, 0 to 1 percent slopes (Gn).--This soil has smooth slopes. Included in mapping are small areas of Minco and Pond Creek soils.

Natural fertility is high in this Grant soil. Soil blowing is a slight hazard if the surface is left unprotected.

This soil is suited to all crops adapted to the climate. Most of the acreage is in wheat and sorghums. Capability unit I-1; Loamy Upland range site; windbreak group 1.

Grant silt loam, 1 to 3 percent slopes (Gr).--This soil has the profile described as representative of the series. In some small areas 4 to 6 inches of the surface layer has been winnowed by wind and is fine sandy loam. This soil has convex slopes that average about 2 percent.

Included with this soil in mapping are small areas of Pond Creek and Minco soils.

This soil has high natural fertility. If it is cultivated and left unprotected, the hazard of water erosion is moderate.

Most areas of this soil are in wheat and sorhums. Capability unit IIe-1; Loamy Upland range site; windbreak group 1.

Grant silt loam, 3 to 6 percent slopes (Gs).--The surface layer of this soil is 3 to 6 inches thinner than that in the profile described for the series. Slopes are convex and average 5 percent.

Included with this soil in mapping are small areas of Minco, Nashville, and Pond Creek soils.

Natural fertility is high in this Grant soil. If this soil is cultivated and left unprotected, the hazard of water erosion is severe.

This soil is suited to all crops adapted to the climate. Capability unit IIIe-1; Loamy Upland range site; windbreak group 1.

Kanza Series

The Kanza series consists of deep, somewhat poorly drained to poorly drained loamy fine sands that have a high water table. These soils formed in coarse-textured alluvium or material deposited by wind. They are adjacent to streams, and slopes range from 0 to 1 percent.

In a representative profile the surface layer is very dark gray loamy fine sand about 8 inches thick. The next layer is loamy fine sand about 7 inches thick. It is gray mottled with yellowish brown. The substratum is light gray mottled with brownish yellow. It is loamy fine sand that is soft when dry and loose when moist.

Kanza soils have rapid permeability down to the water table. The loamy sand has low available water capacity, but the water table is within reach of plant roots.

Representative profile of Kanza loamy fine sand (1,320 feet east and 50 feet south of the northwest corner of sec. 8, T. 31 S., R. 5 W.):

A1--0 to 8 inches, very dark gray (10YR 3/1) heavy loamy fine sand, black (10YR 2/1) when moist; high in organic matter; weak, granular structure; slightly hard when dry, friable when moist; slightly acid; clear, smooth boundary.

AC--8 to 15 inches, gray (10YR 5/1) loamy fine sand, dark gray (10YR 4/1) when moist; common, fine, distinct mottles of yellowish brown (10YR 5/6); single grain; soft when dry, very friable when moist; slightly acid; gradual, smooth boundary.

C--15 to 60 inches, light-gray (10YR 7/2) loamy fine sand; light brownish gray (10YR 6/2) when moist; common, coarse, distinct brownish-yellow (10YR 6/6) mottles; soft when dry, loose when moist; neutral; water table is at a depth of 14 inches.

The A1 horizon ranges from loamy sand to light fine sandy loam in texture, and from 4 to 10 inches in thickness. It has a high content of organic matter, and its color ranges from very dark gray to grayish brown in the 10YR hue. The AC horizon is mottled and ranges from 5 to 15 inches in thickness. It is gray to light brownish gray in the 10YR hue. Texture ranges from loamy fine sand to light fine sandy loam. The C horizon ranges from loamy fine sand to fine sand. Its color is light brownish gray to very pale brown. The water table is seldom deeper than 2 feet from the surface and generally is at a depth between 12 and 15 inches.

Kanza soils have a higher water table than Brazos soils. They are mottled, unlike Pratt and Tivoli soils, which have a water table at a depth of 6 feet or more.

Kanza loamy fine sand (0 to 1 percent slopes) (Ka).--This is the only Kanza soil mapped in the county. Slopes are slightly irregular. Included in mapping are small areas of Brazos loamy fine sand.

Most areas of this soil are used for pasture and range. Production of forage is high. Capability unit Vw-1; Subirrigated range site; windbreak group 8.

Kaski Series

The Kaski series consists of deep, well-drained loams on flood plains. These soils formed in alluvium.

In a representative profile the surface layer is very dark grayish brown loam about 19 inches thick. Below this is brown loam about 7 inches thick. The next layer is brown loam about 14 inches thick. It

is soft when dry and very friable when moist. Below is yellowish-brown sandy loam.

These soils have moderate available water capacity. Permeability also is moderate.

Representative profile of Kaski loam (600 feet west and 200 feet south of the northeast corner of sec. 16, T. 31 S., R. 9 W.):

A11--0 to 19 inches, very dark grayish brown (10YR 3/2) loam, very dark brown (10YR 2/2) when moist; moderate, medium and coarse, granular structure; soft when dry, very friable when moist; slightly acid; gradual, smooth boundary.

A12--19 to 26 inches, brown (10YR 4/3) loam, dark brown (10YR 3/3) when moist; weak, medium, granular structure; soft when dry, very friable when moist; slightly acid; clear, smooth boundary.

AC--26 to 40 inches, brown (10YR 5/3) loam, brown (10YR 4/3) when moist; weak, medium and coarse, granular structure; soft when dry, very friable when moist; neutral; gradual, smooth boundary.

C--40 to 60 inches, yellowish-brown (10YR 5/4) sandy loam; dark yellowish brown (10YR 4/4) when moist; massive; soft when dry, very friable when moist; neutral.

The A1 horizon is dominantly loam, but in many places the upper 4 to 6 inches is sandy loam. This is possibly the result of wind action or deposition from floods. The A11 horizon ranges from 12 to 20 inches in thickness. Its color ranges from very dark grayish brown to brown in the 7.5YR and 10YR hues. The AC horizon ranges from heavy sandy loam to loam, but it generally is loam. It ranges from dark grayish brown to brown in 7.5YR and 10YR hues. The C horizon is sandy loam to sand in texture and is at a depth of 36 to 48 inches. In some places the soil has clayey strata at a depth below 36 inches.

Kaski soils are finer textured than Zavala soils. They are less silty than Port soils.

Kaski loam (0 to 1 percent slopes) (Kk).--This is the only Kaski soil mapped in the county. Included in mapping are small areas of Zavala soils and of Wet alluvial land.

Natural fertility is high in this soil. Flooding damages or destroys crops on an average of about 4 out of every 10 years.

This soil is suited to all crops common to the county. Capability unit IIIw-1; Loamy Lowland range site; windbreak group 7.

Kirkland Series

The Kirkland series consists of deep, moderately well drained silt loams and clay loams on uplands. These soils formed in material weathered from clayey shale. Slopes range from 0 to 3 percent.

In a representative profile the surface layer is brown silt loam about 12 inches thick. The subsoil is brown silty clay and clay about 46 inches thick. When dry, the upper part of the subsoil is hard and the lower part is very hard. Below the subsoil is yellowish-red light clay that contains a few calcareous concretions.

These soils have high available water capacity. Permeability is slow.

Representative profile of Kirkland silt loam, 0 to 1 percent slopes (1,000 feet east and 75 feet north of the southwest corner of sec. 12, T. 35 S., R. 5 W.):

A1--0 to 12 inches, brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; slightly acid; clear, smooth boundary.

B21t--12 to 34 inches, brown (7.5YR 4/2) silty clay; dark brown (7.5YR 3/2) when moist; moderate, medium, blocky and subangular blocky structure; hard when dry, firm when moist; thick continuous clay films; neutral; clear, smooth boundary.

B22t--34 to 58 inches, brown (7.5YR 5/4) clay, brown (7.5YR 4/3) when moist; moderate, coarse, blocky structure; very hard when dry, very firm when moist; thick, continuous clay films; neutral; contains a few calcareous concretions; diffuse, smooth boundary.

C--58 to 60 inches, yellowish-red (5YR 5/6) light clay; yellowish red (5YR 4/6) when moist; moderate, medium, blocky structure; hard when dry, firm when moist; moderately alkaline; a few calcareous concretions.

The A1 horizon generally ranges from 10 to 14 inches in thickness. In the mapping unit Kirkland-Renfrow soils, 1 to 3 percent slopes, eroded, however, the surface layer of the Kirkland soil ranges from 4 to 6 inches in thickness. The color of the A1 horizon ranges from brown to very dark grayish brown in the 7.5YR and 10YR hues. In places a transitional layer from the A horizon to the B horizon is as much as 2 inches thick. The B2t horizon ranges from dark brown to brown in the 7.5YR and 10YR hues. The thickness of the combined B horizons ranges from 30 to 46 inches. The C horizon is clay or heavy clay loam. Clayey shale is at a depth below 50 inches.

Kirkland soils have a B2t horizon that is less reddish than that in Renfrow soils and is less gray than that in Tabler soils. Their B2t horizon contains more clay than that in Bethany soils.

Kirkland silt loam, 0 to 1 percent slopes (Km).--This soil has the profile described as representative of the series. It is mainly on plains, but some areas are in small depressions. Included in mapping are small areas of Bethany, Renfrow, and Tabler soils.

Natural fertility is moderate in this soil. Water is frequently ponded on the surface for long enough periods to affect susceptible crops. The hazard of erosion is slight.

This soil is suited to all crops commonly grown in the county. Most areas are cultivated. Capability unit IIs-1; Clay Upland range site; windbreak group 1.

Kirkland-Renfrow clay loams, 1 to 3 percent slopes (Kr).--Kirkland clay loam makes up about 60 to 75 percent of this complex, and Renfrow clay loam, about 25 to 40 percent. Except that the Kirkland soil has a surface layer of clay loam, each of these soils has a profile like that described as representative of their respective series.

Included in mapping with this unit are small areas of Bethany and Norge soils.

These soils have moderate natural fertility. If they are cultivated and left unprotected, the hazard of water erosion is severe.

These two soils are similar in use and management. The principal crops are wheat and grain sorghums. Capability unit IIIe-6; Clay Upland range site; windbreak group 1.

Kirkland-Renfrow soils, 1 to 3 percent slopes, eroded (Kw).--Kirkland soils make up about 60 to 75 percent of this mapping unit, and Renfrow soils, about 25 to 40 percent. The surface layer of both soils is clay loam, silty clay, or clay about 4 to 6 inches thick. The original surface layer of both soils has been thinned by erosion, and material formerly in the subsoil has been mixed into the remaining surface layer by plowing. In places rock outcrops make up about 5 percent of the mapped areas.

Included with these soils in mapping are small areas of Vernon clay loam, eroded.

The soils in this complex have low fertility and are droughty. Runoff is rapid. If these soils are cultivated and left unprotected, the hazard of water erosion is severe.

Most areas of these soils are in wheat and sorghums. Capability unit IIIe-7; Clay Upland range site; windbreak group 1.

Minco Series

In the Minco series are deep, well-drained silt loams on uplands. These soils formed in loess. Slopes range from 0 to 6 percent.

In a representative profile the surface layer is brown silt loam about 15 inches thick. The subsoil is brown silt loam about 27 inches thick. It is soft when dry and very friable when moist. The substratum is weakly calcareous, reddish-brown silt loam.

Minco soils have high available water capacity. Permeability is moderate.

Representative profile of Minco silt loam, 1 to 3 percent slopes (2,400 feet east and 80 feet north of the southwest corner of sec. 15, T. 33 S., R. 8 W.):

A1--0 to 15 inches, brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) when moist; weak, medium, granular structure; soft when dry, very friable when moist; medium acid; diffuse, smooth boundary.

B2--15 to 42 inches, brown (7.5YR 5/3) silt loam, brown (7.5YR 4/3) when moist; weak, medium, granular structure; soft when dry, very friable when moist; neutral; gradual, smooth boundary.

C--42 to 60 inches, reddish-brown (5YR 5/4) silt loam, reddish brown (5YR 4/3) when moist; weak, granular structure; soft when dry, friable when moist; mildly alkaline; weakly calcareous.

The A horizon ranges from 10 to 20 inches in thickness. Its color ranges from dark brown to brown in the 7.5YR and 10YR hues. The B2 horizon is brown to strong brown in the 7.5YR hue, or it is reddish brown to yellowish red in the 5YR hue. It is 12 to 30 inches thick. The B2 and C horizons are less than 18 percent clay.

Minco soils have less clay in the B horizon than Grant and Pond Creek soils. They contain less clay than Port soils and occupy higher positions on the landscape than those soils.

Minco silt loam, 0 to 1 percent slopes (Mc).--The surface layer of this soil is 1 to 4 inches thicker than that described as representative of the series. Slopes are smooth. Included in mapping are small areas of Port and Pond Creek soils.

Natural fertility is high in this soil. The hazard of erosion is slight to none.

All crops common to the county can be grown on this soil. Nearly all of the acreage, however, is in wheat and grain sorghums. Capability unit I-1; Loamy Upland range site; windbreak group 1.

Minco silt loam, 1 to 3 percent slopes (Mn).--This soil has the profile described as representative of the series. Slopes are smooth.

Included with this soil in mapping are small areas of Pond Creek soils. Also included are small areas of soils that have a clay loam layer at a depth between 20 and 50 inches.

This soil has high natural fertility. If it is cultivated and left unprotected, the hazard of water erosion is moderate.

Nearly all of this soil is in wheat and sorghums. Capability unit IIe-1; Loamy Upland range site; windbreak group 1.

Minco silt loam, 3 to 6 percent slopes (Mo).--This soil has smooth slopes. The surface layer is 1 to 4 inches thinner than that in the profile described as representative of the series.

Included with this soil in mapping are small areas of Pond Creek soils. Also included are small areas of soils that have a clay loam layer between a depth of 20 and 40 inches.

This soil has high natural fertility. If it is cultivated and left unprotected, the hazard of water erosion is severe.

All crops common to the county can be grown on this soil, but wheat is the main crop. Capability unit IIIe-1; Loamy Upland range site; windbreak group 1.

Nashville Series

The Nashville series consists of moderately deep, well-drained silt loams on uplands. These soils formed in material weathered from silty shale. Slopes range from 0 to 6 percent.

In a representative profile the surface layer is brown silt loam about 12 inches thick. The subsoil is reddish-brown silt loam about 18 inches thick. It is soft when dry and friable when moist. Below is red, soft siltstone.

These soils have low available water capacity. Permeability is moderate.

Representative profile of Nashville silt loam, 1 to 3 percent slopes (1,200 feet south and 250 feet east of the northwest corner of sec. 31, T. 32 S., R. 6 W.):

A1--0 to 12 inches, brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) when moist; weak, fine, granular structure; soft when dry, friable when moist; slightly acid; gradual, smooth boundary.

B2--12 to 30 inches, reddish-brown (5YR 5/4) silt loam, reddish brown (5YR 4/3) when moist; moderate, fine, granular structure; soft when dry, friable when moist; a few, soft, siltstone fragments in lower 4 inches; neutral; clear, smooth boundary.

R--30 inches, red (2.5YR 5/6), soft siltstone; noncalcareous except for thin films of segregated lime in seams and partings of the rock.

The A1 horizon generally ranges from 7 to 20 inches in thickness. In the eroded soil on 3 to 6 percent slopes, however, the surface layer ranges from 4 to 7 inches in thickness. Color of the A1 horizon ranges from dark brown to brown in the 7.5YR hue and from dark reddish brown to reddish brown in the 5YR hue. The B2 horizon ranges from dark reddish brown to yellowish red in the 5YR hue. The R horizon is soft, calcareous and noncalcareous siltstone or very fine sandstone. It is reddish colored in most places, but it is mixed with red and gray bedrock in many places. Depth to bedrock ranges from 20 to 36 inches.

Nashville soils are shallower to bedrock than Grant soils. They are unlike Woodward soils in that they are noncalcareous, and Woodward soils are calcareous within 10 inches of the surface.

Nashville silt loam, 0 to 1 percent slopes (Na).--This soil has smooth slopes. Included in mapping are small areas of Grant soils. Also included are a few small areas of soils that are less than 20 inches deep to bedrock.

Natural fertility is moderate in this soil. The hazard of erosion is slight to none.

Except for such deep-rooted crops as alfalfa, this soil is suited to the crops commonly grown in the county. Capability unit IIs-2; Loamy Upland range site; windbreak group 6.

Nashville silt loam, 1 to 3 percent slopes (Ne).--This soil has smooth slopes. It has the profile described as representative of the series.

Included with this soil in mapping are small areas of Grant soils. Also included are a few small areas of soils that are less than 20 inches deep to bedrock.

This soil has moderate natural fertility. If it is cultivated and left unprotected, the hazard of water erosion is moderate.

Except for such deep-rooted crops as alfalfa, this soil is suited to the crops commonly grown in the county. Capability unit IIe-5; Loamy Upland range site; windbreak group 6.

Nashville silt loam, 3 to 6 percent slopes (Nh).--This soil has a profile similar to that described as representative of the series.

Included with this soil in mapping are small areas of Grant soils. Also included are a few small areas of soils that are less than 20 inches deep to bedrock.

This soil has moderate natural fertility. If it is cultivated and left unprotected, the hazard of water erosion is severe.

Except for such deep-rooted crops as alfalfa, this soil is suited to the crops commonly grown in the county. Capability unit IIIe-5; Loamy Upland range site; windbreak group 6.

Nashville silt loam, 3 to 6 percent slopes, eroded (Nn).--The surface layer of this soil is brown to reddish brown and is 4 to 7 inches thick. The original surface layer has been thinned by erosion. In more than half of the mapped area, material from the subsoil has been mixed with the remaining surface layer by plowing. Depth to bedrock ranges from 20 to 30 inches.

Included with this soil in mapping are small areas of Pond Creek silt loam, eroded, and some small areas of soils that are less than 20 inches deep to bedrock. Also included are small outcrops of rock.

Most of this soil is cultivated. Wheat and sorghums are the crops commonly grown. Some areas have been reseeded to grass and are used for pasture and range. This soil is deficient in nitrogen and phosphorus. Capability unit IVe-1; Loamy Upland range site; windbreak group 6.

Norge Series

The Norge series consists of deep, well-drained loams on uplands. These soils formed in outwash. Slopes range from 1 to 3 percent.

In a representative profile the surface layer is brown loam about 10 inches thick. The upper part of the subsoil is brown clay loam about 5 inches thick. The lower part is yellowish-red clay loam about 33 inches thick. It is very hard when dry and very firm when moist. The substratum is yellowish-red clay loam.

Norge soils have high available water capacity. Permeability is moderately slow.

Representative profile of Norge loam, 1 to 3 percent slopes (200 feet south and 100 feet west of the northeast corner of sec. 30, T. 31 S., R. 5 W.):

A1--0 to 10 inches, brown (7.5YR 4/2) loam, dark brown (7.5YR 3/2) when moist; moderate, medium and fine, granular structure; slightly hard when dry, friable when moist; medium acid; clear, smooth boundary.

B1--10 to 15 inches, brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) when moist; strong, medium and coarse, granular structure; hard when dry, friable when moist; slightly acid; clear, smooth boundary.

B2t--15 to 48 inches, yellowish-red (5YR 4/6) clay loam; many sand grains; dark reddish brown (5YR 3/4) when moist; moderate, medium, blocky structure; very hard when dry, very firm when moist; thick continuous clay films; neutral; gradual, smooth boundary.

C--48 to 60 inches, yellowish-red (5YR 5/6) clay loam, yellowish red (5YR 4/6) when moist; massive; hard when dry, firm when moist; neutral.

The A horizon ranges from 8 to 15 inches in thickness. Its color ranges from dark brown to brown in the 7.5YR hue, and from brown to very dark grayish brown in the 10YR hue. The B2t horizon ranges from 20 to 45 inches in thickness. It typically is medium clay loam in the upper part and medium clay loam to heavy clay loam in the lower 10 to 20 inches. The B2t horizon ranges from dark reddish brown to reddish yellow in the 5YR hue. It ranges from blocky to subangular blocky in structure. The C horizon ranges from sandy clay loam to light clay in texture. These soils have more sand in the B2t horizon than the defined range for the series.

Norge soils have a redder B2t horizon than Farnum soils. They have less sand in the A horizon than Shellabarger soils and more clay in the B2t horizon.

Norge loam, 1 to 3 percent slopes (No).--This is the only Norge soil mapped in the county. Slopes average about 2 percent.

Included with this soil in mapping are small areas of Farnum and Shellabarger soils.

This soil has high natural fertility. If it is cultivated and left unprotected, the hazard of water erosion is moderate.

All crops commonly grown in the county are suited to this soil. Most of the acreage, however, is in wheat and sorghums. Capability unit IIe-1; Loamy Upland range site; windbreak group 1.

Pond Creek Series

The Pond Creek series consists of deep, well-drained silt loams on uplands. These soils formed in loess. Slopes range from 0 to 6 percent.

In a representative profile the surface layer is brown silt loam about 13 inches thick. The subsoil is about 41 inches thick. It is brown and reddish-brown silty clay loam in the upper part, and yellowish-red silty clay loam in the lower part. Both layers are hard when dry and firm when moist. The substratum is yellowish-red silty clay loam.

These soils have high available water capacity. Permeability is moderately slow.

Representative profile of Pond Creek silt loam, 0 to 1 percent slopes (1,500 feet west and 60 feet south of the northeast corner of sec. 8, T. 34 S., R. 5 W.):

A1--0 to 13 inches, brown (7.5YR 4/2) heavy silt loam, dark brown (7.5YR 3/2) when moist; moderate, fine, granular structure; soft when dry, friable when moist; medium acid; gradual, smooth boundary.

B1--13 to 18 inches, brown (7.5YR 4/3) light silty clay loam, dark brown (7.5YR 3/3) when moist; moderate, medium and coarse, granular structure; slightly hard when dry, friable when moist; slightly acid; gradual, smooth boundary.

B21t--18 to 34 inches, reddish-brown (5YR 4/3) silty clay loam; dark reddish brown (5YR 3/3) when moist; moderate, medium, subangular blocky structure; hard when dry, firm when moist; thin, continuous clay films; neutral; abrupt, smooth boundary.

B22t--34 to 54 inches, yellowish-red (5YR 5/6) silty clay loam, yellowish red (5YR 4/6) when moist; moderate, medium, subangular blocky structure; hard when dry, firm when moist; neutral; clear, smooth boundary.

C--54 to 60 inches, yellowish-red (5YR 5/6) silty clay loam, yellowish red (5YR 4/6) when moist; massive; slightly hard when dry, firm when moist; neutral.

The A horizon generally ranges from 9 to 18 inches in thickness. In the eroded soil on 3 to 6 percent slopes, however, the surface layer ranges from 4 to 8 inches in thickness. Color ranges from dark brown to brown in the 7.5YR hue. In some places the color is dark reddish brown to reddish brown in the 5YR hue. Texture of the A horizon ranges from silt loam to silty clay loam. The B2t horizon ranges from 20 to 45 inches in thickness. Typically the B21t horizon is medium silty clay loam, but the texture of the B22t horizon ranges from medium silty clay loam to heavy silty clay loam. The color of the B21t horizon and the B22t horizon ranges from dark brown to brown in the 7.5YR

hue and from dark reddish brown to reddish yellow in the 5YR hue. In some places bedrock occurs at a depth of about 40 inches, but in most places it is at a greater depth.

Pond Creek soils have more clay in the B horizon than Nashville and Minco soils. Their Bt horizon contains less clay than that in Kirkland soils but more clay than that in Grant soils.

Pond Creek silt loam, 0 to 1 percent slopes (Pc).--This soil has the profile described as representative of the series. Slopes are slightly convex.

Included with this soil in mapping are small areas of Grant and Kirkland soils.

This soil has high natural fertility. The hazard of erosion is slight to none.

Most of this soil is cultivated. All crops common to the county can be grown, but wheat is the principal crop. Capability unit I-1; Loamy Upland range site; windbreak group 1.

Pond Creek silt loam, 1 to 3 percent slopes (Pd).--This soil has long slopes that average about 2 percent. Included in mapping are small areas of Grant and Kirkland soils.

This soil has high natural fertility. If it is cultivated and left unprotected, the hazard of water erosion is moderate.

Most of this soil is cultivated. All crops commonly grown in the county are suited. Capability unit IIe-1; Loamy Upland range site; windbreak group 1.

Pond Creek silt loam, 3 to 6 percent slopes (Pe).--This soil has short, convex slopes. Included in mapping are small areas of Grant and Nashville soils.

This soil has high natural fertility. If it is cultivated and left unprotected, the hazard of water erosion is severe.

Most of this soil is cultivated. All crops commonly grown in the county are suited. Capability unit IIIe-1; Loamy Upland range site; windbreak group 1.

Pond Creek silt loam, 3 to 6 percent slopes, eroded (Pg).--Most areas of this soil are along the sides of intermittent drainageways on short convex slopes. The surface layer is 4 to 8 inches thick and somewhat lighter colored than that in the profile described as representative of the series. It ranges from silt loam to silty clay loam in texture. Part of the original surface layer has been washed away. In more than half the acreage, material formerly in the subsurface layer has been mixed with the remaining surface layer by plowing.

Included with this soil in mapping are small areas of Nashville silt loam, eroded.

The hazard of water erosion is severe if this soil is cultivated and left unprotected. Nitrogen and phosphorus are deficient in this soil.

Most of this soil is cultivated. All crops common to the county can be grown, but wheat is the principal crop. Capability unit IIIe-4; Loamy Upland range site; windbreak group 1.

Port Series

The Port series consists of deep, well-drained silt loams on low terraces. These soils formed in alluvium. Slopes range from 0 to 1 percent.

In a representative profile the surface layer is brown silt loam about 22 inches thick. Below is brown, calcareous heavy silt loam that is slightly hard when dry and friable when moist. This horizon is about 18 inches thick and grades to the substratum. The calcareous substratum is brown stratified silt loam and light silty clay loam.

These soils have high available water capacity. Permeability is moderate.

Representative profile of Port silt loam (2,640 feet south and 200 feet east of the northwest corner of sec. 7, T. 34 S., R. 5 W.):

A11--0 to 12 inches, brown (7.5YR 5/3) silt loam; dark brown (7.5YR 3/3) when moist; weak, fine, granular structure; soft when dry, very friable when moist; slightly acid; gradual, smooth boundary.

A12--12 to 22 inches, brown (7.5YR 5/4) silt loam; dark brown (7.5YR 3/4) when moist; moderate, fine, granular structure; soft when dry, friable when moist; neutral; abrupt, smooth boundary.

AC--22 to 40 inches, brown (7.5YR 5/3) heavy silt loam; dark brown (7.5YR 3/3) when moist; moderate, medium and fine, granular structure; slightly hard when dry, friable when moist; mildly alkaline; white, calcareous material on peds; clear, smooth boundary.

C--40 to 60 inches, brown (7.5YR 5/4) stratified silt loam and light silty clay loam, dark brown (7.5YR 3/4) when moist; weak, medium, granular structure; slightly hard when dry, friable when moist; moderately alkaline; calcareous.

The A11 and A12 horizons combined range from 10 to 24 inches in thickness. Texture is dominantly silt loam, but it ranges to loam. In color these horizons range from brown to dark brown in the 7.5YR hue. The AC horizon ranges from heavy loam to light silty clay loam in texture. Its color ranges from dark reddish brown to reddish brown in the 5YR hue, and from dark brown to strong brown in the 7.5YR hue. In most places the soil is calcareous below a depth of 15 to 36 inches. In places the C horizon contains layers of sandy loam.

Port soils have more clay and silt and less sand in all horizons than Crisfield soils. They contain more clay than Minco soils and their C horizon is more stratified.

Port silt loam (0 to 1 percent slopes) (Ph).--This soil has the profile described as representative of the series. It is on low terraces above normal overflow.

Included with this soil in mapping are small areas of Crisfield and Gerlane soils. Also included are small areas of Minco, Woodward, and Quinlan soils.

Natural fertility is high in this soil. The hazard of erosion is slight to none.

Most of this soil is cultivated. All crops commonly grown in the county are suited. Wheat, sorghums, and alfalfa are the principal crops. Alfalfa is especially well suited, and much of the acreage is used to produce alfalfa. Capability unit I-1; Loamy Upland range site; windbreak group 7.

Port-Slickspots complex (0 to 1 percent slopes) (Pk).--This complex is on low terraces that are above normal overflow. Port silt loam makes up 40 to 75 percent of the complex, and Slickspots makes up 5 to 35 percent. Soils that are intermediate in characteristics between Port silt loam and Slickspots make up 20 to 25 percent of the complex.

The Port part of this complex consists of Port silt loam similar to that described for the Port series. The Slickspots part has a white crust on the surface that is 1/2 to 4 inches thick. The surface layer is 2 to 4 inches thinner than that in Port silt loam, and the horizons below are finer textured than in that soil. Precipitated salts are present in the horizons below the surface layer.

Such crops as barley, grain sorghums, and rye that are moderately tolerant of salt are grown on these soils. Wheat and alfalfa are poorly suited. Some of the Slickspots are bare of vegetation. Both parts, capability unit IVs-1, windbreak group not assigned; Port part, Loamy Upland range site, Slickspots part, Saline Lowland range site.

Pratt Series

The Pratt series consists of deep and moderately deep, well-drained loamy fine sands on uplands. These soils formed in sandy material laid down by wind. Slopes are undulating to hummocky and range from 3 to 8 percent.

In a representative profile the surface layer is brown loamy fine sand about 12 inches thick. The subsoil also is brown loamy fine sand but is about 24 inches thick. It is loose when dry and very friable when moist. The substratum is strong brown light loamy fine sand that contains thin layers of fine sandy loam.

These soils have low available water capacity. Permeability is rapid.

Representative profile of Pratt loamy fine sand, undulating (2,640 feet north and 250 feet east of the southwest corner of sec. 7, T. 35 S., R. 8 W.):

A1--0 to 12 inches, brown (7.5YR 5/3) loamy fine sand, dark brown (7.5YR 3/3) when moist; weak, fine, granular structure; loose when dry, very friable when moist; medium acid; diffuse, smooth boundary.

B2t--12 to 36 inches, brown (7.5YR 5/4) loamy fine sand, brown (7.5YR 4/4) when moist; weak, granular structure; loose when dry, very friable when moist; medium acid; diffuse, smooth boundary.

C--36 to 60 inches, strong-brown (7.5YR 5/6) light loamy fine sand; layers of fine sandy loam about 1/4 inch thick occur at intervals of about 6 inches; strong brown (7.5YR 4/6) when moist, massive; soft when dry, loose when moist; medium acid.

The A1 horizon ranges from 8 to 16 inches in thickness. Its color ranges from brown to dark brown in the 7.5YR hue. The weakly developed B2t horizon ranges from 10 to 30 inches in thickness. Its color ranges from dark brown to reddish yellow in the 7.5YR hue, and from reddish brown to reddish yellow in the 5YR hue. Horizontal layers of fine sandy loam, 1/16 to 1/4 inch thick, occur at intervals of 4 to 12 inches throughout this horizon. The C horizon is loamy fine sand or fine sand. It is at a depth of 24 to 40 inches. Bedrock generally is at a depth of more than 5 feet. In the siltstone substratum unit, however, depth to siltstone is 24 to 50 inches.

Pratt soils are similar to Tivoli soils, but they are loamy fine sand throughout and, unlike those soils, they have a B2t horizon.

Pratt loamy fine sand, undulating (3 to 8 percent slopes) (Pm).--This soil has the profile described as representative of the series. Included in mapping are small areas of Tivoli and Carwile soils.

This soil has moderate natural fertility. If it is cultivated and left unprotected, the hazard of soil blowing is severe.

About 75 percent of the acreage of this soil is cultivated. The rest is in native grass. Wheat is the main crop, but grain sorghum is grown in some places. Capability unit IIIe-2; Sands range site; windbreak group 4.

Pratt loamy fine sand, siltstone substratum, undulating (3 to 8 percent slopes) (Pn).--This soil is in transitional areas between areas of Grant and Nashville soils and areas of Pratt and Tivoli soils. Siltstone is at a depth of 24 to 50 inches, but otherwise the profile is similar to that described for the series. In most places 4 to 12 inches of reddish-brown to yellowish-red silt loam overlies the siltstone.

Included with this soil in mapping are small areas of Tivoli, Carwile, and Pratt soils.

This soil has moderate natural fertility. If it is cultivated and not protected, the hazard of soil blowing is severe.

This soil is less droughty than Pratt loamy fine sand, undulating, because of slower permeability through the siltstone. It is better suited to small grains than other crops, but grain sorghum is grown in some places. Capability unit IIIe-2; Sands range site; windbreak 4.

Pratt-Carwile complex (3 to 8 percent slopes) (Po).--In this complex slopes are undulating. The Pratt soils are on the slopes, and the Carwile soils

are in low areas between the slopes. Pratt soils make up from about 45 to 75 percent of the acreage and average about 65 percent of the acreage. Carwile soils make up from about 25 to 45 percent of the acreage and average about 30 percent of the acreage. Each soil has a profile similar to the one described for their respective series.

Included with this complex in mapping are small areas of Shellabarger and Tivoli soils.

Most areas of these soils are cultivated. Wheat and grain sorghums are the main crops. In many places water is ponded on the surface of Carwile soils for long enough periods to adversely affect growing crops. If Pratt soils are cultivated and not protected, soil blowing is a severe hazard. Both parts, capability unit IIIe-2; Pratt part, Sands range site, windbreak group 4; Carwile part, Sandy range site, windbreak group 2.

Pratt-Tivoli loamy fine sands (8 to 15 percent slopes) (Pt).--The soils in this complex are on hummocks. Pratt soils are on the lower, less sloping hummocks and Tivoli soils are on the higher, more sloping hummocks. Each soil makes up about 40 to 50 percent of the complex. The surface layer of Tivoli soils is slightly darker colored loamy fine sand that is about 3 inches thicker than that described as representative of the Tivoli series.

Included with this complex in mapping are small areas of Tivoli fine sand and of Carwile fine sandy loam.

Most of the acreage of this complex is in native range. The soils generally are not suitable for cultivation, because they are highly susceptible to soil blowing. Both parts, capability unit VIe-6, Sands range site; Pratt part, windbreak group 4; Tivoli part, windbreak group 5.

Quinlan Series

The Quinlan series consists of shallow, well-drained loams on uplands. These soils formed in material weathered from silty shale. Slopes range from 0 to 6 percent.

In a representative profile the surface layer is yellowish-red, calcareous loam about 9 inches thick. It grades to calcareous siltstone or very fine sandstone at a depth of 11 inches.

These soils have very low available water capacity. Permeability is moderately rapid.

Representative profile of Quinlan loam, 0 to 1 percent slopes (1,800 feet west and 75 feet south of the northeast corner of sec. 4, T. 34 S., R. 9 W.):

A1--0 to 9 inches, yellowish-red (5YR 5/6) loam, yellowish red (5YR 3/6) when moist; moderate, fine, granular structure; soft when dry, friable when moist; moderately alkaline; clear, smooth boundary.

C--9 to 11 inches, red and gray, thin, platy, partly weathered, calcareous siltstone or very fine sandstone; gradual boundary.

R--11 inches +, unweathered, soft, red and gray, calcareous siltstone or very fine sandstone.

The A1 horizon ranges from 4 to 10 inches in thickness. It ranges from loam to silt loam in texture, and from yellowish red and reddish brown to dark reddish brown in color. The C horizon generally is less than 5 inches thick. Depth to the R horizon ranges from 10 to 20 inches. In places where the depth to the R horizon is more than 10 inches, an AC horizon occurs that is lighter colored than the A1 horizon.

Quinlan soils are shallower than Nashville and Woodward soils. They are coarser textured and more limy than Vernon soils.

Quinlan loam, 0 to 1 percent slopes (Qa).--This soil has the profile described as representative of the series. Included in mapping are small areas of Woodward and Nashville soils.

This soil is droughty during periods of low rainfall. Water ponds in some shallow depressional areas for short periods. The hazard of erosion is slight to none.

About 75 percent of the acreage of this soil is used for pasture and range. The rest is cultivated, and wheat is the main crop. Capability unit IIIs-1; Shallow Prairie range site; windbreak group 6.

Quinlan loam, 1 to 3 percent slopes (Qn).--The profile of this soil is similar to that described as representative for the series. Included in mapping are small areas of Woodward and Nashville soils.

The hazard of water erosion is severe on this soil. During periods of low rainfall, the soil is droughty.

About 75 percent of the acreage of this soil is used for pasture and range. The rest is cultivated, and wheat is the principal crop. Capability unit IVe-2; Shallow Prairie range site; windbreak group 6.

Quinlan loam, 3 to 6 percent slopes (Qu).--This soil has short slopes. Included in mapping are small areas of Woodward and Nashville soils. Also included are small areas of steep breaks and of outcrops of siltstone.

This soil generally is not suitable for cultivation. It is shallow to weathered shale, and the hazard of water erosion is very severe. Most of the soil is used for native grasses. Capability unit VIe-1; Shallow Prairie range site; windbreak group 6.

Renfrow Series

The Renfrow series consists of moderately deep and deep, well-drained clay loams on uplands. These soils formed in material weathered from clayey shale (pl. I). Slopes range from 1 to 6 percent.

In a representative profile the surface layer is brown clay loam about 9 inches thick. The

subsoil is reddish-brown and red clay about 51 inches thick. It is very hard to extremely hard when dry and very firm to extremely firm when moist.

These soils have high available water capacity and slow permeability.

Representative profile of Renfrow clay loam, in an area of Kirkland Renfrow clay loams, 1 to 3 percent slopes (600 feet west and 50 feet north of the southeast corner of sec. 4, T. 35 S., R. 5 W.):

A1--0 to 9 inches, brown (7.5YR 4/3) clay loam, dark brown (7.5YR 3/3) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; slightly acid; gradual, smooth boundary.

B21t--9 to 13 inches, reddish-brown (5YR 4/3) light clay; dark reddish brown (5YR 3/2) when moist; moderate, fine, blocky structure; very hard when dry, very firm when moist; neutral; gradual, smooth boundary.

B22t--13 to 29 inches, reddish-brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) when moist; moderate, coarse, blocky structure; extremely hard when dry, extremely firm when moist; thick, continuous clay films; neutral; contains small, hard, calcareous concretions in the lower 3 inches of the horizon; gradual, smooth boundary.

B23t--29 to 42 inches, reddish-brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) when moist; strong, medium, blocky structure; extremely hard when dry, extremely firm when moist; neutral; mass is noncalcareous with many hard, calcareous concretions up to 3 inches in diameter; clear, smooth boundary.

B3--42 to 60 inches, red (2.5YR 4/6) clay, dark red (2.5YR 3/6) when moist; weak, fine and medium, blocky structure; extremely hard when dry, extremely firm when moist; mildly alkaline.

The A1 horizon ranges from 7 to 14 inches in thickness. In the Kirkland-Renfrow soils, 1 to 3 percent slopes, eroded, and in the Vernon-Renfrow complex, 2 to 6 percent slopes, eroded, however, the surface layer of the Renfrow soil ranges from 4 to 7 inches in thickness. The A1 horizon ranges from dark brown to brown in the 7.5YR hue and from dark reddish brown to reddish brown in the 5YR hue. Color of the B2t horizons generally ranges from dark reddish brown to reddish brown in the 5YR hue and in some places from dark reddish brown to red in the 2.5YR hue. Depth to shaly clay ranges from 24 to 70 inches.

Renfrow soils are more red in the Bt horizon than Kirkland soils. They are deeper to bedrock than Vernon soils.

Renfrow-Vernon clay loams, 1 to 3 percent slopes (Rc).--Renfrow clay loam makes up 50 to 65 percent of this complex, and Vernon clay loam, 35 to 50 percent. Each soil has a profile similar to the one described for their respective series.

Included in mapping with these soils are small areas of Kirkland and Norge soils. Also included are small areas of soils that have bedrock within 10 inches of the surface, but that otherwise are similar to the Vernon soils.

The soils in this complex have moderate natural fertility. If they are cultivated and left unprotected, the hazard of water erosion is severe. Because of the slow permeability of both soils and the limited depth of the Vernon soils, these soils are somewhat droughty.

Suitable crops for these soils are grain sorghum and other crops that resist drought or such crops as wheat or barley, which mature early. Alfalfa is poorly suited. Both parts, capability unit IIIe-7; Renfrow part, Clay Upland range site, windbreak group 1; Vernon part, Red Clay Prairie range site, windbreak group 6.

Ruella Series

The Ruella series consists of deep, well-drained loams on uplands. These soils formed in medium-textured, old alluvium. Slopes range from 0 to 6 percent.

In a representative profile the surface layer is reddish-brown loam about 9 inches thick. The yellowish-red subsoil is about 23 inches thick. It is calcareous loam that is slightly hard when dry and very friable when moist. At a depth below 15 inches, calcareous material is in cleavage planes and a few calcareous concretions are present. The substratum is yellowish-red calcareous loam.

These soils have moderate to high available water capacity. Permeability is moderate.

Representative profile of Ruella loam, 1 to 3 percent slopes (550 feet west and 200 feet south of the northeast corner of sec. 3, T. 34 S., R. 8 W.):

A1--0 to 9 inches, reddish-brown (5YR 5/4) loam, reddish brown (5YR 4/4) when moist; moderate, medium and fine, granular structure; soft when dry, very friable when moist; mildly alkaline; abrupt, smooth boundary.

B21--9 to 15 inches, yellowish-red (5YR 5/6) heavy loam; yellowish red (5YR 4/6) when moist; moderate, medium and fine, granular structure; slightly hard when dry, very friable when moist; many worm casts; moderately alkaline; calcareous; gradual, smooth boundary.

B22ca--15 to 32 inches, yellowish-red (5YR 5/6) heavy loam; yellowish red (5YR 4/6) when moist; moderate, medium and fine, granular structure; slightly hard when dry, very friable when moist; moderately alkaline; calcareous; small, white, calcareous bands in cleavage planes and throughout peds; a few calcareous concretions; gradual, smooth boundary.

C--32 to 60 inches, yellowish-red (5YR 5/6) loam, yellowish red (5YR 4/6) when moist; massive; slightly hard when dry, friable when moist; moderately alkaline; calcareous.

The A1 horizon ranges from 5 to 12 inches in thickness. Its color ranges from reddish brown to brown in the 5YR and 7.5YR hues. In most places the A1 horizon is calcareous at the surface, but in places it is noncalcareous to a depth of 10 inches. The B21 and B22ca horizons are loam to light clay loam in texture. These horizons are reddish brown to reddish yellow in hues of 5YR. In many places concretions of calcium carbonate that range from 1/4 inch to 1 1/2 inches in diameter occur in all horizons. Siltstone or fine sandstone generally are at a depth of more than 5 feet, but in places they occur at a depth of about 5 feet.

Ruella soils lack the Bt horizon of Grant soils, and unlike those soils they are calcareous within a depth of 10 inches. They are deeper to bedrock than Woodward and Quinlan soils.

Ruella loam, 0 to 1 percent slopes (Re).--This soil has irregular slopes. Hummocks as much as 2 feet high and 50 to 75 feet in diameter dot the landscape. Included in mapping are small areas of Grant soils.

Natural fertility is moderate in this soil. The hazard of erosion is slight to none.

This soil is suited to all crops commonly grown in the county. In places, however, sorghums are subject to chlorosis. Capability unit I-1; Loamy Upland range site; windbreak group 1.

Ruella loam, 1 to 3 percent slopes (Rh).--This soil has the profile described as representative of the series. Included in mapping are small areas of Grant soils.

This soil has moderate natural fertility. If it is cultivated and left unprotected, the hazard of water erosion is moderate.

All crops commonly grown in the county are suited to this soil. Most of the acreage is in small grains and alfalfa. In a few places sorghums on this soil are subject to chlorosis. Capability unit IIe-1; Loamy Upland range site, windbreak group 1.

Ruella loam, 3 to 6 percent slopes (Ru).--This soil has short, irregular slopes that average about 5 percent. Included in mapping are small areas of Grant soils.

This soil has moderate natural fertility. If it is cultivated and left unprotected, the hazard of water erosion is severe.

All crops commonly grown in the county are suited to this soil. Most of the acreage is in small grains. In a few places sorghums on this soil are subject to chlorosis. Capability unit IIIe-1; Loamy Upland range site; windbreak group 1.

Saline Alluvial Land

Saline alluvial land (0 to 1 percent slopes) (Sa) consists of somewhat poorly drained saline soil material on alluvium. The areas are on flood plains along intermittent drainageways and perennial streams. Most areas are less than 500 feet wide.

The soil material in Saline alluvial land is loam or silty clay loam in the upper 36 to 60 inches. Below is stratified sandy, loamy, and clayey material. In most places the pH is 8.0 or higher throughout all parts of the soil material.

Salt grass and other grasses, weeds, and shrubs that tolerate salt are the main kinds of vegetation on this land type. In severely affected areas the surface is bare. Some areas are grazed, but most areas are wasteland. Capability unit VIs-1; Saline Lowland range site; windbreak group not assigned.

Shellabarger Series

The Shellabarger series consists of deep and moderately deep, well-drained fine sandy loams on uplands. These soils formed in old alluvial outwash. Slopes range from 0 to 15 percent.

In a representative profile the surface layer is brown fine sandy loam about 13 inches thick. The subsoil is brown and reddish-brown sandy clay loam about 25 inches thick. It is slightly hard when dry and friable when moist in the upper part and hard when dry and firm when moist in the lower part. The substratum is yellowish-red sandy loam.

These soils have moderate available water capacity. Permeability is moderate.

Representative profile of Shellabarger fine sandy loam, 1 to 3 percent slopes (2,000 feet south and 40 feet west of the northeast corner of sec. 21, T. 31 S., R. 8 W.):

A1--0 to 13 inches, brown (7.5YR 4/3) fine sandy loam, dark brown (7.5YR 3/3) when moist; weak, very fine, granular structure; soft when dry, very friable when moist; medium acid; gradual, smooth boundary.

B1--13 to 20 inches, brown (7.5YR 4/3) light sandy clay loam, dark brown (7.5YR 3/3) when moist; weak, medium, subangular blocky and fine, granular structure; slightly hard when dry, friable when moist; slightly acid; clear, smooth boundary.

B2t--20 to 38 inches, reddish-brown (5YR 5/4) sandy clay loam that is about 10 percent coarse sand; reddish brown (5YR 4/4) when moist; weak, medium, subangular blocky structure; hard when dry, firm when moist; slightly acid; gradual, smooth boundary.

C--38 to 60 inches, yellowish-red (5YR 5/6) coarse sandy loam; yellowish red (5YR 4/6) when moist; weak granular structure to single grain; soft when dry, very friable when moist; slightly acid.

The A1 horizon generally ranges from 6 to 20 inches in thickness. In the eroded soils on 3 to 6 percent slopes, however, the present surface layer ranges from 4 to 7 inches in thickness. The A1

horizon ranges from fine sandy loam to loamy fine sand in texture. Its color ranges from dark brown to brown in the 7.5YR hue and to reddish brown in the 5YR hue. The B2t horizon ranges from heavy sandy loam to sandy clay loam in texture, and from granular to subangular blocky in structure. Its color ranges from dark reddish brown to reddish brown in the 5YR hue. Depth to the C horizon ranges from about 36 to 48 inches. The C horizon is sandy loam, loamy sand, or sand, and in places it contains a considerable amount of gravel. Bedrock generally is at a depth of more than 5 feet. In the mapping units of Shellabarger fine sandy loam, shale substratum, however, depth to shale is 24 to 45 inches.

Shellabarger soils are more sandy in the A horizon and B2t horizon than Farnum and Norge soils.

Shellabarger fine sandy loam, 0 to 1 percent slopes (Sb).--Except that in some small areas the surface layer is loam, the profile of this soil is similar to that described as representative of the series. Included in mapping are small areas of Farnum, Norge, and Crisfield soils.

This soil has moderate natural fertility. If it is cultivated and left unprotected, the hazard of soil blowing is slight to moderate (pl. I).

Nearly all of this soil is in wheat and sorghums. Capability unit IIe-4; Sandy range site; windbreak group 3.

Shellabarger fine sandy loam, 1 to 3 percent slopes (Se).--This soil has the profile described as representative of the series. Slopes are smooth to irregular. Included in mapping are small areas of Farnum loam, Norge loam, Shellabarger fine sandy loam, and Shellabarger fine sandy loam, shale substratum.

This soil has moderate natural fertility. If it is cultivated and left unprotected, the hazard of water erosion is moderate. The hazard of soil blowing is slight to moderate.

Nearly all of this soil is used for wheat and sorghums. Capability unit IIe-3; Sandy range site; windbreak group 3.

Shellabarger fine sandy loam, 3 to 6 percent slopes (Sf).--This soil has irregular slopes. The surface layer is 2 to 5 inches thinner but the profile of this soil is otherwise similar to that described as representative of the series. Included in mapping are small areas of Norge and Farnum soils.

This soil has moderate natural fertility. If it is cultivated and left unprotected, the hazard of water erosion is severe. The hazard of soil blowing is moderate.

About 80 percent of this soil is cultivated. The rest is used for pasture and range. Capability unit IIIe-3; Sandy range site; windbreak group 3.

Shellabarger fine sandy loam, 3 to 6 percent slopes, eroded (Sg).--This soil has irregular slopes and generally is adjacent to drainageways. The surface layer is 4 to 7 inches thick and is more reddish than that in the profile described as representative of the series. It has been thinned by erosion, and plowing has mixed material from the subsoil with the remaining surface layer in more than 50 percent of the area. Included in mapping are small areas of Farnum clay loam, eroded.

The natural fertility of this soil has been lowered by erosion. If this soil is cultivated and left unprotected, the hazard of water erosion is severe. The hazard of soil blowing is moderate.

Most of this soil is cultivated. The rest is used for pasture and range. Capability unit IIIe-8; Sandy range site; windbreak group 3.

Shellabarger fine sandy loam, shale substratum, 1 to 3 percent slopes (Sh).--This soil is underlain by shale at a depth between 24 and 45 inches, but otherwise its profile is similar to that described as representative of the series. Included in mapping are small areas of Shellabarger fine sandy loam.

This soil has moderate natural fertility. If it is cultivated and left unprotected, the hazard of water erosion is moderate. The hazard of soil blowing is slight to moderate.

Most of this soil is cultivated. Wheat and grain sorghum are the main crops. Capability unit IIe-3; Sandy range site; windbreak group 3.

Shellabarger fine sandy loam, shale substratum, 3 to 6 percent slopes (Sk).--This soil is underlain by shale at a depth between 24 to 45 inches, but otherwise its profile is similar to that described as representative of the series. Included in mapping are small areas of Shellabarger fine sandy loam.

This soil has moderate natural fertility. If it is cultivated and left unprotected, the hazards of water erosion and of soil blowing are moderate.

Most of this soil is cultivated. Wheat is the main crop, but grain sorghum is grown in some places. Capability unit IIIe-3; Sandy range site; windbreak group 3.

Shellabarger fine sandy loam, shale substratum, 3 to 6 percent slopes, eroded (Sm).--This soil has short irregular slopes. It is underlain by shale at a depth between 24 and 45 inches, and the surface layer is 4 to 7 inches thick and more reddish, but otherwise its profile is similar to that described as representative of the series. All of the original surface layer has been removed by erosion, and the subsoil is exposed in more than 15 percent of the mapped areas. Included in mapping are small areas of Shellabarger fine sandy loam, eroded, and some small rock outcrops.

Natural fertility of this soil has been lowered by erosion. The hazard of water erosion is severe, and the hazard of soil blowing is moderate.

Most of this soil is cultivated. Wheat is the principal crop, but sorghum is grown in some places. Capability unit IIIe-8; Sandy range site; windbreak group 3.

Shellabarger loamy fine sand, undulating (0 to 3 percent slopes) (Sn).--This soil has a surface layer of loamy fine sand, but its profile otherwise is similar to that described as representative of the series. In some small areas the uppermost 4 to 10 inches of the surface layer is fine sand. Included in mapping are small areas of Pratt loamy fine sand and Shellabarger fine sandy loam.

This soil has moderate natural fertility. If it is cultivated and left unprotected, the hazard of soil blowing is severe.

This soil is suited to wheat and sorghums, but most of it is used for pasture and range. Capability unit IIIe-2; Sands range site; windbreak group 4.

Shellabarger and Albion soils, 7 to 15 percent slopes (So).--This undifferentiated unit consists primarily of Shellabarger fine sandy loam and Albion sandy loam. The Shellabarger part makes up 60 to 80 percent of the mapping unit and the Albion part, 20 to 40 percent. The soils have profiles similar to those described as representative of their respective series.

Included with these soils in mapping are small areas of Farnum and Shellabarger soils on slopes of 2 to 6 percent. Also included are small areas of Case and Clark soils.

Most of this mapping unit is used for pasture and range. A few small areas are cultivated. In most places, however, the moderately steep slopes and the severe water erosion hazard make the soils unsuitable for cultivation. Capability unit VIe-3; Sandy range site; windbreak group 3.

Slickspots

Slickspots (0 to 2 percent slopes) (Sp) consists of somewhat poorly drained soil material on stream terraces. Most of the areas are above the level of normal stream overflow. Slopes range from slightly concave to gently sloping.

The soil material in Slickspots varies in characteristics, but the sodium content is high in some part. The part that has a high sodium content varies from place to place. In all areas white crystalline salts occur in the lower part of the soil material.

About 30 percent of the mapped areas have a dispersed surface soil of light-colored loam about 5 to 9 inches thick that is slick when wet. Below this the material is grayish sandy clay loam to light clay that is mottled with olive brown in places.

Another 30 percent of the mapped areas consist of dark-colored, noncalcareous loam to clay loam to a depth between 5 and 12 inches. Below is 16 to 30 inches of noncalcareous, brown to reddish-brown heavy clay loam to light clay that has gray mottles in places. This material has columnar structure, and the tops of the columns have grayish coatings on them. The substratum is massive, calcareous, yellowish-red clay loam.

In about 20 percent of the mapped areas, the surface layer and subsoil are calcareous, but the soil is otherwise similar to that described in the preceding paragraph. In the remaining 20 percent of the mapped areas, the surface layer is noncalcareous, dark-colored sandy loam 15 to 30 inches thick.

Included with this land type in mapping are small areas of Crisfield, Gerlane, and Zenda soils.

Most of the acreage of Slickspots is in grass, but small areas are cultivated (pl. II). The only plants that grow on Slickspots are those that tolerate sodium and large amounts of salt. Some of the more severely affected areas are bare of vegetation. Capability unit VIs-1; Saline Lowland range site; windbreak group not assigned.

Tabler Series

The Tabler series consists of deep, moderately well drained clay loams on uplands. These soils formed in old alluvium. Slopes range from 0 to 1 percent.

In a representative profile the surface layer is dark-gray clay loam about 10 inches thick. The subsoil is very dark gray and dark-gray clay about 23 inches thick. It is very hard when dry and very firm when moist. The substratum is gray clay that contains many small calcareous concretions.

These soils have high available water capacity. Permeability is very slow.

Representative profile of Tabler clay loam (1,000 feet south and 150 feet west of the northeast corner of sec. 9, T. 33 S., R. 5 W.):

A1--0 to 10 inches, dark-gray (10YR 4/1) clay loam, very dark gray (10YR 3/1) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; slightly acid; clear, smooth boundary.

B2t--10 to 26 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) when moist; moderate, medium and coarse, blocky structure; very hard when dry, very firm when moist; thick, continuous clay films; neutral; gradual, smooth boundary.

B3--26 to 33 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) when moist; weak to moderate, coarse, blocky structure; very hard when dry, very firm when moist; neutral; contains a few calcareous concretions; gradual, smooth boundary.

C--33 to 60 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) when moist; weak, coarse, blocky structure to massive; very hard when dry, very firm when moist; mildly alkaline; weakly calcareous; many small calcareous concretions.

The A1 horizon ranges from 6 to 12 inches in thickness. It is dominantly clay loam, but it ranges to heavy loam, heavy silt loam, and silty clay loam. The color ranges from very dark grayish brown to dark gray and dark grayish brown in the 10YR hue. The B2t horizon ranges from 14 to 36 inches in thickness. Its color ranges from very dark gray to gray.

Tabler soils lack the B1 horizon typical of Bethany soils. Their B2t horizon is grayer than that of Kirkland, Corbin, and Renfrow soils. They have more clay in the B2t horizon than Corbin soils.

Tabler clay loam (0 to 1 percent slopes) (Ta).--This is the only Tabler soil mapped in the county. Included in mapping are small areas of Kirkland soils.

The hazard of erosion is slight to none on this soil. In some places water is ponded on the surface.

Most of this soil is cultivated. Wheat and sorghums are the principal crops (pl. II). Alfalfa is poorly suited. Small areas are used for pasture or range. Capability unit IIs-1; Clay Upland range site; windbreak group 2.

Tivoli Series

The Tivoli series consists of deep, excessively drained fine sands and loamy fine sands on uplands. These soils formed in fine sand laid down by wind. Slopes range from 8 to 15 percent.

In a representative profile the surface layer is brown fine sand about 5 inches thick. Below is reddish-yellow, loose fine sand about 55 inches thick.

Tivoli soils have low available water capacity. Permeability is rapid.

Representative profile of Tivoli fine sand, hummocky (1,320 feet north and 600 feet west of the southeast corner of sec. 27, T. 34 S., R. 9 W.):

A1--0 to 5 inches, brown (7.5YR 5/3) fine sand, brown (7.5YR 4/3) when moist; single grain; loose when dry and when moist; medium acid; diffuse, smooth boundary.

C--5 to 60 inches, reddish-yellow (7.5YR 7/6) fine sand, reddish yellow (7.5YR 6/6) when moist; single grain; loose when dry and when moist; slightly acid.

The A1 horizon ranges from 3 to 12 inches in thickness. Its color ranges from brown to light brown in the 7.5YR and 10YR hues. Texture ranges from fine sand to loamy fine sand. The C horizon ranges from light brown to strong brown or reddish yellow in the 7.5YR hue.

Tivoli soils lack the B2t horizon of loamy fine sand typical of Pratt soils.

Tivoli fine sand, hummocky (8 to 15 percent slopes) (Th).--This soil consists of hummocks that range from 6 to 8 feet high and 100 feet in diameter to as much as 30 feet high and several hundred feet in diameter.

Included with this soil in mapping are small areas of Pratt loamy fine sand and of Tivoli loamy fine sand.

This soil has low natural fertility. The hazard of soil blowing is very severe. Most areas are used for range. Capability unit VIe-6; Sands Range site; windbreak group 5.

Vernon Series

The Vernon series consists of shallow, well-drained clay loams on uplands. These soils formed in material weathered from calcareous shale. Slopes range from 1 to 6 percent.

In a representative profile the surface layer is reddish-brown, calcareous clay loam about 7 inches thick. Below this is reddish-brown, calcareous clay that is very hard when dry and very firm when moist. Red and gray calcareous and noncalcareous clayey shale is at a depth of about 24 inches.

These shallow soils have low available water capacity. Permeability is slow.

Representative profile of Vernon clay loam in an area of Renfrow-Vernon clay loams on 1 to 3 percent slopes (800 feet west and 150 feet north of the southeast corner of sec. 19, T. 34 S., R. 5 W.):

A1--0 to 7 inches, reddish-brown (5YR 4/3) clay loam, dark reddish brown (5YR 3/3) when moist; weak, medium, granular structure; slightly hard when dry, friable when moist; moderately alkaline; calcareous; clear, smooth boundary.

AC--7 to 18 inches, reddish-brown (5YR 4/3) clay, dark reddish brown (5YR 3/3) when moist; massive when moist, but breaks to weak, fine and very fine, blocky structure when dry; very hard when dry, very firm when moist; moderately alkaline; calcareous; a few, small, calcareous concretions.

C--18 to 24 inches, reddish-brown (5YR 5/3) clay, dark reddish brown (5YR 4/3) when moist; massive; very hard when dry, very firm when moist; calcareous; diffuse, smooth boundary.

R--24 inches +, red and gray calcareous and noncalcareous unweathered clayey shale.

The A1 horizon ranges from 4 to 13 inches in thickness. Its color ranges from dark brown in the 7.5YR hue to reddish brown and dark reddish brown in the 5YR hue. The AC horizon ranges from dark reddish brown to reddish brown in the 5YR and 2.5YR hues. Depth to the C horizon ranges from 14 to 24 inches.

Vernon soils are not so deep as Renfrow and Kirkland soils, and they lack the B2t horizon typical of those soils.

Vernon-Renfrow complex, 2 to 6 percent slopes, eroded (Vr).--Vernon soils make up 50 to 75 percent of this complex, and Renfrow soils, from 25 to 50 percent. Except for the surface layer, each soil has a profile similar to that described as representative of their respective series. The surface layer is clay loam to clay and is 4 to 7 inches thick. In most places the original surface layer has been thinned by erosion, and material from the layers below has been mixed with the remaining surface layer by plowing. In some places all of the original surface layer has been washed away. In most places the surface layer is dark reddish brown or reddish brown.

Included with this complex in mapping are small areas of uneroded Vernon and Renfrow soils. Also included are some small rock outcrops.

Natural fertility is moderate in these soils, but erosion has lowered the fertility. If these soils are cultivated and left unprotected, the hazard of water erosion is very severe.

Most of this complex is in wheat and sorghums. Both parts, capability unit VIe-4; Vernon soil, Red Clay Prairie range site, windbreak group 6; Renfrow soil, Clay Upland range site, windbreak group 1.

Wet Alluvial Land

Wet alluvial land (0 to 1 percent slopes) (Wa) consists of poorly drained, loamy soils formed in alluvium. These soils are on flood plains.

This land type is fine sandy loam to clay loam to a depth of 18 to 36 inches. Below this is sand and gravel. The water table generally is at a depth of 2 to 4 feet, but seasonally it is at a depth of less than 2 feet.

Included with this land type in mapping are small areas of Brazos soils.

Because of the frequency of flooding and the high water table, Wet alluvial land is used for pasture and range. Capability unit Vw-1; Subirrigated range site; windbreak group 8.

Woodward Series

The Woodward series consists of moderately deep, well-drained loams on uplands. These soils formed in material weathered from sandstone. Slopes range from 0 to 6 percent.

In a representative profile the surface layer is reddish-brown, calcareous loam about 10 inches thick. The next layer is yellowish-red loam about 14 inches thick. It is slightly hard when dry and friable when moist. Below this is partly weathered red and gray sandstone that grades to unweathered sandstone at a depth of 30 inches.

Woodward soils have low available water capacity and moderate permeability.

Representative profile of Woodward loam in an area of Woodward-Quinlan loams, 0 to 1 percent slopes (1,650 feet east and 200 feet north of the southwest corner of sec. 8, T. 33 S., R. 9 W.):

A1--0 to 10 inches, reddish-brown (5YR 5/4) loam, dark reddish brown (5YR 3/4) when moist; weak, granular structure; slightly hard when dry, friable when moist; moderately alkaline; calcareous; gradual, smooth boundary.

AC--10 to 24 inches, yellowish-red (5YR 5/6) loam, yellowish red (5YR 4/6) when moist; moderate, medium and fine, granular structure; slightly hard when dry, friable when moist; moderately alkaline; calcareous; clear, smooth boundary.

C--24 to 30 inches, partly weathered, red and gray, platy very fine sandstone; calcareous.

R--30 inches, unweathered, soft, red and gray, very fine sandstone; calcareous.

The A1 horizon ranges from 5 to 16 inches in thickness. Its color ranges from brown to dark brown in the 7.5YR hue and from dark reddish brown to reddish brown in the 5YR hue. The soil is calcareous within 10 inches of the surface. It is dominantly loam, but it ranges to silt loam. Color of the AC horizon ranges from yellowish red to reddish brown. In some places the AC horizon is lacking. The C horizon consists of partly weathered, calcareous, red or red and gray siltstone or very fine sandstone. Depth to the R horizon ranges from 20 to 30 inches.

Woodward soils, unlike Nashville soils, are calcareous within 10 inches of the surface. They are deeper to bedrock than Quinlan soils.

Woodward-Quinlan loams, 0 to 1 percent slopes (Wd).--These soils have smooth to slightly convex slopes. The two soils occupy about equal parts of this complex. The Woodward soil has the profile described as representative of the Woodward series. The Quinlan soil is described under the Quinlan series.

Included in mapping with these soils are small areas of soils that have a surface layer of fine sandy loam about 4 to 7 inches thick, but that otherwise are like the Woodward part of this complex. Other small included areas consist of soil like the Woodward soil, except that depth to bedrock is 30 to 48 inches. Also included are small areas of Port soils.

These soils have moderate natural fertility. The hazard of erosion is slight to none.

Most areas of this complex are in wheat and grain sorghum. The rest is in pasture or range. These soils are poorly suited to deep-rooted crops. Both parts, capability unit IIs-2, windbreak group 6; Woodward part, Loamy Upland range site; Quinlan part, Shallow Prairie range site.

Woodward-Quinlan loams, 1 to 3 percent slopes (We).--These two soils occupy about equal parts of this complex. Each soil has a profile similar to the one described as representative of its respective series.

Included with this complex in mapping are soils like the Woodward soil, except that the surface layer is fine sandy loam 4 to 7 inches thick. In other small included areas, the soil is like the

Woodward soil, but depth to bedrock is 30 to 48 inches.

These soils have moderate natural fertility. If they are cultivated and left unprotected, the hazard of water erosion is moderate.

Most of this complex is in wheat and grain sorghum. The rest is in pasture or range. These soils are poorly suited to deep-rooted crops. Both parts, capability unit IIe-5, windbreak group 6; Woodward part, Loamy Upland range site; Quinlan part, Shallow Prairie range site.

Woodward-Quinlan loams, 3 to 6 percent slopes (Ww).--These soils have short, irregular slopes. The two soils occupy about equal parts of this complex. The surface layer is 3 to 5 inches thinner, but the profile of each soil otherwise is similar to that described as representative of its respective series.

Included with this complex in mapping are Woodward and Quinlan soils that have slopes of 6 to 9 percent. Also included are small areas of rock outcrops.

These soils have moderate natural fertility. If they are cultivated and left unprotected, the hazard of water erosion is severe.

About half of this complex is in wheat and grain sorghums. The rest is used for pasture and range. Both parts, capability unit IIIe-5, windbreak group 6; Woodward part, Loamy Upland range site; Quinlan part, Shallow Prairie range site.

Zavala Series

The Zavala series consists of deep, well-drained fine sandy loams on flood plains. These soils formed in alluvium. Slopes range from 0 to 1 percent.

In a representative profile the surface layer is dark grayish-brown fine sandy loam about 21 inches thick. Below is a layer of brown light sandy loam about 16 inches thick. It is soft when dry and very friable when moist. The next layer is brown loamy sand to a depth of 60 inches.

These soils have low available water capacity. Permeability is moderately rapid.

Representative profile of Zavala fine sandy loam (1,800 feet east and 200 feet north of the southwest corner of sec. 24, T. 31 S., R. 7 W.):

A1--0 to 21 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) when moist; very weak, fine, granular structure; soft when dry, friable when moist; medium acid; gradual, smooth boundary.

AC--21 to 37 inches, brown (7.5YR 4/3) light sandy loam, dark brown (7.5YR 3/2) when moist; very weak, fine, granular structure; soft when dry, very friable when moist; slightly acid; diffuse, smooth boundary.

C--37 to 60 inches, brown (7.5YR 5/4) loamy sand, brown (7.5YR 4/4) when moist; single grain; soft when dry, loose when moist; slightly acid.

The A1 horizon ranges from 10 to 24 inches in thickness. Its color ranges from very dark grayish brown to brown in the 7.5YR and 10YR hues. The color of the AC horizon is dark grayish brown to brown in the 7.5YR and 10YR hues. In places sand and gravel are at a depth of 45 to 60 inches. The annual temperature of these soils is a few degrees cooler, and the surface layer is darker colored than the defined range for the series, but these differences do not alter the use and management of the soils.

Zavala soils are darker to a greater depth than Crisfield soils. They are less sandy than Brazos soils.

Zavala fine sandy loam (0 to 1 percent slopes) (Za).--This is the only Zavala soil mapped in the county. It is on flood plains. Included in mapping are small areas of Brazos and Crisfield soils.

This soil has moderate natural fertility. It is flooded occasionally, but the flood water generally remains on the areas for only a short time. The flood water normally does not cause erosion and does not seriously damage growing crops. If this soil is cultivated and not protected, the hazard of soil blowing is moderate.

All crops common to the county are grown on this soil. Wheat and sorghums are the main crops. Capability unit IIe-4; Sandy Lowland range site; windbreak group 7.

Zenda Series

The Zenda series consists of deep, somewhat poorly drained fine sandy loams on flood plains and low terraces. These soils formed in alluvium. Slopes range from 0 to 1 percent.

In a representative profile the surface layer is brown fine sandy loam about 15 inches thick. The upper part of the subsoil is brown sandy clay loam about 7 inches thick. The lower part of the subsoil is brown clay loam mottled with yellowish red. It is hard when dry and firm when moist. This layer is about 11 inches thick. Below is brown sandy clay loam.

These soils have high available water capacity. Permeability is moderate.

Representative profile of Zenda fine sandy loam (450 feet north and 2,440 feet east of the southwest corner of sec. 17, T. 32 S., R. 9 W.):

A1--0 to 15 inches, brown (7.5YR 4/3) fine sandy loam, dark brown (7.5YR 3/3) when moist; weak, medium, granular structure; soft when dry, friable when moist; slightly acid; friable, soft; gradual, smooth boundary.

B1--15 to 22 inches, brown (7.5YR 5/3) sandy clay loam, dark brown (7.5YR 3/3) when moist; moderate, medium, granular structure; slightly

hard when dry, friable when moist; neutral; gradual, smooth boundary.

B2--22 to 33 inches, brown (10YR 5/3) light clay loam, brown (10YR 4/3) when moist; a few, fine, distinct, yellowish-red (5YR 5/6) mottles; moderate, coarse, subangular blocky structure; hard when dry, firm when moist; moderately alkaline; calcareous; a few, hard, calcareous concretions; clear, smooth boundary.

IIC--33 to 60 inches, brown (10YR 5/3) sandy clay loam, brown (10YR 4/3) when moist; many, fine, distinct, strong-brown (7.5YR 5/6) mottles; a few, distinct, gray (10YR 5/1) mottles; weak, medium and fine, subangular blocky structure; hard when dry, friable when moist; moderately alkaline; calcareous; many small, calcareous concretions.

The A1 horizon ranges from 12 to 22 inches in thickness. Its color ranges from very dark grayish brown to brown in the 7.5YR and 10YR hues. The B1 and B2 horizons range from dark gray to brown in the 7.5YR and 10YR hues. Texture of these horizons ranges from sandy clay loam to clay loam. In places the B1 horizon is mottled. The combined thickness of the B1 and B2 horizons is 18 to 36 inches. In most places the water table fluctuates between a depth of 48 and 72 inches. In some places sand or loamy sand is at a depth of 42 to 48 inches.

Zenda soils have more clay in the B2 horizon than Crisfield and Gerlane soils. Also, they are not so red as those soils.

Zenda fine sandy loam (0 to 1 percent slopes) (Zf).--This is the only Zenda soil mapped in the county. It is on low terraces above the normal overflow of nearby streams. Included in mapping are small areas of Crisfield, Gerlane, and Zavala soils.

This soil has moderate natural fertility. If it is cultivated and left unprotected, the hazard of soil blowing is moderate.

Most of this soil is in wheat and sorghums. Capability unit IIe-4; Subirrigated range site; windbreak group 7.

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The soils of Harper County are used chiefly for dryland farming and range. This section explains how the soils can be managed for these main uses and gives predicted yields for the chief dryland crops. In addition it explains how the soils can be managed for range, for windbreaks, and for wildlife habitat and discusses the suitability of the soils for building highways, farm ponds, and other engineering structures.

In discussing the management of the soils for dryland crops and range, the procedure is to describe groups of soils that have similar uses and that require similar management and then suggest management suitable for the group. Also provided is a table that groups soils and provides information that is helpful in planning management of windbreaks. The soils in each group are listed in the "Guide to Mapping Units" at the back of this survey.

Management of the Soils for Crops [2/]

The major management needs in this county are conservation of moisture, control of erosion, and maintenance of fertility and tilth. Effective practices on the deep, nearly level soils are use of conservation cropping systems, proper use of crop residues, wind stripcropping, the growing of cover crops, farming on the contour, keeping tillage to a minimum, and applying fertilizer. In addition terraces, waterways, and other structures for controlling erosion and conserving moisture are needed on the sloping soils.

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 rice, cranberries, 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 engineering.

In the capability system, all kinds of soils are grouped at three levels, the capability class, subclass, and unit. These are discussed 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.

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, range, woodland, or wildlife.

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.

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.

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes. (None in Harper 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 some parts of the United States but not in this county, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few 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, range, woodland, wildlife, or recreation.

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Gently sloping and sloping soils of the Minco-Pond Creek association.

Typical profile of Renfrow clay loam.

Stripcropping holds blowing snow and also helps to control soil blowing.

Slickspots in a cultivated field.

Area of Tabler clay loam planted to wheat.

Loamy Upland range site on a Farnum loam that has an excellent stand of big bluestem, little bluestem, indiangrass, and switchgrass.

Sandy range site on a Shellabarger fine sandy loam. The dominant grasses are sand bluestem, little bluestem, and blue grama.

Shocks of sorghum for use as reserve feed for livestock in winter on a Shellabarger fine sandy loam.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-4 or VIw-1. 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.

In the following pages the capability units in Harper County are described and suggestions for the use and management of the soils are given. The names of soil series represented are mentioned in the description of each capability unit, but this does not mean that all soils of a given series are in the unit. The soils in any given capability unit can be found by referring to the "Guide to Mapping Units" at the back of this survey.

Capability Unit I-1

This unit consists of well-drained soils of the Bethany, Corbin, Farnum, Grant, Minco, Pond Creek, Port, and Ruella series. All of these soils are deep and nearly level. They are on uplands, except for the Port soils, which are on low terraces. These soils have a surface layer of silt loam or loam. The subsoil is clay in Bethany soils; silty clay loam in Corbin, Grant, and Pond Creek soils; clay loam in Farnum soils; silt loam in Port and Minco soils; and loam in Ruella soils.

The available water capacity is moderate to high in these soils. Permeability is moderate to slow. Neither soil blowing nor water erosion are serious hazards.

These soils are well suited to all crops adapted to the climate. Small grains and grain sorghum are the principal crops. Port soils are particularly well suited to alfalfa. Management is needed that helps to maintain organic matter, fertility, and tilth. Effective practices for conserving moisture are keeping tillage to a minimum and proper use of crop residues.

Capability Unit IIe-1

This unit consists of deep, well-drained, gently sloping soils of the Corbin, Farnum, Grant, Minco, Norge, Pond Creek, and Ruella series. These soils are on uplands. They have a surface layer of silt loam or loam. The subsoil is silty clay loam in Corbin, Grant, and Pond Creek soils; clay loam in Farnum and Norge soils; silt loam in Minco soils; and loam in Ruella soils.

The available water capacity is moderate to high in these soils. Permeability is moderate to moderately slow, except in the Corbin soils, where permeability is slow in the lower part of the subsoil.

These soils are well suited to all crops adapted to the climate. Small grains and grain sorghum are the principal crops.

If these soils are cultivated, the hazard of water erosion is moderate. Terraces, waterways, and contour farming are effective means of controlling water erosion.

Capability Unit IIe-2

Bethany silt loam, 1 to 3 percent slopes, is the only soil in this capability unit. It is a deep, well-drained soil on uplands. The subsoil is clay.

The available water capacity is high in this soil. Permeability is slow.

This soil is well suited to all crops adapted to the climate. Small grains and grain sorghum are the principal crops, but alfalfa is grown in places.

If this soil is cultivated, the hazard of water erosion is moderate. Terraces, waterways, and contour farming are effective means of controlling erosion.

Capability Unit IIe-3

This unit consists of deep and moderately deep, gently sloping, well-drained soils on uplands. These soils are in the Shellabarger series. They have a s surface layer of fine sandy loam and a subsoil of sandy clay loam. One of the soils has a shale substratum.

The available water capacity is moderate in these soils. Permeability also is moderate.

These soils are well suited to all crops adapted to the climate. Small grains and grain sorghum are the principal crops.

If these soils are cultivated, the hazard of water erosion is moderate. Terraces and waterways are effective means of controlling water erosion. Practices that help to maintain fertility, tilth, and content of organic matter are choosing a suitable cropping system, farming on the contour, keeping tillage to a minimum, and proper use of crop residues.

Capability Unit IIe-4

This unit consists of nearly level soils of the Crisfield, Gerlane, Shellabarger, Zavala, and Zenda series and of the gently sloping Attica soil. The Attica and Shellabarger soils are on uplands, but the other soils are on flood plains or low terraces. All of the soils are deep and have a surface layer of fine sandy loam. The subsoil is sandy loam or fine sandy loam in the Attica, Crisfield, Gerlane, and Zavala soils; sandy clay loam in the Shellabarger soil; and clay loam in the Zenda soil. The Gerlane soil is moderately well drained, the Zenda soil is somewhat poorly drained, and the other soils are well drained.

The available water capacity is moderate to low in the Attica, Crisfield, Gerlane, Shellabarger, and Zavala soils, and permeability is moderate to moderately rapid. In the Zenda soil, available water capacity is high and permeability is moderate.

These soils are well suited to all crops adapted to the climate. Small grains and grain sorghum are the principal crops. The Gerlane soils are also well suited to alfalfa.

If these soils are cultivated, the hazard of soil blowing is moderate. An effective program for control of soil blowing includes wind stripcropping, stubble mulching, and minimum tillage. Emergency tillage may be needed to control soil blowing in areas that have little or no vegetative cover.

Capability Unit IIe-5

This unit consists of well-drained, moderately deep and shallow, gently sloping soils of the Nashville, Quinlan, and Woodward series. These soils are on uplands. They have a surface layer and subsoil of silt loam and loam. Nashville and Woodward soils are underlain by siltstone or very fine sandstone at a depth of 20 to 36 inches. The Quinlan soil is underlain by siltstone or very fine sandstone at a depth of 10 to 20 inches.

The available water capacity is low to very low in these soils. Permeability is moderate to moderately rapid.

These soils are better suited to small grains, which have shallow to moderately deep roots and mature early, than to other crops. Grain sorghum is poorly suited.

The low to very low available water capacity and shallow to moderately deep root zone limit the choice of crops on these soils. If the soils are cultivated, erosion is a moderate hazard. Terraces, waterways, and contour farming generally are used to control water erosion. Proper use of crop residues helps to conserve moisture and to maintain organic matter, fertility, and tilth.

Capability Unit IIw-1

Only Carwile fine sandy loam is in this unit. It is a deep, somewhat poorly drained, nearly level to slightly concave soil on uplands. The subsoil is sandy clay loam to clay.

The available water capacity is high in this soil. Permeability is slow. Wetness is the dominant hazard to use of this soil. In some areas water is ponded on the surface for periods long enough to adversely affect growing crops. Soil blowing is also a hazard.

This soil is suited to all crops adapted to the climate except alfalfa. Small grains and grain sorghums are the principal crops. Suitable management practices include surface drainage where feasible, proper use of crop residues, and wind stripcropping.

Capability Unit IIs-1

This unit consists of nearly level, moderately well drained to somewhat poorly drained soils in the Kirkland and Tabler series. These soils are on uplands. Their surface layer is silt loam and clay loam. The subsoil is clay.

The available water capacity is high in these soils. Permeability is slow to very slow. The hazard of erosion is slight.

These soils are suited to all crops adapted to the climate. Small grains and grain sorghums are the principal crops.

Droughtiness and slow and very slow permeability somewhat limit use of these soils. Doing all tillage when moisture conditions are most favorable helps to keep the soils in good tilth. If the soils are worked when too wet or too dry, clods form and structure is destroyed. Proper use of crop residues helps to maintain organic matter and fertility.

Capability Unit IIs-2

This unit consists of moderately deep and shallow, nearly level, well-drained soils of the Nashville, Quinlan, and Woodward series. These soils are on uplands. Their surface layer and subsoil are silt loam and loam. Siltstone or very fine sandstone is at a depth of 20 to 36 inches in Woodward and Nashville soils and at a depth of 10 to 20 inches in Quinlan soils.

The available water capacity is low to very low in these soils. Permeability is moderate to moderately rapid. The hazard of water erosion is slight.

These soils are better suited to small grains, which have shallow to moderately deep roots and mature early, than to other crops. Grain sorghum is poorly suited.

The low to very low available water capacity and the shallow to moderately deep root zone limit the choice of crops on these soils. Proper use of crop residues helps to maintain organic matter, fertility, and tilth.

Capability Unit IIIe-1

This unit consists of deep, well-drained, sloping soils of the Farnum, Grant, Minco, Pond Creek, and Ruella series. These soils are on uplands. They have a surface layer of loam and silt loam. The subsoil is clay loam in Farnum soils; silty clay loam in Grant and Pond Creek soils; silt loam in Minco soils; and loam in Ruella soils.

The available water capacity is moderate to high in these soils. Permeability is moderate to moderately slow.

These soils are suited to all crops adapted to the climate. Small grains and grain sorghums are the principal crops.

If these soils are cultivated, the hazard of water erosion is severe. Terraces, waterways, and contour farming are effective means of controlling erosion. Proper use of crop residues helps to conserve moisture and to maintain fertility, tilth, and content of organic matter.

Capability Unit IIIe-2

This unit consists of undulating soils in the Carwile, Pratt, and Shellabarger series that are on uplands. The Pratt and Shellabarger soils are well drained, and the Carwile soil is somewhat poorly drained. Most of the soils are deep. The Pratt soil that has a siltstone substratum, however, has siltstone at a depth of 24 to 50 inches. The surface layer is loamy fine sand in the Pratt and Shellabarger soils and fine sandy loam in the Carwile soil. The subsoil is loamy fine sand in the Pratt soils, sandy clay loam in the Shellabarger soil, and sandy clay loam to clay in the Carwile soil.

The available water capacity is low in the Pratt soils, moderate in the Shellabarger soil, and high in the Carwile soil. Permeability is rapid in the Pratt soils, moderate in the Shellabarger soil, and slow in the Carwile soil.

These soils are suited to all crops adapted to the climate. Small grains and grain sorghum are the principal crops.

If these soils are cultivated, the hazard of soil blowing is severe. An effective program for control of soil blowing includes keeping a vegetative cover on the soils during critical seasons when the hazard of soil blowing is most severe. Also needed are wind stripcropping, stubble mulching, and field windbreaks. Emergency tillage should be done when conditions warrant its use.

Capability Unit IIIe-3

This unit consists of deep and moderately deep, well-drained, sloping soils of the Shellabarger series. These soils are on uplands. They have a surface layer of fine sandy loam. The subsoil is sandy clay loam. One of the soils has a shale substratum.

Available water capacity and permeability are moderate in these soils.

These soils are suited to crops adapted to the climate. Small grains and grain sorghum are the principal crops.

If these soils are cultivated, the hazard of water erosion is severe. Terraces, waterways, and contour farming are effective means of controlling erosion. A cropping system that includes soil-conserving crops most of the time also is effective. Other important management practices are keeping tillage to a minimum and proper use of crop residues.

Capability Unit IIIe-4

This unit consists of deep, well-drained, sloping soils of the Farnum and Pond Creek series. These soils are on uplands. They have a surface layer of clay loam and silt loam that has been thinned by erosion. In places material formerly in the subsoil has been mixed with the remaining surface layer by plowing. The subsoil is clay loam and silty clay loam.

The available water capacity is high in these soils. Permeability is moderately slow.

These soils are suited to all crops adapted to the climate. Small grains and sorghums are the principal crops.

If these soils are cultivated, the hazard of water erosion is severe. Waterways, terraces, and contour farming are effective means of controlling erosion. Using a cropping system that includes soil-conserving crops most of the time also is effective. Other important management practices are keeping tillage to a minimum and proper use of crop residues.

Capability Unit IIIe-5

In this unit are moderately deep and shallow, well-drained, sloping soils of the Nashville, Quinlan, and Woodward series. These soils are on uplands. Their surface layer and subsoil are silt loam and loam. Depth to siltstone or very fine sandstone is 20 to 36 inches in the Nashville and Woodward soils and 10 to 20 inches in the Quinlan soil.

The available water capacity is low to very low in these soils. Permeability is moderate to moderately rapid.

These soils are better suited to small grains, which mature early and have shallow to moderately deep roots, than to other crops. Grain sorghum is poorly suited.

The low to very low available water capacity, severe hazard of water erosion, and shallow to moderately deep root zone limit the choice of crops on these soils. Terraces, waterways, and contour farming are effective means of controlling erosion. Proper use of crop residues helps to conserve moisture and to maintain organic matter, fertility, and tilth.

Capability Unit IIIe-6

Only Kirkland-Renfrow clay loams, 1 to 3 percent slopes, is in this unit. These soils are moderately deep to deep, moderately well drained and well-drained and are on uplands. They have a surface layer of clay loam. Their subsoil is clay.

The available water capacity is high in these soils. Permeability is slow.

These soils are suited to all crops adapted to the climate. The principal crops are wheat and grain sorghums.

If these soils are cultivated, the hazard of water erosion is severe. Terraces, waterways, and contour farming generally are used to control water erosion. Other suitable practices include minimum tillage and proper use of crop residues.

Capability Unit IIIe-7

This unit consists of gently sloping, well drained and moderately well drained soils of the

Kirkland, Renfrow, and Vernon series. These soils are on uplands. Kirkland soils are deep, Renfrow soils are deep and moderately deep, and Vernon soils are shallow to underlying material. The surface layer is clay loam, silty clay, and clay. The subsoil is clay.

Kirkland and Renfrow soils have high available water capacity and slow permeability. Vernon soils have low available water capacity and slow permeability. All of these soils are droughty and are low in fertility.

These soils are suited to all crops adapted to the climate. Wheat and grain sorghums are the principal crops.

If these soils are cultivated, the hazard of water erosion is severe. Terraces, waterways, and contour farming are effective means of controlling water erosion. Other good management practices include keeping tillage to a minimum and proper use of crop residues.

Capability Unit IIIe-8

This unit consists of deep and moderately deep, sloping, well-drained soils of the Shellabarger series. These soils are on uplands. The surface layer is fine sandy loam that has been thinned by erosion. The subsoil is sandy clay loam. One of the soils has a shale substratum.

Available water capacity and permeability are moderate in these soils.

Small grains are the principal crops on these soils. Practices that control erosion are needed, for if these soils are cultivated, the hazard of further water erosion is severe. Terraces, waterways, and farming on the contour are effective means of controlling water erosion. Other suitable practices include keeping tillage to a minimum and proper use of crop residues.

Capability Unit IIIw-1

Kaski loam is the only soil in this unit. It is a deep, well-drained, nearly level soil on flood plains. The surface layer and subsoil are loam.

The available water capacity is high in this soil. Permeability is moderate.

This soil is suited to all crops adapted to the climate. Wheat and sorghums are commonly grown.

The hazard of flooding is severe on this soil, and crops are damaged or destroyed by flooding about 4 out of every 10 years. Flooding can be prevented by building dikes and levees. Keeping stream channels free of debris so that water flows freely through the channel also helps to control flooding.

Capability Unit IIIs-1

Quinlan loam, 0 to 1 percent slopes, is the only soil in this unit. It is shallow and is well drained. This nearly level to slightly concave soil is on uplands. It has a surface layer of loam that is underlain by siltstone or very fine sandstone at a depth of 10 to 20 inches.

The available water capacity is very low in this soil. Permeability is moderately rapid.

Shallowness to bedrock and very low available water capacity severely limit the choice of crops on this soil. Only crops that have shallow roots and mature early are suited. Small grains are the chief crops grown.

Among the management practices used if this soil is cultivated, are those that maintain organic matter, fertility, and tilth. Other beneficial practices are stubble mulching and use of green-manure crops.

Capability Unit IVe-1

Nashville silt loam, 3 to 6 percent slopes, eroded,is the only soil in this unit. This moderately deep, well-drained soil is on uplands. The surface layer is silt loam that has been thinned by water erosion. The subsoil is silt loam underlain by siltstone at a depth of 20 to 30 inches.

The available water capacity is low in this soil. Permeability is moderate.

The slope, erosion hazard, moderately deep root zone, and low available water capacity severely limit the choice of crops that can be grown on this soil. The soil is better suited to small grains, which have moderately deep roots and mature early, than to other crops. Grain sorghum is poorly suited.

If this soil is cultivated, the hazard of further erosion is severe. Terraces, waterways, and contour farming are effective means of controlling erosion. Proper residue management helps to maintain organic matter, fertility, and tilth.

Capability Unit IVe-2

Quinlan loam, 1 to 3 percent slopes, is the only soil in this unit. This shallow, well-drained soil is on uplands. It is underlain by siltstone or very fine sandstone at a depth of 10 to 20 inches.

The available water capacity is very low in this soil. Permeability is moderately rapid.

Shallowness to bedrock, very low available water capacity, and the very severe hazard of water erosion severely limit the choice of crops on this soil. Only crops that have shallow roots and that mature early are suited. Small grains are the chief crops.

If this soil is cultivated, the hazard of erosion is very severe. Terraces, waterways, and contour farming are effective means of controlling erosion. Terraces are difficult to construct, however, because of the limited amount of soil over bedrock. Establishing vegetation in waterways also is difficult because the soil is shallow to bedrock and the available water capacity is very low.

Capability Unit IVe-3

This capability unit consists only of Case-Clark complex, 2 to 6 percent slopes. These deep, well-drained soils are on uplands. The surface layer is calcareous loam and clay loam. It is underlain by calcareous clay loam.

The available water capacity is high in these soils. Permeability is moderate.

Because these soils are calcareous and are subject to water erosion, the choice of crops is severely limited. Close-growing crops are suited, and wheat is the main crop. Sorghums are subject to chlorosis.

If these soils are cultivated, the hazard of erosion is severe to very severe. Terraces, waterways, and contour farming are effective means of controlling erosion. Proper use of crop residues helps to maintain organic matter, fertility, and tilth.

Capability Unit IVs-1

Only Port-Slickspots complex is in this capability unit. It consists of deep, nearly level soils on low terraces that are above normal overflow. The Port soil has a surface layer of silt loam that is underlain by heavy loam, silt loam, or light silty clay loam. It is well drained. Slickspots have a white crust on the surface that ranges from 1/2 inch to 4 inches in thickness. Texture of the surface layer is silt loam. The material below the surface layer is silty clay loam and contains precipitated salts. The Slickspots are somewhat poorly drained.

The available water capacity is high in these soils. Infiltration of water is moderate in the Port soil, but it is slow or very slow in the Slickspot areas.

Choice of crops on these soils is very severely limited by the Slickspots. Only such salt-tolerant crops as barley, grain sorghum, and rye can be grown. Wheat and alfalfa are poorly suited. Seed germination is poor in the Slickspots. Some seeds germinate, and then the young seedlings die. A few plants mature in the Slickspots, and some areas of Slickspots are bare of vegetation.

Good management practices on these soils include intensive use of crop residues. Returning all crop residues to the Slickspots and adding other organic matter helps to keep the areas from spreading. Structure and tilth also are improved.

Capability Unit Vw-1

This unit consists of deep, poorly drained to somewhat poorly drained, nearly level Kanza soils and of Wet alluvial land. These soils are on flood plains. The Kanza soil consists of loamy fine sand. Wet alluvial land is fine sandy loam to clay loam to a depth of 18 to 36 inches. Below this is sand and gravel.

The water table is within reach of plant roots in these soils. Permeability is moderate to rapid down to the water table. The hazard of erosion is slight to none.

The high water table and flooding make these soils better suited to pasture or range than to other uses. In places deposition of soil materials occurs during floods. Suitable grasses need to be planted in areas that are now cultivated. Management practices that improve or maintain native grasses or planted grasses include proper stocking rates and control of undesirable vegetation.

Capability Unit VIe-1

Only Quinlan loam, 3 to 6 percent slopes, is in this capability unit. This shallow, well-drained soil is on uplands. It has a surface layer of loam. Siltstone or very fine sandstone is at a depth of 10 to 20 inches.

The available water capacity is very low in this soil. Permeability is moderately rapid.

Slope, shallowness to bedrock, and very low available water capacity make this soil better suited to range than to other uses. Management practices that maintain or improve desirable grasses include proper stocking rates and control of undesirable vegetation.

Capability Unit VIe-2

This unit consists of deep, somewhat excessively drained, nearly level Brazos soils on first terraces above flood plains. These soils have a surface layer of loamy fine sand. Brazos loamy fine sand has a subsoil of fine sand. Brazos loamy fine sand, clayey subsoil variant, has clay at a depth of 20 to 36 inches.

The available water capacity is low to moderate in these soils. Permeability is rapid in Brazos loamy fine sand. It is rapid above the clayey subsoil in Brazos loamy fine sand, clayey subsoil variant, and slow in the subsoil.

These soils are better suited to range than to other uses because of the low to moderate available water capacity and the severe hazard of soil blowing. Management practices that maintain or improve native grasses include proper stocking rates and control of undesirable vegetation.

Capability Unit VIe-3

Only Shellabarger and Albion soils, 7 to 15 percent slopes, is in this capability unit. These soils are well-drained and are moderately deep and deep. They are on uplands. Their surface layer is sandy loam and fine sandy loam. Their subsoil is sandy loam and sandy clay loam. In the Albion soil coarse sand and gravel are at a depth of 20 to 30 inches.

The available water capacity is moderate in these soils. Permeability is moderate, but it is moderately rapid to rapid in the substratum of Albion soils.

These soils are better suited to range than to other uses because of the strong slopes and the severe hazard of water erosion. Management practices that improve or maintain native grasses include proper stocking rates and control of undesirable vegetation.

Capability Unit VIe-4

Only Vernon-Renfrow complex, 2 to 6 percent slopes, eroded, is in this capability unit. These soils are well-drained and are on uplands. They have a surface layer of clay loam to clay that has been thinned by erosion. Material formerly in the lower layers has been mixed into the remaining surface layer by plowing. The subsoil is clay, and in places it is exposed at the surface. The Vernon soil is underlain by shaly clay at a depth of 14 to 24 inches. The Renfrow soil is underlain by shaly clay at a depth of 24 to 70 inches.

The available water capacity is high in the Renfrow soils, but it is low in the Vernon soils. Permeability is slow.

Slow permeability and the low available water capacity of the Vernon soils make these eroded soils better suited to pasture or range than to other uses. Areas now cultivated can be seeded to adapted native grasses or introduced grasses. Management practices that maintain or improve desirable grasses include proper stocking rates and control of undesirable vegetation.

Capability Unit VIe-5

Only Breaks-Alluvial land complex is in this unit. This land type consists of broken side slopes and narrow valley floors in upland drainageways. The areas range from about 50 to 750 feet in width. Depth from the top of the side slopes to the valley floor is 10 to 30 feet. In both parts of the complex the surface layer and subsoil are loam, silt loam, silty clay loam, and clay loam. The Breaks part is moderately deep over siltstone, very fine sandstone, or shaly clay. The Alluvial land part is deep.

Breaks-Alluvial land complex is better suited to range than to other uses. On the broken side slopes water erosion is a hazard, and on areas of Alluvial land flooding is a hazard. Management practices that improve or maintain existing grasses include proper stocking rates and control of undesirable vegetation.

Capability Unit VIe-6

This unit consists of deep, hummocky soils of the Pratt and Tivoli series. These soils are on uplands. Pratt soils have a surface layer and subsoil of loamy fine sand. Tivoli soils have a surface layer of loamy fine sand to fine sand underlain by fine sand. The Pratt soils are well drained, and the Tivoli soils are excessively drained.

The available water capacity is low in these soils. Permeability is rapid.

These soils are better suited to range than to other uses because of the severe hazard of soil blowing and the low available water capacity. Areas that are now cultivated can be reseeded to native grasses. Management that maintains or improves native grasses includes proper stocking rates, stabilizing blowout areas, and controlling undesirable vegetation.

Capability Unit VIw-1

Only Alluvial land is in this capability unit. This land type consists of deep, nearly level soils on flood plains. In most places all layers of the soil material are loam, but the texture ranges from heavy sandy loam to clay loam. The substratum, at a depth of 36 to 60 inches, consists of layers of sandy and clayey material.

Because of frequent flooding, Alluvial land is better suited to range than to other uses. Areas that are now cultivated can be seeded to native or introduced grasses. Management practices that maintain or improve desirable grasses include proper stocking rates and control of undesirable vegetation.

Capability Unit VIs-1

This unit consists of deep, nearly level areas of Saline alluvial land and of Slickspots. Saline alluvial land is on flood plains of intermittent and perennial streams. Slickspots is on low terraces above normal overflow. Saline alluvial land consists of saline loam or silty clay loam to a depth of 36 to 60 inches. Below this is stratified sandy, loamy, and clayey material. Slickspots are high in sodium. Their surface layer is sandy loam to clay loam. The subsoil is sandy clay loam to light clay.

Salinity and high sodium content make these land types better suited to range than to other uses. Management practices that maintain or improve desirable grasses include seeding areas to adapted salt-tolerant grasses, proper stocking rates after stands of grass are established, and control of undesirable vegetation.

Capability Unit VIIw-1

Only Broken alluvial land is in this unit. This land type is on flood plains and on steep, broken banks of deeply entrenched streams. The soil

material on the narrow flood plains is loamy, and the areas are flooded frequently.

Nearly all of this land type is idle, but limited grazing is done in some areas. Trees and shrubs are the principal vegetation. The shrubs and the low branches of trees provide browse for deer.

Predicted Yields

Table 2 gives the predicted average annual yields per acre of wheat and grain sorghum grown on arable soils of the county in capability classes I, II, III, and IV. The yields shown are for two levels of management. They are based mainly on information obtained from interviews with farmers and on observations of conservationists and the county agricultural agent. In addition information was obtained from records of yields obtained on test plots managed in cooperation with the Kansas State University.

The yields shown are not for any specific tract of land, because management practices vary from farm to farm. They can be used chiefly to determine the relative productivity of the soils.

Yields to be expected under the average, or most common system of management, are shown in columns A.

This level of management consists of--

1. Planting varieties of crops that are suited to the area.
2. Seeding at the proper rates and on the proper dates, and using efficient methods of planting and harvesting.
3. Controlling weeds, insects, and diseases.
4. Applying limited amounts of fertilizer.
5. Using few practices that conserve moisture and help to control erosion.

Yields to be expected under improved management are shown in columns B. This management includes the first three practices for columns A, plus the following:

1. Applying fertilizer according to the need indicated by soil tests.
2. Managing crop residues properly and establishing terraces and grassed waterways, farming on the contour, and using other practices that conserve moisture and help to control erosion by wind and water.
3. Choosing a cropping system that fits the needs of the operator and keeps the soil in good condition.

TABLE 2.--PREDICTED AVERAGE YIELDS PER ACRE OF DRYLAND CROPS UNDER TWO LEVELS OF MANAGEMENT.

[Columns A show yields to be expected under average management, and columns B show yields to be expected under improved management. Only the arable soils are listed]

Soil	Wheat		Grain sorghum	
	A	B	A	B
	Bu.	Bu.	Bu.	Bu.
Attica fine sandy loam, 1 to 3 percent slopes	20	28	30	46
Bethany silt loam, 0 to 1 percent slopes	28	35	40	55
Bethany silt loam, 1 to 3 percent slopes	25	33	35	50
Carwile fine sandy loam	18	20	24	30
Case-Clark complex, 2 to 6 percent slopes	16	22	27	40
Corbin silt loam, 0 to 1 percent slopes	28	35	40	55
Corbin silt loam, 1 to 3 percent slopes	25	33	35	50
Crisfield fine sandy loam	20	28	32	48
Farnum clay loam, 3 to 6 percent slopes, eroded	16	25	24	40
Farnum loam, 0 to 1 percent slopes	28	35	40	55
Farnum loam, 1 to 3 percent slopes	25	33	35	50
Farnum loam, 3 to 6 percent slopes	22	31	30	45
Gerlane fine sandy loam	20	28	32	48
Grant silt loam, 0 to 1 percent slopes	28	35	40	55
Grant silt loam, 1 to 3 percent slopes	25	33	35	50
Grant silt loam, 3 to 6 percent slopes	22	31	30	45
Kaski loam	25	33	35	50
Kirkland silt loam, 0 to 1 percent slopes	26	33	36	48
Kirkland-Renfrow clay loams, 1 to 3 percent slopes	20	28	30	44
Kirkland-Renfrow soils, 1 to 3 percent slopes, eroded	18	26	24	40
Minco silt loam, 0 to 1 percent slopes	28	35	40	55
Minco silt loam, 1 to 3 percent slopes	25	33	35	50
Minco silt loam, 3 to 6 percent slopes	22	31	30	45
Nashville silt loam, 0 to 1 percent slopes	20	26	28	38
Nashville silt loam, 1 to 3 percent slopes	18	24	24	36
Nashville silt loam, 3 to 6 percent slopes	16	22	20	34
Nashville silt loam, 3 to 6 percent slopes, eroded	14	20	16	30
Norge loam, 1 to 3 percent slopes	25	33	35	50
Pond Creek silt loam, 0 to 1 percent slopes	28	35	40	55
Pond Creek silt loam, 1 to 3 percent slopes	23	31	35	50
Pond Creek silt loam, 3 to 6 percent slopes	21	27	30	45
Pond Creek silt loam, 3 to 6 percent slopes, eroded	18	23	25	40
Port silt loam	28	33	40	55
Port-Slickspots complex	15	20	24	32
Pratt loamy fine sand, undulating	18	24	30	44
Pratt loamy fine sand, siltstone substratum, undulating	18	24	30	44
Pratt-Carwile complex	20	26	30	44
Quinlan loam, 0 to 1 percent slopes	13	15	20	25
Quinlan loam, 1 to 3 percent slopes	12	15	18	25
Renfrow-Vernon clay loams, 1 to 3 percent slopes	16	24	20	36
Ruella loam, 0 to 1 percent slopes	22	28	32	44
Ruella loam, 1 to 3 percent slopes	20	26	28	42
Ruella loam, 3 to 6 percent slopes	18	24	24	40
Shellabarger fine sandy loam, 0 to 1 percent slopes	21	28	35	50
Shellabarger fine sandy loam, 1 to 3 percent slopes	20	26	32	48
Shellabarger fine sandy loam, 3 to 6 percent slopes	18	24	28	44
Shellabarger fine sandy loam, 3 to 6 percent slopes, eroded	15	22	24	40
Shellabarger fine sandy loam, shale substratum, 1 to 3 percent slopes	18	25	35	50
Shellabarger fine sandy loam, shale substratum, 3 to 6 percent slopes	16	23	30	45
Shellabarger fine sandy loam, shale substratum, 3 to 6 percent slopes, eroded	14	21	25	40
Shellabarger loamy fine sand, undulating	20	28	32	46
Tabler clay loam	24	30	32	40
Woodward-Quinlan loams, 0 to 1 percent slopes	16	20	20	25
Woodward-Quinlan loams, 1 to 3 percent slopes	14	20	18	25
Woodward-Quinlan loams, 3 to 6 percent slopes	10	13	16	19
Zavala fine sandy loam	22	30	35	50
Zenda fine sandy loam	20	28	32	48

Range Management[3/]

Rangeland occurs throughout Harper County. It makes up about 150,000 acres, or 30 percent of the farm and ranch land. Some of the largest areas are in the western part of the county, and others are along the Chikaskia River in the northeastern part. Much of the farm income in the county comes from the sale of livestock and livestock products. In 1964, according to the U.S. Census of Agriculture, about 48 percent of the income on the farms and ranches came from the sale of beef cattle, sheep, and dairy and poultry products. The number of cattle, including calves, was nearly 53,000. Sheep and lambs numbered nearly 17,000.

Native range is the major source of feed for the livestock. Supplemental feed is provided by farm crops and their byproducts.

In addition to producing pasture and hay for livestock, the rangeland in the county supplies food and cover for wildlife. Also, the plant cover in range that is well managed holds much of the precipitation that falls in the root zone. In this way runoff and flooding are reduced.

Range Sites and Condition Classes

For efficient range management an operator needs to know the capabilities of the soils in each site, the range plants and combinations in which they grow, and the effects of grazing on the different kinds of plants. He also must be able to read the signs that show him if the range is getting better or worse. Management can then be used that encourages growth of the best forage plants on each site.

Range sites are areas of rangeland that, because of soils, climate, and relief, differ from each other in their ability to produce a significantly different kind or amount of climax, or original, vegetation. A significant difference is one that is great enough to require different grazing use or management. No significant differences in climate and elevation occur within the county. The soils therefore have been grouped into range sites on basis of differences in relief and in such soil characteristics as depth, texture, and salinity. A characteristic type of climax vegetation grows on each range site, and each site thus requires different management to keep it productive.

Climax vegetation is the combination of plants that grow originally on a given site. The most productive combination of forage plants on rangeland generally is the climax type of vegetation.

Livestock graze selectively, and they seek out the more palatable and nutritious plants. Unless grazing is regulated, the better plants are weakened and decrease in abundance. Decreasers therefore are plants of the original community that decrease in amount of herbage they contribute to the total cover if they are closely and continuously grazed. Increasers are plants of the original cover that normally increase in the relative amount of total herbage they produce. They increase as the decreasers cover less of the site. If heavy grazing continues, even the increaser plants are weakened and decline in abundance. They are replaced by less desirable grasses and weeds, called invaders.

Range condition is rated by comparing the composition of the existing plant community with that of the potential plant community. Such a rating is useful because an estimate of the deterioration that has taken place indicates the degree of improvement possible. Four range condition classes are recognized: excellent, good, fair, and poor.

A range is in excellent condition if 76 to 100 percent of the present vegetation is of the same composition as that of the original stand. It is in good condition if the percentage is between 51 and 75, in fair condition if the percentage is between 26 and 50, and in poor condition if the percentage is less than 26.

The rancher needs to know the condition of his range and whether it is deteriorating or improving. He wants his range to be in excellent or good condition for such range produces the most forage. The plant cover also is the best for conserving moisture and protecting the soils from erosion. If the range is in fair condition, weedy plants are invading and little palatable forage is produced. In range that is in poor condition, few original plants remain and production of forage is unsatisfactory. Range can be kept in excellent or good condition if the operator learns to recognize the condition of his range and regulates grazing to encourage growth of the better forage plants.

Descriptions of Range Sites

The soils of Harper County have been grouped into range sites according to their ability to produce similar kinds and amounts of climax vegetation. The description of each range site gives the more important characteristics of the soils and the names of the principal decreaser, increaser, and invader plants. Also given in each range site are estimates of potential yields of forage. The names of the soils in any given site can be found by referring to the "Guide to Mapping Units" at the back of this survey. The land type Broken alluvial land was not placed in a range site, because it is not suitable for range.

Clay Upland Range Site

This site consists of deep and moderately deep, well drained to moderately well drained, medium-textured to fine-textured soils. These soils are nearly level to sloping and are on uplands. Permeability is slow to very slow. These soils are droughty during periods of low rainfall. A few areas are eroded.

3/ By HARLAND E. DIETZ, and PETER N. JENSEN, range conservationists, Soil Conservation Service.

The climax plant cover on this site is primarily a mixture of such decreaser grasses as big bluestem, little bluestem, indiangrass, and switchgrass. These grasses make up at least 50 percent of the total plant production and other perennial grasses and forbs make up the rest. Under prolonged heavy grazing, western wheatgrass, side-oats grama, blue grama, buffalograss, heath aster, goldenrod, and cactus increase. If overgrazing continues, broomweed, annual three-awn, western ragweed, tumblegrass, and silver bluestem invade the site.

When this site is in excellent condition, the average annual yield of air-dry herbage is 4,500 pounds per acre in years of favorable moisture and 2,500 pounds per acre in years of unfavorable moisture.

Limy Upland Range Site

Case-Clark complex, 2 to 6 percent slopes, is the only mapping unit in this site. These soils are deep, well drained, and moderately fine and medium textured. They are gently sloping and sloping and are on uplands. Available water capacity is high.

The climax plant cover on this site is a mixture of decreaser grasses, shrubs, and forbs. The decreaser plants make up at least 75 percent of the total plant production. Principal decreaser grasses include big bluestem, little bluestem, indiangrass, and switchgrass. Important legumes and forbs are Illinois bundleflower, roundhead prairieclover, catclaw, sensitive brier, scurfpea, and blacksamson. Important increasers include side-oats grama, blue grama, tall dropseed, and Missouri goldenrod. Common invaders are silver bluestem, windmillgrass, western ragweed, and annual broomweed.

When this site is in excellent condition, the average annual yield of air-dry herbage is 4,500 pounds per acre in years of favorable moisture and 3,000 pounds per acre in years of unfavorable moisture.

Loamy Lowland Range Site

This site consists of deep, moderately fine textured to moderately coarse textured soils. These soils are nearly level and are on flood plains. They are well drained but are subject to flooding. The available water capacity is high, and the soils receive extra moisture from flooding.

The climax plant cover on this site is primarily a mixture of such warm season decreaser grasses as big bluestem, indiangrass, switchgrass, little bluestem, and prairie cordgrass. These grasses make up about 80 percent of the total plant production.

Trees grow naturally along streambanks, and they consist mainly of elm, cottonwood, and willow. Under the canopy of these trees are Canada wildrye, Virginia wildrye, and other shade tolerant grasses that grow well in cool weather. Overgrazing causes an increase in these woody plants and in such grasses as western wheatgrass and tall dropseed. Common invaders include tumblegrass, western ragweed, buffalograss, and silver bluestem.

When this site is in excellent condition, the average annual yield of air-dry herbage is 7,000 pounds per acre in years of favorable moisture and 4,500 pounds per acre in years of unfavorable moisture.

Loamy Upland Range Site

This site consists of deep and moderately deep, well drained, medium textured to moderately fine textured soils. These soils are nearly level to sloping and are on uplands and low terraces (pl. III). The available water capacity ranges from high to low. Some areas are eroded.

The climax plant cover on this site is primarily a mixture of such decreaser grasses as little bluestem, big bluestem, indiangrass, and switchgrass. These grasses make up at least 65 percent of the total plant cover. Other perennial grasses and forbs make up the rest. The principal increaser grasses are blue grama, side-oats grama, tall dropseed, and buffalograss. Forbs that commonly increase on this site include Missouri goldenrod, ironweed, slimflower scurfpea, and western ragweed. The more common invaders are annual three-awn, annual brome, windmillgrass, silver bluestem, and broomweed.

When this site is in excellent condition, the average annual yield of air-dry herbage is 5,000 pounds per acre in years of favorage moisture and 3,000 pounds per acre in years of unfavorable moisture.

Red Clay Prairie Range Site

This site consists of shallow, well drained, moderately fine textured and fine textured soils. These soils are gently sloping and sloping and are on uplands. The available water capacity is low.

In the climax plant community, decreasers make up about 50 percent of the total production and increasers make up the rest. Principal decreaser grasses are little bluestem, big bluestem, and switchgrass. Side-oats grama is the most important increaser on this site. Other increaser grasses include blue grama, hairy grama, buffalograss, and western wheatgrass. Important legumes and forbs are slimflower scurfpea, Illinois bundleflower, bigtop dalea, and serrateleaf eveningprimrose. Common invaders are silver bluestem, tumblegrass, sand dropseed, western ragweed, annual broomweed, and red three-awn.

When this site is in excellent condition, the average annual yield of air-dry herbage is 1,750 pounds per acre in years of favorable moisture and 1,000 pounds per acre in years of unfavorable moisture.

Saline Lowland Range Site

This site consists of deep, somewhat poorly drained to well drained, moderately coarse textured to moderately fine textured soils. These soils are nearly level and are on flood plains and stream terraces. They are either saline or are high in sodium. Some of the soils have a deep fluctuating water table that benefits the growth of deeper rooted plants.

The climax plant cover on this site consists of a mixture of such salt-tolerant grasses as switchgrass, indiangrass, alkali sacaton, western wheatgrass, tall dropseed, prairie cordgrass, vinemesquite, and saltgrass. These grasses make up at least 80 percent of the total vegetation. Under prolonged overgrazing, alkali sacaton, tall dropseed, and saltgrass increase along with buffalograss and bluegrama. Common invaders are kochia, alkali muhly, Japanese brome, and western ragweed.

When this site is in excellent condition, the average annual yield of air-dry herbage is 4,500 pounds per acre in years of favorable moisture and 3,500 pounds per acre in years of unfavorable moisture.

Sands Range Site

This site consists of deep, well drained to excessively drained, coarse textured soils on uplands. Slopes are undulating and hummocky. The available water capacity is moderate to low.

The climax plant cover on this site is primarily a mixture of such decreaser grasses as sand bluestem, little bluestem, indiangrass, switchgrass, and sand lovegrass. These grasses comprise at least 70 percent of the total plant production, and other perennial grasses, forbs, and shrubs make up the rest. Principal increasers are sand dropseed, fall witchgrass, prairie sagewort, sand paspalum, and sand plum. Common invaders are sandbur, annual eriogonum, camphorweed, and western ragweed.

When this site is in excellent condition, the average annual yield of air-dry herbage is 5,000 pounds per acre in years of favorable moisture and 3,000 pounds per acre in years of unfavorable moisture.

Sandy Range Site

This site consists of deep and moderately deep, well drained to somewhat poorly drained, moderately coarse textured soils (pl. III). These soils are nearly level to strongly sloping and are on uplands. The available water capacity ranges from high to low.

The climax plant cover on this range site is primarily a mixture of such decreaser grasses as big bluestem, little bluestem, switchgrass, and indiangrass. These grasses make up at least 70 percent of the total plant production. Important decreaser forbs on this site are leadplant, pitchers sage, prairie-clover, and Virginia tephrosia. Blue grama, purple lovegrass, sand dropseed, tall dropseed, scribners panicum, side-oats grama, prairie sagewort, and goldenrod replace the decreasers when the site is repeatedly overgrazed. Common invaders are broomweed, western ragweed, annual three-awn and silver bluestem.

When this site is in excellent condition, the average annual yield of air-dry herbage is 5,000 pounds per acre in years of favorable moisture and 2,500 pounds per acre in years of unfavorable moisture.

Sandy Lowland Range Site

This site consists of deep, well drained and somewhat excessively drained, moderately coarse textured and coarse textured soils. These soils are nearly level and are on terraces and flood plains. The available water capacity is low to moderate. Deep-rooted grasses on these soils get moisture from a deep water table.

The climax plant cover is predominantly a mixture of such decreaser grasses as sand bluestem, indiangrass, switchgrass, and little bluestem. Grasses that increase with overgrazing are tall dropseed, purpletop, sand paspalum, purple lovegrass, and Texas bluegrass. Common invaders include sand dropseed, silver bluestem, sandbur, camphorweed, and western ragweed.

Such woody plants as cottonwood, willow, sandplum, skunkbush, and elm occur in small amounts in the climax plant community. These plants increase with continued overgrazing. In some areas brush control is necessary to hasten range improvement.

When this site is in excellent condition, the average annual yield of air-dry herbage is 6,000 pounds per acre in years of favorable moisture and 3,500 pounds per acre in years of unfavorable moisture.

Shallow Prairie Range Site

This site consists of shallow, well-drained, medium-textured soils. These soils are nearly level to sloping and are on uplands. The available water capacity is very low.

In the climax plant community, decreasers comprise about 50 percent of the total production and increasers make up the rest. Little bluestem is the principal decreaser, but sand bluestem, indiangrass, and switchgrass grow in places. Important forbs and legumes include blacksamson, pitchers sage, catclaw sensitivebrier, bigtop dalea, and prairie-clover. Side-oats grama, hairy grama, blue grama, and sand dropseed are common increasers. Plants that commonly invade the site under prolonged overgrazing are annual broomweed, wax goldweed, windmillgrass, silver bluestem, and annual three-awn.

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When this site is in excellent condition, the average annual yield of air-dry herbage is 3,500 pounds per acre in years of favorable moisture and 1,500 pounds per acre in years of unfavorable moisture.

Subirrigated Range Site

This site consists of deep, somewhat poorly drained to moderately well drained, coarse textured to moderately fine textured soils. These soils are nearly level and are on flood plains and low terraces. They have a fluctuating water table that supplies moisture for plant use.

The climax plant cover on this site is primarily a mixture of such decreaser grasses as indiangrass, big bluestem, prairie cordgrass, eastern gamagrass, and switchgrass. These grasses make up at least 80 percent of the total plant production. Grasses that increase under prolonged heavy grazing are western wheatgrass, knotroot bristlegrass, alkali sacaton, meadow tall dropseed, and sedges. Woody plants that increase under overgrazing include willow, cottonwood, buttonbush, and indigobush. Common invaders are saltgrass, western ragweed, ironweed, foxtail barley, Tamarix, and Russian-olive.

When this site is in excellent condition, the average annual yield of air-dry herbage is 9,000 pounds per acre in years of favorable moisture and 7,000 pounds per acre in years of unfavorable moisture.

Management of Windbreaks[4/]

Cottonwood, green ash, and wild plum grow along most of the streams and drainageways in Harper County, but no large areas are wooded. Planted shelterbelts and windbreaks make up the largest areas in trees. The principal vegetation on soils that are not cultivated is native grass.

On most of the soils, windbreaks can be established and maintained to protect farmsteads and feedlots. Control of grass and weeds is needed to prevent competition of moisture and to help young trees to become established.

The soils in the county that are suitable for windbreak plantings have been placed in eight windbreak groups. Each group consists of soils that are suitable for about the same kinds of trees, that require similar management, and that provide about the same chance of survival and rate of growth. The soils in each group are listed in the "Guide to Mapping Units" at the back of this survey and are described in the section "Descriptions of the Soils."

In windbreak group 1 are deep and moderately deep, moderately well drained and well drained loams and silt loams that are nearly level to sloping and are on uplands. Windbreak group 2 consists of deep, somewhat poorly drained and moderately well drained fine sandy loams and clay loams that are nearly level and are on uplands. In windbreak group 3 are deep and moderately deep, well-drained fine sandy loams that are nearly level to strongly sloping and are on uplands. Windbreak group 4 is made up chiefly of deep and moderately deep, well drained to somewhat excessively drained loamy fine sands. These soils are nearly level, undulating, and hummocky and are on uplands and low terraces.

Soils of the Tivoli series are in windbreak group 5. These soils are deep and excessively drained and are on uplands. Windbreak group 6 consists chiefly of silt loams, loams, and clay loams. These upland soils are shallow and moderately deep, well drained, and nearly level to sloping. In windbreak group 7 are deep, somewhat poorly drained, moderately well drained, and well drained fine sandy loams to silt loams and alluvial areas on flood plains and low terraces. Windbreak group 8 consists of deep, somewhat poorly drained and poorly drained loamy fine sands and of wet alluvial areas on flood plains.

Table 3 lists trees suitable for soils in the eight windbreak groups and gives suitability ratings and estimated height of the trees at 20 years of age. The ratings given are excellent, good, fair, and poor, based on the rate of growth and the chance of survival of the trees.

More information on planting and caring for trees in windbreaks can be obtained from the local representative of the Soil Conservation Service or from the county agent.

4/ By F. DeWITT ABBOTT, State resource conservationist, Soil Conservation Service.

Wildlife[5/]

The soils of Harper County provide habitat for many kinds of wildlife. Pheasants, bobwhite quail, mourning doves, turkeys, and white-tailed deer are important as game. Migratory waterfowl use the waterways as resting areas in spring and fall. Many kinds of fish live in the ponds and in the larger streams. All of the soils in the county can be managed to attract wildlife, and most species are compatible with farming operations.

WILDLIFE HABITAT. A convenient way of discussing wildlife in the county is by soil associations, which are described in the section "General Soil Map." The location of each association is shown on the general soil map at the back of this soil survey. Table 4 rates the potential of each of the associations for producing food and cover for three main groups of wildlife--openland, woodland, and wetland--which are defined in the paragraphs that follow.

Openland wildlife consists of those species that normally inhabit areas of cropland, rangeland, pasture, meadow, and odd areas where shrubs and herbaceous plants grow. Examples are pheasant, quail, cottontail rabbit, coyote, badger, and meadowlarks.

Woodland wildlife consists of species that generally live in wooded areas or partly wooded areas. Examples of woodland wildlife are deer, squirrels, raccoon, thrushes, and cardinals.

Wetland wildlife consists of species that inhabit ponds, lakes, streams and marshes. Examples of wetland wildlife are ducks, shorebirds, beaver, muskrat, and mink.

KINDS OF WILDLIFE. Many kinds of wildlife are in Harper County. Among the most important are those referred to as game birds and game animals, such as waterfowl, ring-necked pheasant, bobwhite quail, and deer.

Waterfowl are numerous in the county during the migratory season, but few waterfowl nest in the county. During periods of above normal rainfall, the Crisfield and Port soils in the southwest corner of the county and the Carwile soils within the Pratt-Brazos-Tivoli soil association provide temporary water areas that are used by waterfowl as resting areas. These areas provide some opportunity for hunting in fall.

The ring-necked pheasant and the bobwhite quail are perhaps the most important game birds in the county. These birds produce a maximum of one brood each year, and about 70 percent of the birds die from natural causes each year. Only part of the surplus population is taken by hunters.

Pheasant live in all parts of the county. They are most numerous in areas used for farming, because cultivated crops supply a substantial part of their

5/ By JACK W. WALSTROM, biologist, Soil Conservation Service.

TABLE 3.--SUITABILITY OF WINDBREAK GROUPS FOR SPECIFIED TREES

[Estimates of height are not shown for a rating of poor or for American plum. The mapping
Saline alluvial land, Sa; and Slickspots, Sp, are not placed in a

Species	Windbreak group 1		Windbreak group 2		Windbreak group 3	
	Suitability	Height	Suitability	Height	Suitability	Height
		Feet		Feet		Feet
American plum	Good	--	Poor	--	Excellent	--
Bur oak	Good	23	Good	23	Poor	--
Catalpa	Poor	--	Poor	--	Good	30
Cottonwood	Fair	35	Fair	35	Good	40
Eastern redcedar	Excellent	25	Excellent	22	Good	18
Green ash	Fair	20	Poor	--	Fair	22
Hackberry	Good	26	Fair	22	Fair	21
Honeylocust	Fair	24	Poor	--	Fair	26
Mulberry	Fair	18	Poor	--	Good	21
Osage-orange	Excellent	20	Good	18	Fair	14
Ponderosa pine	Good	24	Fair	18	Good	24
Russian-olive	Fair	17	Poor	--	Fair	15
Siberian elm [1/]	Good	40	Fair	25	Fair	25

1/ Commonly called Chinese elm.

AND THE ESTIMATED HEIGHT OF THE TREES AT 20 YEARS OF AGE

units Breaks-Alluvial land complex, Bp; Broken alluvial land, Br; Port-Slickspots complex, Pk; windbreak suitability group, because they are not suited to windbreaks]

Windbreak group 4		Windbreak group 5		Windbreak group 6		Windbreak group 7		Windbreak group 8	
Suitability	Height	Suitability	Height	Suitability	Height	Suitability	Height	Suitability	Height
	Feet		Feet		Feet		Feet		Feet
Excellent--	--	Good--------	--	Poor--------	--	Good--------	--	Poor--------	--
Fair-------	20	Poor--------	--	Poor--------	--	Excellent---	26	Poor--------	--
Good-------	28	Poor--------	--	Poor--------	--	Excellent---	32	Good--------	30
Good-------	40	Poor--------	--	Poor--------	--	Excellent---	50	Excellent---	50
Good-------	18	Fair--------	13	Good--------	17	Excellent---	25	Poor--------	--
Poor-------	--	Poor--------	--	Poor--------	--	Good--------	26	Poor--------	--
Poor-------	--	Poor--------	--	Poor--------	--	Excellent---	30	Poor--------	--
Good-------	28	Poor--------	--	Poor--------	--	Good--------	28	Poor--------	--
Good-------	22	Poor--------	--	Poor--------	--	Excellent---	24	Fair--------	18
Poor-------	--	Poor--------	--	Poor--------	--	Excellent---	22	Poor--------	--
Good-------	26	Poor--------	--	Poor--------	--	Excellent---	26	Poor--------	--
Fair-------	15	Poor--------	--	Fair--------	16	Good--------	19	Fair--------	15
Fair-------	25	Poor--------	--	Poor--------	--	Excellent---	45	Poor--------	--

TABLE 4.--POTENTIAL OF THE SOIL ASSOCIATIONS FOR PROVIDING THE HABITAT REQUIRED BY THREE MAIN GROUPS OF WILDLIFE

[Absence of entry indicates that potential of soil association is not rated]

Soil association	Kind of wildlife	Potential for producing different habitat requirements		
		Woody	Herbaceous	Aquatic
Grant-Nashville-Pond Creek	Openland	Good	Good	
	Woodland	Good	Good	
	Fish			Good.
Shellabarger-Farnum	Openland	Good	Good	
	Woodland	Good	Good	
	Wetland			Fair.
	Fish			Good.
Crisfield-Port-Zenda	Openland	Good	Good	
	Woodland	Good	Good	
	Wetland			Good.
	Fish			Good.
Kirkland-Renfrow	Openland	Fair	Fair	
	Fish			Good.
Bethany-Corbin-Tabler	Openland	Fair	Fair	
	Woodland	Fair	Fair	
	Fish			Fair.
Farnum-Norge	Openland	Fair	Fair	
	Woodland	Fair	Fair	
	Fish			Fair.
Pratt-Brazos-Tivoli	Openland	Good	Good	
	Woodland	Fair	Fair	
	Wetland			Fair.
Minco-Pond Creek	Openland	Good	Good	
	Woodland	Good	Good	
	Fish			Good.
Quinlan-Woodward	Openland	Fair	Fair	

food. Pheasant are least numerous on the nearly level to sloping, shallow to moderately deep Quinlan and Woodward soils in association 9. The vegetation on these soils consists chiefly of mid grasses used as range, which provide poor cover for wildlife.

The bobwhite quail prefers a habitat similar to that occupied by pheasant, and they like to live near fields that are cropped. This bird is native to Kansas. It lives in all parts of the State, though the number of quail declines progressively from the eastern part of the State to the west. Harper County is within the transition zone. Quail live in all soil associations in the county. They generally are most abundant on the Grant, Nashville, and Pond Creek soils of association 1; the Pratt, Brazos, and Tivoli soils of association 7; the Crisfield, Port, and Zenda soils of association 3; the Shellabarger and Farnum soils of association 2; and the Farnum and Norge soils of association 6.

The mourning dove is a migratory bird that nests in the county. This popular game bird likes to nest in low growing trees and shrubs. It produces 3 or 4 broods of young birds each year, and the broods average two young birds per brood. Most of the soil associations contain habitat suitable for the mourning dove. Less woody plants grow on the Kirkland and Renfrow soils in association 4 and on the Quinlan and Woodward soils in association 9 than on other soil associations of the county. As a result, fewer mourning doves are in these associations.

A few Rio Grande turkeys are in the county, chiefly along Big Sandy Creek. This bird prefers a habitat similar to that used by quail and deer, and it likes a source of clean water nearby. The range now used by the Rio Grande turkey consists mainly of cottonwood, willow, cedar, plum, elm, ash, hackberry, and mulberry trees along streams and of mixed prairie grassland. The Pratt, Brazos, and Tivoli soils of association 7 provide suitable habitat for the Rio Grande turkey. As the numbers of these birds increase, they will most likely move into other suitable habitat sites.

Some great blue herons nest in Harper County in summer. The cluster of nests, referred to as a rookery, is in trees that generally are near streams or other water areas. These birds nest mainly in areas of Crisfield, Port, and Zenda soils in association 3.

Many white-tailed deer, and smaller numbers of mule deer, live in the county. Good habitat for these deer are along the Chikaskia River and many other streams. The areas could support many more deer than presently are in the county. When the number of deer increase in an area where crops are grown extensively, however, the deer feed on the crops and cause considerable damage. Management therefore is needed that plans on harvesting enough deer each year so that the number is kept at a desirable level.

The Chikaskia River and the perennial streams in the county provide good opportunities for fishing. Many fish also are taken in the farm ponds in the county. The Anthony City Lake, which covers about 160 acres, also provides opportunities for fishing as well as for other kinds of recreation. Bass, bluegill, crappie, channel catfish, bullheads, and carp are the fish most commonly caught.

Other mammals beside deer in the county include raccoon, badger, coyote, fox, cottontail rabbit, blacktailed jackrabbit, fox squirrel, striped skunk, black-tailed prairie dog, opossum, muskrat, mink, and beaver.

Further information and assistance in planning developments for wildlife can be obtained from the local office of the Soil Conservation Service and from the Kansas Forestry, Fish, and Game Commission; the Bureau of Sport Fisheries and Wildlife; and from the County Agricultural Extension Service.

Engineering Uses of the Soils[6/]

Some soil properties are of special interest to engineers because they affect the construction and maintenance of roads, airports, and pipelines, the foundations of buildings, facilities for storing water, structures for controlling erosion, drainage systems, and systems for disposing of sewage. Among the properties most important to the engineers are permeability to water, shear strength, compaction characteristics, soil drainage, shrink-swell characteristics, grain size, plasticity, and soil reaction. Also important are depth to water table, flooding hazard, depth to bedrock or to sand and gravel, and relief. Such information is made available in this section. Engineers can use it to--

1. Make studies that will aid in selecting and developing sites for industries, business, residences, and recreational areas.
2. Make estimates of the engineering properties of soils for use in the planning of agricultural drainage systems, waterways, farm ponds, irrigation systems, terraces and diversions, and other structures for conserving soil and water.
3. Make preliminary evaluations of soil and ground conditions that will aid in selecting locations for highways, airports, pipelines, cables, and sewage disposal fields and in planning more detailed surveys of the soils at the selected locations.
4. Locate probable sources of sand, gravel, and other materials for use in construction.
5. Correlate performance of engineering structures with the soil mapping units and thus develop information for overall planning that will be useful in designing and maintaining the structures.
6. Determine the suitability of the soils for cross-country movement of vehicles and of construction equipment.

6/ By GERALD D. NORRIS, Civil Engineer, Soil Conservation Service, Hutchinson, Kansas.

7. Supplement information obtained from other published maps, reports, and aerial photographs for the purpose of making maps and reports that can be used readily by engineers.
8. Develop other preliminary estimates for construction purposes pertinent to the particular area.

It should be emphasized that the interpretations made in this soil survey are not a substitute for the sampling and testing needed at a site chosen for a specific engineering work that involves heavy loads or at a site where excavations are to be deeper than the depths of the layers here reported. Nevertheless, by using this survey, an engineer can select and concentrate on those soil units most important for the proposed kind of construction. In this way he can reduce the number of soil samples taken for laboratory testing and complete an adequate soil investigation at minimum cost.

The soil mapping units shown on the maps in this survey may include small areas of a different soil material. These included soils may be as much as 2 acres in size. They are too small to be mapped separately and generally are not significant to the farming in the area but may be important in engineering planning.

Information of value in planning engineering work is given throughout the text, particularly in the sections "Descriptions of the Soils" and "Formation and Classification of Soils."

Some of the terms used by the scientist may be unfamiliar to the engineer, and some words--for example, soil, clay, silt, and sand--may have special meaning in soil science. These and other special terms used in the soil survey are defined in the Glossary at the back of this survey.

Engineering Classification Systems

Agricultural scientists of the U.S. Department of Agriculture (USDA) classify soils according to texture, color, and structure. This system is useful only as the initial step in making engineering classifications of soils. Additional properties important in engineering must either be estimated or determined by tests. The two systems commonly used by engineers are the system developed by the American Association of State Highway Officials (AASHO) and the Unified system.

The AASHO system (1) is based on actual performance of material used as a base for roads and highways. In this sytem all the soils are classified in seven groups. The soils most suitable for road subgrade are classed as A-1, and the soils least suitable are classed as A-7. Within rather broad limits, soils are classified numerically between A-1 and A-7, according to their load-carrying ability. Three of the seven basic groups may also be divided into subgroups to designate within-group variations. Within each group, the relative engineering value of the soil material is indicated by a group index number, which is shown in parentheses following the group classification. The index number ranges from 0 for the best material to 20 for the poorest and indicates progressively less load-carrying capacity.

In the AASHO system the soil material 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 has a plasticity index greater than 10. The plasticity index refers to 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 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 material passes from a semisolid to a plastic state.

In the Unified system (13) the soils are grouped on the basis of their texture and plasticity, as well as on their performance when used as material for engineering structures. The soil materials are identified as coarse grained, which are gravel (G) and sand (S); fine grained, which are silt (M) and clay (C); and highly organic (Pt). No highly organic soils are mapped in this county.

Under the Unified system, clean sands are identified by the symbols SW or SP; sands with fines of silt and clay, by the symbols SM and SC; silts and clays that have a low liquid limit, by the symbols ML and CL; and silts and clays that have a high liquid limit, by the symbols MH and CH.

Engineering Properties and Interpretations

Information and interpretations of most significance to engineers are presented in tables 5, 6, and 7.

Table 5 presents data obtained by laboratory tests on soil samples taken from selected soil profiles.

In table 6 are estimates of some soil properties that affect engineering work. The estimates are based on data given in table 5, on tests performed at construction sites by the Kansas State Highway Department, on experience with the same kinds of soil in other counties, and on the information in other sections of this survey. Some of the terms for which data are shown are explained in the paragraphs that follow. A complete description of a profile typical of each series is given in the section "Descriptions of the Soils."

The particle-size distribution shown under "Percentage passing sieve" is based on tests made by the combined sieve and hydrometer methods. It shows the percentages of material that pass through the openings of sieves of various sizes. Coarse-grained material is retained on the No. 200 sieve.

Soil permeability is the quality of the soil that enables it to transmit air and water. It is measured in terms of the rate at which water passes downward through undisturbed soil. It does not include lateral seepage. The estimates are based on structure and porosity of the soil. Not considered in the ratings are surface crusting, a plowpan, and other factors that result from use of the soils.

Available water capacity is 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.

Reaction gives the intensity of the acidity or alkalinity of the soil, expressed in pH values. A pH notation of 7.0 is neutral. A lower value indicates acidity, a higher value indicates alkalinity.

Shrink-swell potential is an indication of the volume change to be expected of the soil material with changes in moisture content. Shrinking and swelling of soils causes much damage to building foundations, roads, and other structures. A rating of high indicates that the shrink-swell potential is a hazard in maintaining structures built on the soil.

Some of the soils in the county have a fluctuating water table. In the Brazos soils the water table is at a depth between 48 and 96 inches, and in the Zenda soils the water table fluctuates between a depth of 48 and 72 inches. The Gerlane soils have a seasonal water table that fluctuates from a depth of about 24 inches in spring and winter to a depth of about 72 inches in summer and fall. The water table in the Kanza soils is near the surface during wet seasons and seldom is at a depth of more than 24 inches. In Wet alluvial land the water table fluctuates from near the surface to a depth of 48 inches below the surface.

Salinity and dispersion are not serious problems in most of the soils in the county. Dispersion is a moderate problem, however, in the Kirkland soils. Also, salinity and dispersion are severe problems in Slickspots soils and in the Slickspots part of the Port-Slickspots complex.

Table 7 gives specific features of the soils that affect their use in constructing highways and structures that conserve soil and water. The interpretations are based on available test data, on estimated engineering properties of the soils in table 6, and on field experience.

The suitability of the soils as a source of topsoil refers to soil material, preferably rich in organic matter, that is used as a topdressing for lawns, gardens, roadbanks, and other areas where a good seedbed is needed for establishing vegetation.

Ratings of the suitability of the soils as a source of sand and gravel are based on the probability of the soil containing deposits of sand and gravel. The ratings do not indicate the quality or the extent of the deposits.

Ratings of the suitability of the soils as a source of road subgrade and road fill are based on the estimated performance of the soil material that normally would be borrowed for these purposes.

The features of the soils as they occur in place were considered in rating the soils as to their suitability for highways. The entire soil profile was considered. The ratings are for soil that has had the organic surface layer removed but that has not been artificially drained.

Some features that affect the suitability of the soils for farm ponds are permeability, strength and stability, water capacity, and underlying material. Both the subsoil and substratum are considered where they have significant thickness. Soils underlain by permeable loess or sand are likely to be excessively permeable and have poor capacity for storing water.

The need for drainage and the kind of drainage needed to correct wetness are indicated in table 7. Some soil features considered in evaluating the suitability of the soils for drainage are permeability, soil texture, and seasonal water table.

The soil features that affect the suitability of the soils for irrigation are shown in table 7. Irrigation is not needed or is not applicable, however, on many of the soils.

Among the soil features that affect use of the soils for terraces and diversions and for grassed waterways are erodibility, water capacity, depth to underlying material, droughtiness, and soil fertility. On many of the soils, terraces and diversions and waterways are not applicable or are not needed.

TABLE 5.--ENGINEERING

[Tests performed by the State Highway Commission of Kansas under a cooperative agreement with the Bureau of Officials

Soil name and location	Parent material	Kansas report No. S-63-	Depth from surface	Moisture-density 1/	
				Maximum dry density	Optimum moisture
			Inches	Lb. per cu. ft.	Pct.
Farnum loam:					
0.25 mile S. and 100 feet E. of the NW. corner of sec. 17, T. 31 S., R. 8 W. (Modal)	Old loamy alluvium.	39-55-1	0-11	110	15
		2	16-41	104	19
		3	41-62	114	14
Kirkland silt loam:					
1,000 feet E. and 85 feet N. of the SW. corner of sec. 12, T. 35 S., R. 5 W. (Modal)	Red clay beds.	39-60-1	0-12	107	16
		2	12-32	100	19
		3	42-60	103	21
Nashville silt loam:					
0.25 mile S. and 165 feet E. of the NW. corner of sec. 31, T. 32 S., R. 6 W. (Modal)	Soft red siltstone.	39-51-1	0-14	107	15
		2	14-28	107	16
		3	28-36	109	14
Pond Creek silt loam:					
90 feet S. and 2,550 feet W. of the NE. corner of sec. 8, T. 34 S., R. 5 W. (Modal)	Loess.	39-61-1	0-10	112	15
		2	17-42	102	21
		3	42-55	107	18
Shellabarger fine sandy loam:					
0.35 mile S. and 110 feet W. of the NE. corner of sec. 21, T. 31 S., R. 8 W. (Modal)	Old moderately sandy alluvium.	39-56-1	0-10	125	10
		2	16-35	118	12
		3	35-45	124	11
Woodward loam:					
275 feet E. and 375 feet N. of the SW. corner of sec. 8, T. 33 S., R. 9 W. (Modal)	Soft red siltstone.	39-57-1	0-15	118	11
		2	15-22	116	14
		3	22-30	115	15

1/ Based on AASHO Designation: T 99-57, Method A (1), with the following variations: (1) All material is ovendried at 230° F., and crushed in a laboratory crusher, and (2) no time is allowed for dispersion of moisture after mixing with the soil material.

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

TEST DATA

Public Roads (BPR) in accordance with standard procedures of the American Association of State Highway (AASHO)]

Mechanical analysis 2/							Liquid limit	Plasticity index	Classification	
Percentage passing sieve--			Percentage smaller than--						AASHO	Unified 3/
No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.				
100	94	71	60	26	9	5	28	7	A-4(7)	ML-CL
100	86	69	65	51	35	28	52	30	A-7-6(17)	CH
100	69	53	49	38	25	20	44	25	A-7-6(10)	CL
100	99	88	78	44	21	17	33	14	A-6(10)	CL
100	100	95	86	64	43	38	56	37	A-7-6(19)	CH
100	98	87	79	54	37	33	49	31	A-7-6(18)	CL
100	100	90	75	31	12	8	31	8	A-4(8)	ML-CL
100	100	94	81	33	15	10	30	8	A-4(8)	ML-CL
100	97	79	63	26	9	6	27	5	A-4(8)	ML-CL
100	100	81	69	36	18	13	28	8	A-4(8)	CL
100	100	84	75	48	33	29	47	29	A-7-6(17)	CL
100	100	87	74	42	24	20	39	21	A-6(12)	CL
100	76	33	12	12	4	2	19	4	A-2-4(0)	SM-SC
100	70	40	25	25	15	13	35	18	A-6(3)	SC
100	56	31	22	22	13	10	44	25	A-2-7(2)	SC
100	93	69	51	19	7	4	23	5	A-4(7)	ML-CL
100	95	76	66	36	16	10	26	7	A-4(8)	ML-CL
100	99	90	80	53	23	14	29	10	A-4(8)	CL

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

3/ SCS and BPR have agreed to consider that all soils having plasticity indexes within two points of the A-line are to be given a borderline classification. Examples of borderline classifications obtained by this use are ML-CL and SM-SC.

TABLE 6.--ESTIMATED

[Not included in this table, because their characteristics are too variable to be estimated, are the land
Sa; Slickspots, Sp; and

Soil series and map symbols	Depth to bedrock	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Inches	Inches			
Albion---------- (Mapped only with soils of the Shellabarger series.)	60+	0-7 7-21 21-60	Sandy loam--------- Sandy loam--------- Sand and gravel----	SM SM or SC SP-SM	A-2 A-2, A-6 A-2, A-3
Attica: At----------	60+	0-60	Fine sandy loam----	SM	A-4
Bethany: Be, Bh----------	60+	0-13 13-17 17-38 38-60	Silt loam---------- Silty clay loam---- Clay---------- Silty clay loam----	CL CL CH CL	A-6 A-7 A-7 A-7
Brazos:					
Bm----------	60+	0-21 21-60	Loamy fine sand---- Sand----------	SM SP-SM	A-2 A-1
Bo----------	60+	0-30 30-60	Loamy fine sand---- Clay----------	SM CH or CL	A-2 A-7
Carwile: Ca----------	60+	0-14 14-20 20-60	Fine sandy loam---- Sandy clay loam---- Clay----------	SM SM or SC CH	A-2 A-2 A-7
Case: Cc---------- (For properties of Clark soils in this mapping unit, refer to Clark series in this table.)	60+	0-60	Clay loam----------	CL	A-6
Clark---------- (Mapped only in a complex with Case soils.)	60+	0-8 8-60	Loam---------- Clay loam----------	ML CL	A-6 A-6
Corbin: Ce, Cf----------	60+	0-16 16-30 30-55 55-60	Silt loam---------- Silty clay loam---- Clay---------- Silty clay loam----	ML ML-CL or CL CH ML-CL or CL	A-4 A-7 A-7 A-7
Crisfield: Ch----------	60+	0-45 45-60	Fine sandy loam---- Loamy fine sand----	SM SM	A-4 A-2
Farnum: Fa, Fm, Fn, Fu-----	60+	0-11 11-16 16-41 41-60	Loam---------- Clay loam---------- Clay loam---------- Clay loam----------	ML or ML-CL CL CH or CL CL	A-4 A-7 A-7 A-7
Gerlane: Ge----------	60+	0-40 40-48 48-60	Fine sandy loam---- Loamy sand--------- Clay loam----------	SM or ML SM CL	A-4 A-2 A-7

See footnote at end of table.

PROPERTIES OF THE SOILS[1/]

types Alluvial land, An; Breaks-Alluvial land complex, Bp; Broken alluvial land, Br; Saline alluvial land, Wet alluvial land, Wa]

Percentage passing sieve--				Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4	No. 10	No. 40	No. 200				
				Inches per hour	Inches per inch of soil	pH value	
100	95-100	60-70	25-35	0.63-2.00	0.09-0.13	5.6-6.0	Low.
100	95-100	60-70	30-40	0.63-2.00	0.09-0.13	5.6-6.0	Low.
90-100	90-100	50-70	5-15	2.00-10.0	0.03-0.05	5.6-6.0	Low.
100	100	70-85	40-50	2.00-6.30	0.09-0.13	6.1-6.5	Low.
100	100	90-100	70-90	0.20-0.63	0.14-0.18	5.6-6.5	Moderate.
100	100	90-100	70-90	0.20-0.63	0.14-0.18	5.6-6.5	Moderate.
100	100	95-100	75-95	0.06-0.20	0.14-0.18	6.6-7.3	High.
100	100	95-100	85-95	0.20-0.63	0.15-0.19	7.4-7.8	High.
100	100	50-75	15-30	6.30-10.0	0.06-0.09	6.1-6.5	Low.
100	100	50-70	5-15	6.30-10.0	0.03-0.05	6.1-6.5	Low.
100	100	50-75	15-30	6.30-10.0	0.06-0.09	6.1-6.5	Low.
100	100	90-100	75-95	0.06-0.20	0.14-0.18	7.4-7.8	High.
100	100	70-85	20-35	0.63-2.00	0.09-0.13	5.6-6.0	Low.
100	100	80-90	20-35	0.20-0.63	0.12-0.16	5.6-6.0	Low.
100	100	90-100	75-95	0.06-0.20	0.14-0.18	6.6-7.3	Moderate to high.
100	100	90-100	70-80	0.63-2.00	0.15-0.19	7.4-8.4	Moderate.
100	100	85-95	60-75	0.63-2.00	0.12-0.16	7.4-7.8	Moderate.
100	100	90-100	70-80	0.63-2.00	0.15-0.19	7.9-8.4	Moderate.
100	100	90-100	70-90	0.63-2.00	0.14-0.18	5.6-6.0	Low.
100	100	95-100	85-95	0.63-2.00	0.15-0.19	6.6-7.3	Low.
100	100	90-100	75-95	0.06-0.20	0.14-0.18	6.6-7.3	Moderate.
100	100	95-100	85-95	0.20-0.63	0.15-0.19	6.6-7.3	Low.
100	100	70-85	40-50	2.00-6.30	0.09-0.13	5.6-6.0	Low.
100	100	50-75	15-30	2.00-6.30	0.06-0.09	6.1-6.5	Low.
100	100	85-95	60-75	0.20-0.63	0.12-0.16	6.1-6.5	Low.
100	100	65-90	60-75	0.20-0.63	0.15-0.19	6.6-7.3	Moderate.
100	100	65-90	55-75	0.20-0.63	0.15-0.19	6.6-7.3	Moderate.
100	100	60-85	50-70	0.20-0.63	0.15-0.19	6.6-7.3	Moderate.
100	100	70-85	40-55	2.00-6.30	0.09-0.13	6.6-7.3	Low.
100	100	50-75	15-30	2.00-6.30	0.06-0.09	7.4-7.8	Low.
100	100	90-100	70-80	2.00-6.30	0.15-0.19	7.4-7.8	Low.

TABLE 6.--ESTIMATED PROPERTIES

Soil series and map symbols	Depth to bedrock	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Inches	Inches			
Grant: Gn, Gr, Gs---------	36-60	0-18 18-33 33-60	Silt loam---------- Silty clay loam---- Silt loam----------	ML ML-CL or CL ML	A-4 A-6 A-4
Kanza: Ka----------	60+	0-60	Loamy fine sand----	SM	A-2
Kaski: Kk----------	60+	0-40 40-60	Loam---------- Sandy loam---------	CL SM	A-6 A-2 or A-4
Kirkland: Km, Kr, Kw------ (For properties of Renfrow soils in mapping units Kr and Kw, refer to Renfrow series in this table.)	50-60	0-12 12-60	Silt loam---------- Silty clay and clay.	CL CH	A-6 A-7
Minco: Mc, Mn, Mo---------	60+	0-60	Silt loam----------	ML	A-4
Nashville: Na, Ne, Nh, Nn-	20-36	0-30 30+	Silt loam---------- Bedrock (soft siltstone).	ML-CL	A-4
Norge: No----------	60+	0-10 10-60	Loam---------- Clay loam----------	CL CL	A-6 A-6
Pond Creek: Pc, Pd, Pe, Pg.	60+	0-13 13-18 18-60	Silt loam---------- Silty clay loam---- Silty clay loam----	CL CL CL	A-4 A-4 A-7
Port: Ph, Pk---------- (Pk includes Slick-spots, described in the text under Slickspots.)	60+	0-40 40-60	Silt loam---------- Silt loam and silty clay loam.	ML-CL ML-CL	A-4 A-4 or A-6
Pratt: Pm, Po, Pt---------- (For properties of Carwile soils in mapping unit Po and for Tivoli soils in unit Pt, refer to the Carwile and Tivoli series, respectively, in this table.)	60+	0-60	Loamy fine sand----	SM	A-2
Pn----------	24-50	0-40 40+	Loamy fine sand---- Bedrock (soft siltstone).	SM	A-2
Quinlan: Qa, Qn, Qu-------	10-20	0-11 11+	Loam---------- Bedrock (soft siltstone or very fine sandstone).	ML	A-4

See footnote at end of table.

OF THE SOILS[1/] --Continued

Percentage passing sieve--				Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4	No. 10	No. 40	No. 200				
				Inches per hour	Inches per inch of soil	pH value	
100	100	90-100	70-90	0.63-2.00	0.14-0.18	6.1-6.5	Low.
100	100	95-100	85-95	0.63-2.00	0.15-0.19	6.6-7.3	Low.
100	100	90-100	70-90	0.63-2.00	0.14-0.18	6.6-7.3	Low.
100	100	50-75	15-30	6.30-10.0	0.06-0.09	6.1-7.3	Low.
100	100	85-95	60-75	0.63-2.00	0.12-0.16	6.1-7.3	Low.
100	100	60-70	30-40	0.63-2.00	0.09-0.13	6.6-7.3	Low.
100	100	90-100	70-90	0.20-0.63	0.14-0.18	6.1-6.5	Moderate.
100	100	90-100	85-95	0.06-0.20	0.14-0.18	6.6-8.4	High.
100	100	90-100	70-90	0.63-2.00	0.14-0.18	5.6-7.8	Low.
100	100	100	90-100	0.63-2.00	0.14-0.18	6.1-7.3	Low.
100	100	85-95	60-75	0.20-0.63	0.12-0.16	5.6-6.0	Low.
100	100	90-100	70-80	0.20-0.63	0.15-0.19	6.1-7.3	Moderate.
100	100	100	70-90	0.63-2.00	0.14-0.18	6.1-6.5	Low.
100	100	100	70-90	0.63-2.00	0.14-0.18	6.1-6.5	Low.
100	100	100	85-95	0.20-0.63	0.15-0.19	6.6-7.3	Moderate.
100	100	90-100	70-90	0.63-2.00	0.14-0.18	6.1-7.8	Low.
100	100	95-100	85-95	0.63-2.00	0.15-0.19	7.9-8.4	Low.
100	100	50-75	15-30	6.30-10.0	0.09-0.13	5.6-6.0	Low.
100	100	50-75	15-30	6.30-10.0	0.06-0.09	5.6-6.0	Low.
100	100	85-95	60-75	2.00-6.30	0.12-0.16	7.9-8.4	Low.

TABLE 6.--ESTIMATED PROPERTIES

Soil series and map symbols	Depth to bedrock	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Inches	Inches			
Renfrow: Rc---------- (For properties of Vernon soils in this mapping unit, refer to Vernon series in this table.)	24-60	0-9 9-60	Clay loam---------- Clay----------	CL CH	A-6 A-7
Ruella: Re, Rh, Ru--------	60+	0-60	Loam----------	ML	A-4
Shellabarger:					
Sb, Se, Sf, Sg, So------- (For properties of Albion soils in mapping unit So, refer to Albion series in this table.)	60+	0-13 13-38 38-60	Fine sandy loam------ Sandy clay loam------ Sandy loam----------	SM or SM-SC SC SC	A-2, A-4 A-6 A-2
Sh, Sk, Sm----------	24-45	0-13 13-38 38+	Fine sandy loam------ Sandy clay loam------ Bedrock (shale).	SM SC	A-2, A-4 A-6
Sn----------	60+	0-13 13-38 38-60	Loamy fine sand------ Sandy clay loam------ Sandy loam----------	SM SC SM	A-2 A-6 A-2
Tabler: Ta----------	60+	0-10 10-60	Clay loam---------- Clay----------	CL CH	A-6 A-7
Tivoli: Th----------	60+	0-60	Fine sand----------	SM	A-2
Vernon: Vr---------- (For properties of Renfrow soils in this mapping unit, refer to the Renfrow series in this table.)	14-30	0-7 7-24 24+	Clay loam---------- Clay---------- Bedrock (clayey shale).	CL CH	A-7 A-7
Woodward: Wd, We, Ww------ (For properties of Quinlan soils in all these mapping units, refer to Quinlan series in this table.)	20-30	0-10 10-30 30+	Loam---------- Loam---------- Bedrock (sandstone).	ML-CL ML-CL or CL	A-4 A-4
Zavala: Za----------	60+	0-37 37-60	Fine sandy loam------ Loamy sand----------	SM SM	A-4 A-2
Zenda: Zf----------	60+	0-15 15-22 22-33 33-60	Fine sandy loam------ Sandy clay loam------ Clay loam---------- Sandy clay loam------	SM SC or CL CL SC or CL	A-4 A-6 A-6 A-6

1/ Information about soils that have a high water table and about soils that are subject to flooding can be obtained from the section "Descriptions of the Soils."

OF THE SOILS[1/]--Continued

Percentage passing sieve--				Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4	No. 10	No. 40	No. 200				
				Inches per hour	Inches per inch of soil	pH value	
100	100	90-100	70-80	0.20-0.63	0.12-0.16	6.1-6.5	Moderate.
100	100	90-100	75-95	0.06-0.20	0.14-0.18	6.6-7.8	High.
100	100	85-95	60-75	0.63-2.00	0.12-0.16	7.4-8.4	Low.
100	100	70-85	30-40	0.63-2.00	0.09-0.13	5.6-6.0	Low.
100	100	70-85	35-50	0.63-2.00	0.12-0.16	6.1-6.5	Low.
100	100	50-75	20-35	0.63-2.00	0.09-0.13	6.1-6.5	Low.
100	100	70-85	30-40	0.63-2.00	0.09-0.13	5.6-6.0	Low.
100	100	70-85	35-50	0.63-2.00	0.12-0.16	6.1-6.5	Low.
100	100	50-75	15-30	2.00-6.30	0.06-0.09	5.6-6.0	Low.
100	100	70-85	35-50	0.63-2.00	0.12-0.16	6.1-6.5	Low.
98-100	90-100	50-75	20-35	0.63-2.00	0.09-0.13	6.1-6.5	Low.
100	100	90-100	70-80	0.06-0.20	0.15-0.19	6.1-6.5	Moderate.
100	100	90-100	75-95	0.02-0.06	0.14-0.18	6.6-7.8	High.
100	100	65-80	20-35	6.30-10.0	0.06-0.09	5.6-6.5	Low.
100	100	90-100	70-80	0.06-0.20	0.15-0.19	7.9-8.4	Moderate.
100	100	90-100	75-95	0.06-0.20	0.14-0.18	7.9-8.4	High.
100	100	85-95	60-75	0.63-2.00	0.12-0.16	7.9-8.4	Low.
100	100	85-100	65-95	0.63-2.00	0.12-0.16	7.9-8.4	Low.
100	100	70-85	40-50	2.00-6.30	0.09-0.13	5.6-6.5	Low.
100	100	50-75	15-30	2.00-6.30	0.06-0.09	6.1-6.5	Low.
100	100	70-85	40-50	0.63-2.00	0.09-0.13	6.1-6.5	Low.
100	100	80-90	35-55	0.63-2.00	0.12-0.16	6.6-7.3	Low.
100	100	90-100	70-80	0.63-2.00	0.15-0.19	7.9-8.4	Moderate.
100	95-100	80-90	35-55	0.63-2.00	0.12-0.16	7.9-8.4	Low.

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TABLE 7.--ENGINEERING

[Not included in this table, because their characteristics are too variable to be estimated, are Alluvial land, and Wet

Soil series and map symbols	Suitability as source of--				Soil features affecting--
	Topsoil	Sand and gravel	Road subgrade 1/	Road fill 1/	Highway location 1/
Albion---------- (Mapped only with soils of the Shellabarger series.)	Fair----------	Good----------	Good if mixed with other material.	Good if mixed with other material.	Well graded; well drained.
Attica: At----------	Fair----------	Not suitable--	Good----------	Good----------	(3/)----------
Bethany: Be, Bh----------	Good----------	Not suitable--	Poor----------	Fair----------	Well drained; high plasticity.
Brazos: Bm----------	Poor----------	Good----------	Good----------	Good----------	Somewhat excessively drained.
Bo----------	Poor----------	Good----------	Good----------	Good----------	Somewhat excessively drained above substratum.
Carwile: Ca----------	Fair----------	Not suitable--	Surface layer good; subsoil poor.	Fair----------	Somewhat poorly drained; in places has seasonal perched water table.
Case: Cc---------- (For interpretations of Clark soils in this mapping unit, refer to Clark series in this table.)	Poor----------	Not suitable--	Fair----------	Good----------	Well drained; highly calcareous.
Clark----------	Surface layer fair; subsoil poor.	Not suitable--	Fair----------	Good----------	Well drained; highly calcareous.
Corbin: Ce, Cf----------	Good----------	Not suitable--	Fair----------	Good----------	Stable; well drained.
Crisfield: Ch----------	Good----------	Local pockets-	Good----------	Good----------	Well drained; erodible.
Farnum: Fa, Fm, Fn, Fu----	Good----------	Not suitable--	Poor----------	Fair----------	High plasticity; well drained.

See footnotes at end of table.

An; Breaks-Alluvial land complex, Bp; Broken alluvial land, Br; Saline alluvial land, Sa; Slickspots, Sp; alluvial land, Wa]

Soil features affecting--Continued					
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
Reservoir area	Embankment 2/				
Moderate permeability.	Moderate permeability; erodible on slopes.	Well drained-----	Low available water capacity.	Highly erodible; intensive maintenance required.	Low available water capacity; highly erodible.
Moderately rapid permeability.	Stable in fill----	Well drained-----	(4/)----------	(4/)----------	(4/).
Slow permeability.	High plasticity; low shear strength.	Well drained-----	Slow permeability.	(3/)----------	(3/).
Rapid permeability.	Erodible on slopes; porous and seepy; binder needed.	Somewhat excessively drained.	(4/)----------	(4/)----------	(4/).
Rapid permeability above substratum; slow permeability in substratum.	Erodible on slopes; porous and seepy; binder needed.	Somewhat excessively drained above substratum.	(4/)----------	(4/)----------	(4/).
Slow permeability.	In places has seasonal perched water table; fair stability and compaction; erodible in sloping areas.	In places has seasonal perched water table; slow permeability; undulating.	Moderate water intake; slow permeability; somewhat poorly drained.	(4/)----------	(4/).
Moderate permeability.	Highly calcareous; erodible in sloping areas; fair stability and compaction.	Well drained-----	(3/)----------	(3/)----------	Highly calcareous; difficult to establish vegetation in subsoil material.
Moderate permeability.	Highly calcareous; erodible in sloping areas; fair stability and compaction.	Well drained-----	(3/)----------	(3/)----------	Highly calcareous; difficult to establish vegetation in subsoil material.
(3/)----------	(3/)----------	Well drained-----	(3/)----------	(3/)----------	(3/).
Moderately rapid permeability.	Low shear strength; susceptible to piping.	Well drained-----	Deep; moderately rapid permeability; low to moderate available water capacity.	Nearly level; highly erodible.	(4/).
Moderately slow permeability.	Moderate shear strength.	Well drained-----	Moderately slow permeability.	(3/)----------	(3/).

Soil series and map symbols	Suitability as source of--				Soil features affecting--
	Topsoil	Sand and gravel	Road subgrade 1/	Road fill 1/	Highway location 1/
Gerlane: Ge	Good	Local pockets	Good	Good	Moderately well drained; erodible.
Grant: Gn, Gr, Gs	Good	Not suitable	Fair	Good	(3/)
Kanza: Ka	Poor	Poor	Good on elevated grade.	Good	High water table; somewhat poorly drained to poorly drained.
Kaski: Kk	Good	Not suitable	Fair	Fair	Flooding hazard
Kirkland: Km, Kr, Kw (For interpretations of Renfrow soils in mapping units Kr and Kw, refer to Renfrow series in this table.)	Surface layer good; subsoil poor.	Not suitable	Poor	Fair	Moderate to high shrink-swell potential; slow permeability.
Minco: Mc, Mn, Mo	Good	Not suitable	Fair	Good	Well drained; erodible.
Nashville: Ne, Nh, Nn	Good	Not suitable	Fair	Good	Well drained; erodible on slopes.
Norge: No	Fair	Not suitable	Poor	Fair	(3/)
Pond Creek: Pc, Pd, Pe, Pg.	Good	Not suitable	Poor	Fair	(3/)
Port: Ph, Pk (Pk includes Slickspots, described in the text under Slickspots.)	Good	Not suitable	Poor	Fair	Well drained; fair stability.

See footnotes at end of table.

INTERPRETATIONS--Continued

Soil features affecting--Continued					
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
Reservoir area	Embankment 2/				
Moderately rapid permeability.	Low shear strength; susceptible to piping.	Moderately well drained.	Deep; moderately rapid permeability; moderate available water capacity.	Nearly level; highly erodible.	(4/).
(3/)----------	(3/)----------	Well drained-----	(3/)----------	(3/)----------	(3/).
Rapid permeability; high water table.	Stable in fill; high shear strength; steep areas unstable; porous; subject to piping.	High water table; somewhat poorly drained to poorly drained.	Rapid permeability; high water table; subject to soil blowing.	(4/)----------	(4/).
Moderately rapid permeability in stratified substratum.	Stable in fill-----	Well drained-----	(3/)----------	(4/)----------	(3/).
Slow permeability	Low shear strength; cracks when dry.	Moderately well drained.	(3/)----------	(4/)----------	(3/).
(3/)----------	Low shear strength; subject to piping.	Well drained-----	Moderate permeability; high available water capacity.	Highly erodible	(3/).
Moderate permeability.	Low shear strength; susceptible to piping; erodible.	Well drained-----	Moderately deep soils over soft siltstone.	Erodible on slopes.	Difficult to establish vegetation in siltstone.
Moderately slow permeability.	Moderate shear strength.	Well drained-----	Moderately slow permeability; high available water capacity.	(3/)----------	(3/).
(3/)----------	(3/)----------	Well drained-----	Deep; well drained; moderately slow permeability; high available water capacity.	(3/)----------	(3/).
Moderate permeability.	Moderate shear strength; moderate permeability.	Well drained-----	Moderate water intake rate; high available water capacity.	(4/)----------	(4/).

Soil series and map symbols	Suitability as source of--				Soil features affecting--
	Topsoil	Sand and gravel	Road subgrade 1/	Road fill 1/	Highway location 1/
Pratt: Pm, Po, Pt (For interpretations of Carwile soils in mapping unit Po and for Tivoli soils in unit Pt, refer to Carwile and Tivoli series, respectively, in this table.)	Poor	Poor for sand; not suitable for gravel.	Good	Good	Lacks stability on slopes.
Pn	Poor	Poor for sand; not suitable for gravel.	Good	Good	Lacks stability on slopes.
Quinlan: Qa, Qn, Qu	Good	Not suitable	Fair	Good	Shallow to siltstone or very fine sandstone.
Renfrow: Rc (For interpretations of Vernon soils in this mapping unit, refer to Vernon series in this table.)	Surface layer fair; subsoil poor.	Not suitable	Poor; high shrink-swell potential.	Fair	High shrink-swell potential; high compressibility.
Ruella: Re, Rh, Ru	Good	Not suitable	Fair	Good	Well drained; erodible on slopes; calcareous.
Shellabarger: Sb, Se, Sf, Sg, So, Sn (For interpretations of Albion soils in mapping unit So, refer to Albion series in this table.)	Fair	Good in some local pockets.	Poor to fair	Good	Well drained
Sh, Sk, Sm	Fair	Poor	Poor to fair	Good	Shale at a depth of 24 to 45 inches.

See footnotes at end of table.

Soil features affecting--Continued					
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
Reservoir area	Embankment 2/				
Rapid permeability.	Erodible in sloping areas; porous and seepy; binder needed.	Well drained----	Moderately rapid to rapid water intake; low available water capacity.	(4/)----------	(4/).
Rapid permeability above substratum.	Erodible in sloping areas; porous and seepy; binder needed.	Well drained above siltstone substratum.	Moderately rapid to rapid water intake; low available water capacity; siltstone substratum.	(4/)----------	(4/).
Shallow to siltstone or very fine sandstone.	(3/)----------	Well drained----	Shallow to siltstone or very fine sandstone.	Shallow to siltstone or very fine sandstone.	Shallow to siltstone or very fine sandstone.
Slow permeability.	Low shear strength; cracks when dry; fair to poor stability.	Well drained----	Moderately slow water intake; cracks when dry.	Susceptible to ponding in channels.	Droughty.
Moderate permeability.	Low shear strength; susceptible to piping.	Well drained----	(3/)----------	(3/)----------	(3/).
In places rapid permeability in substratum.	Fair stability; subject to piping; erodible in sloping areas.	Well drained----	Moderate permeability; moderate available water capacity.	Erodible on slopes; subject to soil blowing.	Erodible on slopes.
Shale at a depth of 24 to 45 inches.	Fair stability; subject to piping; erodible in sloping areas.	(4/)----------	Shale at a depth of 24 to 45 inches.	Erodible on slopes; subject to soil blowing; shale at a depth of 24 to 45 inches.	Erodible on slopes; shale at a depth of 24 to 45 inches.

Soil series and map symbols	Suitability as source of--				Soil features affecting--
	Topsoil	Sand and gravel	Road subgrade 1/	Road fill 1/	Highway location 1/
Tabler: Ta----------	Surface layer fair; subsoil poor.	Not suitable--	Poor----------	Fair----------	Moderately well drained; possible frost heaving; high plasticity; high shrink-swell potential.
Tivoli: Th----------	Not suitable---	Good for very fine sand and poorly graded sand; not suitable for gravel.	Good if confined.	Good if confined.	Sand dunes; excessively drained.
Vernon: Vr---------- (For interpretations of Renfrow soils in this mapping unit, refer to Renfrow series in this table.)	Poor----------	Not suitable--	Poor----------	Fair----------	Low bearing strength on clay; shallow to shale.
Woodward: Wd, We, Ww----- (For interpretations of Quinlan soils in all these units, refer to Quinlan series in this table.)	Good----------	Not suitable--	Fair----------	Good----------	Well drained; erodible.
Zavala: Za----------	Fair----------	Good----------	Good----------	Good----------	Flooding hazard---
Zenda: Zf----------	Good----------	Good----------	Poor to fair---	Good----------	Fluctuating water table.

1/ C. W. HECKATHRON, field soils engineer, and HERBERT E. WORLEY, soils research engineer, Kansas State Highway Commission, helped prepare these columns. This assistance was performed under a cooperative agreement with the U.S. Department of Commerce, Bureau of Public Roads.

2/ Embankments more than about 25 feet high not considered.

INTERPRETATIONS--Continued

Soil features affecting--Continued					
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
Reservoir area	Embankment 2/				
Very slow permeability.	Fair to poor stability; cracks when dry.	Very slow permeability; nearly level relief; moderately well drained.	Very slow permeability; moderately well drained.	(4/)----------	(4/).
Excessively drained; rapid permeability.	Binder needed; excessive seepage; erodible in sloping areas.	Excessively drained.	Sand dunes; excessively drained; rapid permeability; subject to severe soil blowing.	(4/)----------	(4/).
Slow permeability; shallow to shale.	Cracks when dry; shallow to shale.	Well drained-----	Slow permeability; shallow to shale; low available water capacity.	Shallow to shale.	Erodible on slopes; droughty; moderate fertility.
Moderate permeability; moderately deep to sandstone.	Low shear strength; susceptible to piping; erodible.	Well drained-----	Low available water capacity; moderate permeability; moderately deep.	Erodible--------	Erodible; moderately deep.
Moderately rapid permeability.	Low shear strength; may lack fines.	Well drained-----	Flooding hazard--	(4/)----------	(4/).
Rapid permeability in stratified substratum; fluctuating water table.	Moderate shear strength.	Somewhat poorly drained.	Flooding hazard; fluctuating water table.	(4/)----------	(4/).

3/ No features that significantly affect design.

4/ Practice not applicable or not needed.

This section tells how the factors of soil formation affected the development of soils in Harper County. Then the current system of soil classification is explained and the soil series are placed in higher categories of that system. The soil series in the county, including a profile representative of each series, are described in the section, "Descriptions of the Soils."

Factors of Soil Formation

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

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

The factors of soil formation are 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

Parent material is the unconsolidated mass from which soil forms. It is largely responsible for the chemical and mineralogical composition of a soil. Most of the soils of Harper County formed in material weathered from underlying rock. Some of the soils, however, formed partly in material laid down by wind, and some in sediment deposited by streams or washed downslope. The parent material ranges from Permian to Recent in age.

Rock of Permian age underlies most of the county (6). It is at a depth ranging from a few inches to 100 feet or more. About 25 percent of the soils in the county are derived from Permian material and have retained the red color of the parent material.

The oldest member of the Permian system in the county underlies the soils in the eastern part where the Renfrow and Vernon soils formed. One of the siltstone members of the Permian system underlies the soils in that part of the county that extends from north of Runnymede to the southern county line and is east of Harper and Anthony and west of Danville and Bluff City. The main soils formed in material weathered from this rock are in the Grant and Nashville series. Another siltstone and very fine sandstone member of the Permian system occurs throughout the western half of the county. Examples of soils formed in material weathered from this rock are those of the Quinlan and Woodward series.

Material laid down during Pliocene time is in four small areas in the southeast corner of the county. It probably once covered the county but later was removed by erosion.

The soils in the northwestern part of the county formed in deposits laid down during Pleistocene time. These deposits have been affected by erosion and by deposition by water and wind. Erosion removed the original deposits, and the areas then were covered by alluvium, dune sand, and loess. The process of erosion and deposition still continues.

Cycles of erosion have exposed sandy, gravelly, and silty sediment in the uplands. These deposits were laid down during the Kansas and Nebraskan stages of Early Pleistocene time. The erosion that exposed the deposits occurred later, probably during the Illinoian stage and after. In places clayey strata or rock of Permian age underlie the soils at a depth between 2 and 4 feet. Examples of soils formed in these deposits are the Farnum, on old alluvium; the Norge, which formed partly in material from outwash and partly in loess; and the Shellabarger, on old alluvial outwash.

Alluvium deposited along stream valleys during the Wisconsin glacial stage and the Recent epoch is the parent material of the Brazos, Gerlane, Port, and Zenda soils. Dune sand also was deposited in large areas. The main soils on the sand dunes are those of the Pratt and Tivoli series. Much loess also was laid down at this time. Most of the loess was derived locally and was redeposited. It, in part, is the parent material of the Bethany and Tabler soils. Loess probably was also laid down in other parts of the county at this time.

Climate

Harper County has a subhumid continental climate characteristic of the southern part of the Great Plains. The climate is fairly uniform throughout the county. It therefore has caused few differences among the soils.

The downward movement of water is a major factor in changing the parent material into a soil that has distinct horizons. The amount of water that percolates through the soils depends partly on rainfall, humidity, and frost-free periods. Water

dissolves small amounts of minerals and carries them out of the soil. It moves other minerals, such as clay and calcium carbonate, downward only a short distance in the soil profile.

In Harper County rainfall is sufficient to leach most of the soils in the uplands. Rainfall is about 3 inches less in the western part of the county than in the eastern part. This factor alone probably has had little effect on the kind of soils that formed.

Wind velocity in the county is fairly high. The strong winds have influenced soil formation by sorting the soil materials. For example, the sand dunes in the southwestern part of the county are made up of material blown onto the area from sandy areas to the south. In this sandy material the Pratt and Tivoli soils formed.

Plants and Animals

Plants and animals have an important effect on the formation of soils. Small burrowing animals, earthworms, and insects help to mix the soil, and bacteria, fungi, and other micro-organisms help to weather rock and to decompose organic matter. Plants and animals also influence the chemical and biological processes that take place in the soils.

The kinds and amount of vegetation are important in soil formation. Vegetation adds organic matter to the soil and thus influences its physical and chemical characteristics. It makes the soil more permeable to water, promotes leaching, and affects soil structure. Burrowing animals, insects, and earthworms move large quantities of soil. Their activity improves aeration, mixes the soil horizons, and helps in decomposing plant materials.

The soils of Harper County formed chiefly under grass. Remains of grass roots and leaves have added organic matter to the soils over a long period of time. Consequently, the soils typically have a dark-colored surface layer.

Man also has had an effect on the soils. By using poor cropping and tillage practices, man has removed the protective cover from soils and caused loss of organic matter. Because the protective cover of plants was gone, accelerated erosion occurred. As the result of erosion, soil materials washed from one place were deposited on soils in another place. Man also has changed the soils in many areas through irrigation, drainage, land leveling, and land forming.

Relief

Relief influences soil formation through its effect on drainage, runoff, erosion, and soil temperature. Through its effect on soil moisture and soil temperature, relief also affects the kinds of plants and animals that live on and in the soil. On the more sloping areas where runoff is rapid, the soil material is likely to be washed away before well-developed horizons can form. In the more nearly level areas, erosion is slight. Here the soils generally are deep, and their horizons are well developed.

Harper County has four main kinds of relief--nearly level, gently sloping, and sloping plains; undulating hills; small choppy dunes; and irregular rough breaks. The slope of the county is from the northwest corner toward the southeast corner. The highest place in the county is just south of the northwest corner. This point is 1,700 feet above sea level. The lowest point, 1,180 feet above sea level, is in Bluff Creek Valley just north of the southeast corner of the county.

Most of the soils on the nearly level and gently sloping plains have a clayey subsoil. Examples are the Bethany, Kirkland, and Tabler soils. The soils that have a loamy subsoil generally are on the gently sloping to strongly sloping plains or are on short irregular slopes. Examples of soils in these areas are those of the Grant, Nashville, Minco, and Shellabarger series. On the undulating and hummocky relief, are such sandy soils as the Pratt and Tivoli.

Many of the soils occur on more than one type of relief, but some occur on only one type. For example, Tabler soils occur only on nearly level plains, and Tivoli soils occur only on hummocky relief. Shellabarger soils, on the other hand, generally occur on gently sloping to sloping relief but may also occur on nearly level plains.

Time

Time is needed for soils to form from parent material. Some soils form rapidly, and others form slowly. The length of time required for a particular soil to form depends on the other factors involved. Development of horizons is related to time. As water moves downward through the soils soluble matter and fine particles are leached from the surface layer and deposited in the subsoil. How long this process takes depends chiefly on how long the soil has been in place and on how much water penetrates the soil.

Some of the soils lack horizon development because they formed in material weathered from quartz, which is highly resistant to weathering. Tivoli soils are an example. Other soils, such as the Port that formed in recent alluvium, are young and show little horizon development. Time has been insufficient for genetic horizons to develop in these soils. Shellabarger soils, on old outwash, have been exposed to soil-forming processes for thousands of years. These soils have well-defined horizons and are considered to be old, or mature soils.

Classification of the Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the

soils, to see their relationship to one another and to the whole environment, and to develop principles that help us understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

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

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (2) and later revised (10). The system currently used was adopted for general use by the National Cooperative Soil Survey in 1965. It is under continual study. Therefore, readers interested in developments of the current system should search the latest literature available (9, 11). In table 8 the soil series of Harper County are placed in some categories of the current system.

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped together. Most of the classes of the current system are briefly defined in the following paragraphs.

ORDERS. Ten soils 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. Two exceptions, the Entisols and Histosols, occur in many different kinds of climate. The four orders in Harper County are Alfisols, Entisols, Inceptisols, and Mollisols.

Alfisols are mineral soils that contain horizons of clay accumulation. Unlike the Mollisols, they lack a thick, dark-colored surface layer that contains colloids dominated by bivalent cations, but the base status of the lower horizons is not extremely low.

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.

Inceptisols are mineral soils that generally occur on young, but not recent, land surfaces.

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

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

GREAT GROUPS. Suborders are separated into great groups on basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those that contain a pan that interferes with the growth of roots or movement of water. The features used are the self-mulching properties of clays, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like. The great group is not shown separately in table 8, because it is the last word in the name of the subgroup.

SUBGROUPS. Great groups are subdivided into subgroups, one representing the central (typic) segment of the group, and others, called intergrades, that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the great group.

FAMILIES. Families are separated 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.

TABLE 8.--SOIL SERIES CLASSIFIED ACCORDING TO THE CURRENT SYSTEM OF CLASSIFICATION 1/

Series	Family	Subgroup	Order
Albion	Coarse-loamy, mixed, thermic	Udic Argiustolls	Mollisols.
Attica	Coarse-loamy, mixed, thermic	Udic Haplustalfs	Alfisols.
Bethany	Fine, mixed, thermic	Pachic Paleustolls	Mollisols.
Brazos	Sandy, mixed, thermic	Typic Ustifluvents	Entisols.
Carwile	Fine, mixed, noncalcareous, thermic	Typic Argiaquolls	Mollisols.
Case	Fine-loamy, mixed, thermic	Rendollic Ustochrepts	Inceptisols.
Clark	Fine-loamy, mixed, thermic	Typic Calciustolls	Mollisols.
Corbin	Fine-silty, mixed, thermic	Pachic Argiustolls	Mollisols.
Crisfield	Coarse-loamy, mixed, thermic	Udic Haplustolls	Mollisols.
Farnum	Fine-loamy, mixed, thermic	Pachic Argiustolls	Mollisols.
Gerlane	Coarse-loamy, mixed, thermic	Typic Haplustolls	Mollisols.
Grant	Fine-silty, mixed, thermic	Udic Argiustolls	Mollisols.
Kanza	Mixed, thermic	Mollic Psammaquents	Entisols.
Kaski	Fine-loamy, mixed, thermic	Cumulic Haplustolls	Mollisols.
Kirkland	Fine, mixed, thermic	Abruptic Pachic Paleustolls	Mollisols.
Minco	Coarse-silty, mixed, thermic	Udic Haplustolls	Mollisols.
Nashville	Fine-silty, mixed, thermic	Udic Haplustolls	Mollisols.
Norge 2/	Fine-silty, mixed, thermic	Udic Paleustolls	Mollisols.
Pond Creek	Fine-silty, mixed, thermic	Pachic Argiustolls	Mollisols.
Port	Fine-silty, mixed, thermic	Cumulic Haplustolls	Mollisols.
Pratt	Sandy, mixed, thermic	Psammentic Haplustalfs	Alfisols.
Quinlan	Loamy, mixed, thermic, shallow	Typic Ustochrepts	Inceptisols.
Renfrow	Fine, mixed, thermic	Udertic Paleustolls	Mollisols.
Ruella	Fine-loamy, mixed, thermic	Typic Ustochrepts	Inceptisols.
Shellabarger	Fine-loamy, mixed, thermic	Udic Argiustolls	Mollisols.
Tabler	Fine, montmorillonitic, thermic	Pachic Argiustolls	Mollisols.
Tivoli	Mixed, thermic	Typic Ustipsamments	Entisols.
Vernon	Fine, mixed, thermic	Typic Ustochrepts	Inceptisols.
Woodward	Coarse-silty, mixed, thermic	Typic Ustochrepts	Inceptisols.
Zavala 3/	Coarse-loamy, mixed, nonacid, hyperthermic.	Typic Ustifluvents	Entisols.
Zenda	Fine-loamy, mixed, thermic	Aquic Fluventic Haplustolls	Mollisols.

1/ Placement of some soil series in the current system of classification, particularly in families, may change as more information becomes available.

2/ These soils are taxadjuncts to the Norge series. The argillic horizon contains more sand than the defined range for the series.

3/ These soils are taxadjuncts to the Zavala series. The soil temperature is cooler than the defined range for the series and the soils have a mollic epipedon.

Harper County was organized in 1878, and the present boundaries were established a year later. Little of the acreage was cultivated until the 1890's, and corn was the chief crop. Later wheat became the principal crop, and it remains so today.

Methods for conserving soil and water were used by only a few farmers in the first 50 years. As a result, erosion occurred in much of the cultivated acreage and yields decreased. Concerned farmers sought a way to obtain technical assistance in planning and applying practices that would reduce erosion. They therefore formed the Harper County Soil Conservation District in 1945, and by 1964 effective measures for control of erosion were being used on about 30 percent of the land in crops.

Farming is the main enterprise in the county. Anthony, Attica, and Harper are the chief trading centers. Grain handling and storing facilities in these towns and in most other communities are connected by rail to terminal elevators and markets outside the county. U.S. Highway No. 160 passes from east to west through about the middle of the county. In addition several State highways traverse the county. The county also has many other hard surfaced roads, as well as other roads that are well maintained. Most of the farms are 1 to 4 miles from a hard surfaced road.

Oil and gas are produced in the northwestern part of the county. Sand and gravel are available along the streams of the county and in outwash areas in the northwestern part. In the southeastern part of the county, Permian shale is used locally to provide material for the building of roads.

Most water for domestic use comes from drilled or dug wells. These wells also provide most of the water for livestock, though farm ponds also are used for this purpose. The ground water in the county generally is suitable for domestic use and for use by livestock. In places in the area underlain by Permian rock, however, the water contains so much salt that it is not suitable for domestic use and may not be suitable for livestock. Also, the supply of water in this area is inadequate during droughts. In places in the county the supply of water is sufficient for irrigation. Irrigation wells could be developed and as much as 300 to 500 gallons of water per minute could be pumped.

Climate[7/]

The climate of Harper County is subhumid continental. Summers are hot, and winters are fairly cold. Wide daily and yearly variations in temperature are characteristic. The growing season is long and generally is accompanied by adequate rainfall, abundant sunshine, and moderate temperature. Thus, except that rainfall is short in some years, the climate of Harper County is well suited to many farm crops. Facts about the precipitation and temperature in the county are given in table 9.

Harper County is in the south-central part of Kansas on a sloping to gently rolling prairie (7). It is within the drainage system of the Arkansas River. Elevation averages about 1,500 feet above sea level. The county is in the rain shadow of the Rocky Mountains. These mountains form a massive barrier that blocks storms that frequently move in from the Pacific Ocean in fall, winter, and spring. The effect of these mountains is not so great in Harper County, however, as in areas farther to the west.

PRECIPITATION: The Gulf of Mexico is the principal source of moisture in Harper County, though the county does not receive as much moisture from the Gulf as do areas to the east. From east to west the average annual amount of precipitation decreases from about 41 inches in the southeastern corner of the State to about 16 inches along the southwestern border (4). The amount of precipitation Harper County receives is about halfway between that received in the eastern part of the State and that received in the western part.

On the average, about 75 percent of the annual precipitation in the county comes as rain between the first of April and the end of September. The wettest months are May and June, when about 30 percent of the annual rainfall comes. Rainfall averages about 4 inches in May and June, and about 3 inches in July and August. In January, the driest month, precipitation is 0.70 inch on the average. Total precipitation in December, January, and February averages only 2.65 inches. In 1 year in 10, on the average, nearly 9 inches of rain falls during the month of May and less than 0.01 inch falls in November.

Rainfall fluctuates greatly from year to year. During the period 1898 through 1964, the annual precipitation at Anthony ranged from a low of 12.54 inches, in 1910, to a high of about 50 inches in 1951 (fig. 2). Precipitation in 1952, the year following the heaviest annual rainfall of record, amounted to only 19 inches. In 1911, the year following the driest calendar year of record, precipitation totaled 30 inches. Droughts that damage crops, however, are likely to continue for several years.

Droughts were very severe in Harper County during the 1930's and again from 1952 to 1957. The drought of the 1950's lasted longer and was of greater intensity than any drought in the period from 1931 through 1957 (8). During the 1950's, the weather was dry for 57 months and drought was severe or extreme for 46 months. In the period from 1931 through 1960, the weather was dry for about 2 months in 10, and drought was severe or extreme for 63 months.

Snowfall averages between 11 and 12 inches annually. The heaviest snowfall is likely to occur in February, though the average for that month is only

7/ By MERLE J. BROWN, State climatologist for Kansas, Weather Bureau, ESSA, U.S. Department of Commerce.

TABLE 9.--TEMPERATURE AND PRECIPITATION

All data from records kept at Anthony, 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 monthly total 3/	One year in 10 will have 1/--	
			Maximum temperature equal to or higher than--	Minimum temperature equal to or lower than--		Monthly total less than--	Monthly total less than--
	°F.	°F.	°F.	°F.	Inches	Inches	Inches
January	44.6	22.0	64	5	0.70	0.05	1.49
February	50.8	25.9	68	10	1.02	.11	2.26
March	60.0	33.3	79	15	1.52	.20	3.05
April	70.1	44.1	86	31	2.63	.68	4.77
May	78.2	53.9	92	42	4.36	1.25	8.84
June	89.1	63.7	101	54	3.89	1.47	7.00
July	94.7	68.1	105	61	3.10	.70	5.60
August	94.3	67.1	106	59	2.85	.76	5.92
September	86.0	58.8	99	45	2.80	.55	5.69
October	74.0	46.9	89	33	2.22	.06	5.01
November	59.1	33.4	75	18	1.61	.01	3.71
December	47.3	24.7	65	11	.93	.03	2.65
Year	70.7	45.2	4/ 107	5/ -2	27.63	20.12	37.32

1/ Data from records kept from 1907 to 1964.

2/ Data from records kept from 1936 to 1960.

3/ Data from records kept from 1898 to 1964.

4/ Average annual highest temperature.

5/ Average annual lowest temperature.

TABLE 10.--FREQUENCY OF RAINS OF STATED DURATION AND AMOUNT

Frequency	Duration of--						
	½ hour	1 hour	2 hours	3 hours	6 hours	12 hours	24 hours
	Inches	Inches	Inches	Inches	Inches	Inches	Inches
Once in--							
1 year	1.0	1.3	1.6	1.7	2.0	2.3	2.7
2 years	1.3	1.7	2.0	2.1	2.5	3.0	3.3
5 years	1.7	2.2	2.6	2.9	3.3	3.9	4.5
10 years	2.0	2.6	3.1	3.3	4.0	4.5	5.2
25 years	2.4	3.1	3.7	4.0	4.5	5.3	6.1
50 years	2.7	3.5	4.1	4.5	5.2	6.0	7.0
100 years	3.0	3.9	4.6	5.0	5.8	6.7	7.7

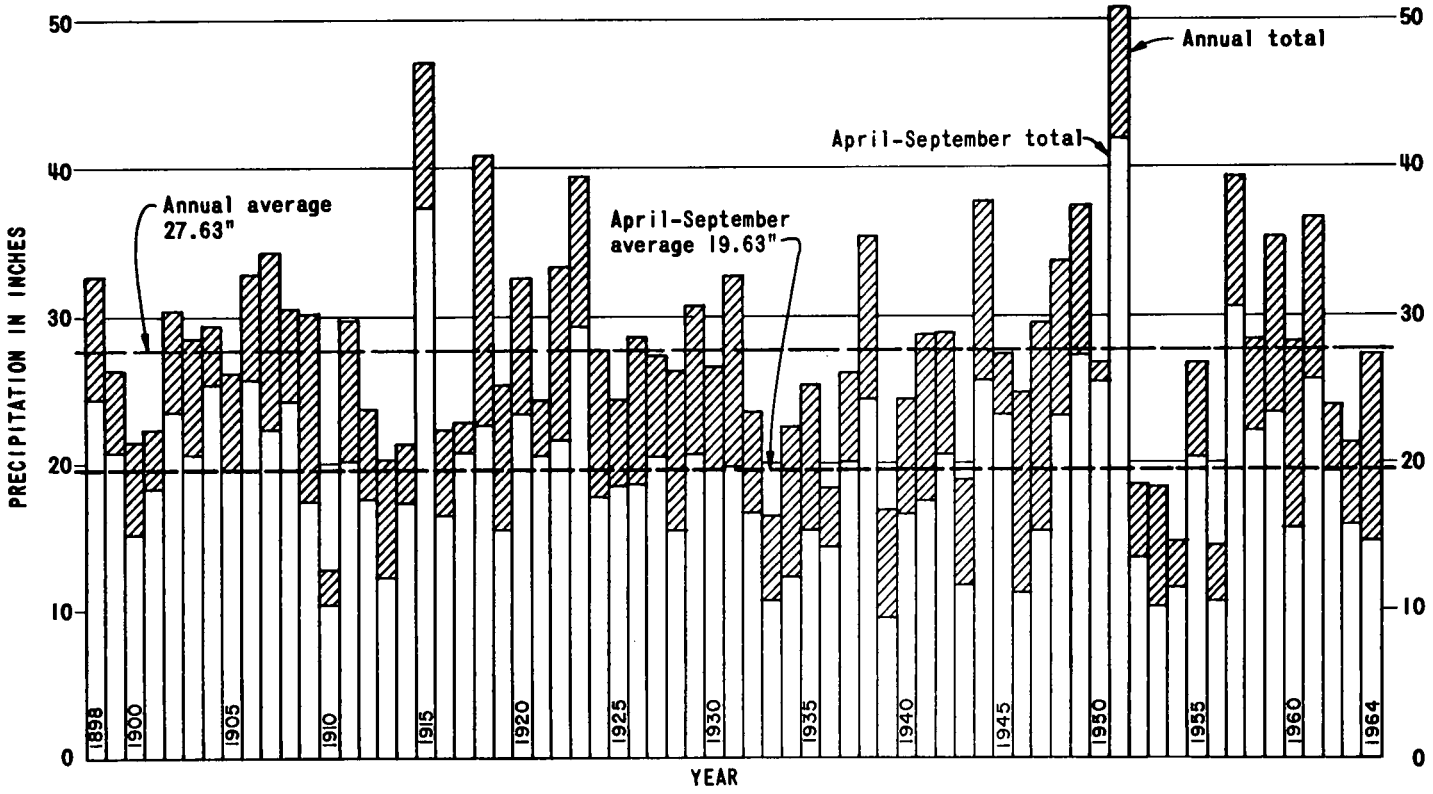

Figure 2.--Annual precipitation and precipitation from April through September at Anthony, Kans., for the period 1898 through 1964. White part of bar represents precipitation from April through September; white part plus shaded part represents annual precipitation.

between 3 and 4 inches. As much as 16 inches of snow have been recorded in a single month, but seldom does more than 10 inches of snow fall in any 30-day period. The snow does not remain on the ground for long.

Figure 3 shows the probability, in percent, of receiving specified amounts of precipitation in any week of the year. The normal weekly (smoothed) amount of precipitation is also shown in the figure. The percentages are based on data recorded at Medicine Lodge (5), which has a climate similar to that of Harper County. The best chances of receiving a significant amount of moisture (0.2 inch or more in 1 week) are late in May and early in June. During the summer months, the probability of significant rainfall is least late in July.

In table 10 the frequencies of rainfall of specified duration and amount are given for stated periods (12). For example, the table shows that 2.6 inches of rain in 2 hours can be expected to fall on an average of once in 5 years, and 2.0 inches in 1/2 hour can be expected on an average of once in 10 years.

TEMPERATURE: Because of the elevation and the influence of the surrounding land mass, daily and annual temperatures vary greatly. The change in temperature from the cold of winter to the warmth of spring and from the heat of summer to colder weather in fall is rapid. For example, the average monthly temperature in March is 47° F., compared to 57° in April. In fall the change is even more rapid, and the temperature changes from 60° in October to 47° in November.

The average monthly temperature at Anthony has ranged from a low of 15° below zero to a high of 115° above. Figure 4 shows the dates of means and extremes in temperature. On an average of 2 years in 10, January will have at least 4 days with a temperature of 5° or lower, and August will have at least 4 days with a temperature equal to or higher than 106° (see table 9). At Anthony in the period from 1898 through 1965, the temperature failed to reach 100° or higher in only one summer. On the other hand, an average of 6 out of 10 winters have had at least 1 day with a temperature below zero.

The average freeze-free period in the county ranges from 195 to 200 days (3). In the extreme southeastern corner of the county, however, the growing season averages slightly more than 200 days. This part of the county is in an area where the growing season is longer than elsewhere in Kansas. Table 11 gives probable dates of the last occurrence of freezing temperatures in spring, and the first in fall. At Anthony, the latest date in spring that had a temperature of 32° was May 15, 1907. The earliest date in fall was September 26, 1912. The data in table 11 indicate that, on the average, the last occurrence of temperature of 32° is after April 14 in spring, and before October 26 in fall. The principal crops grown in the county are seldom damaged by freezing.

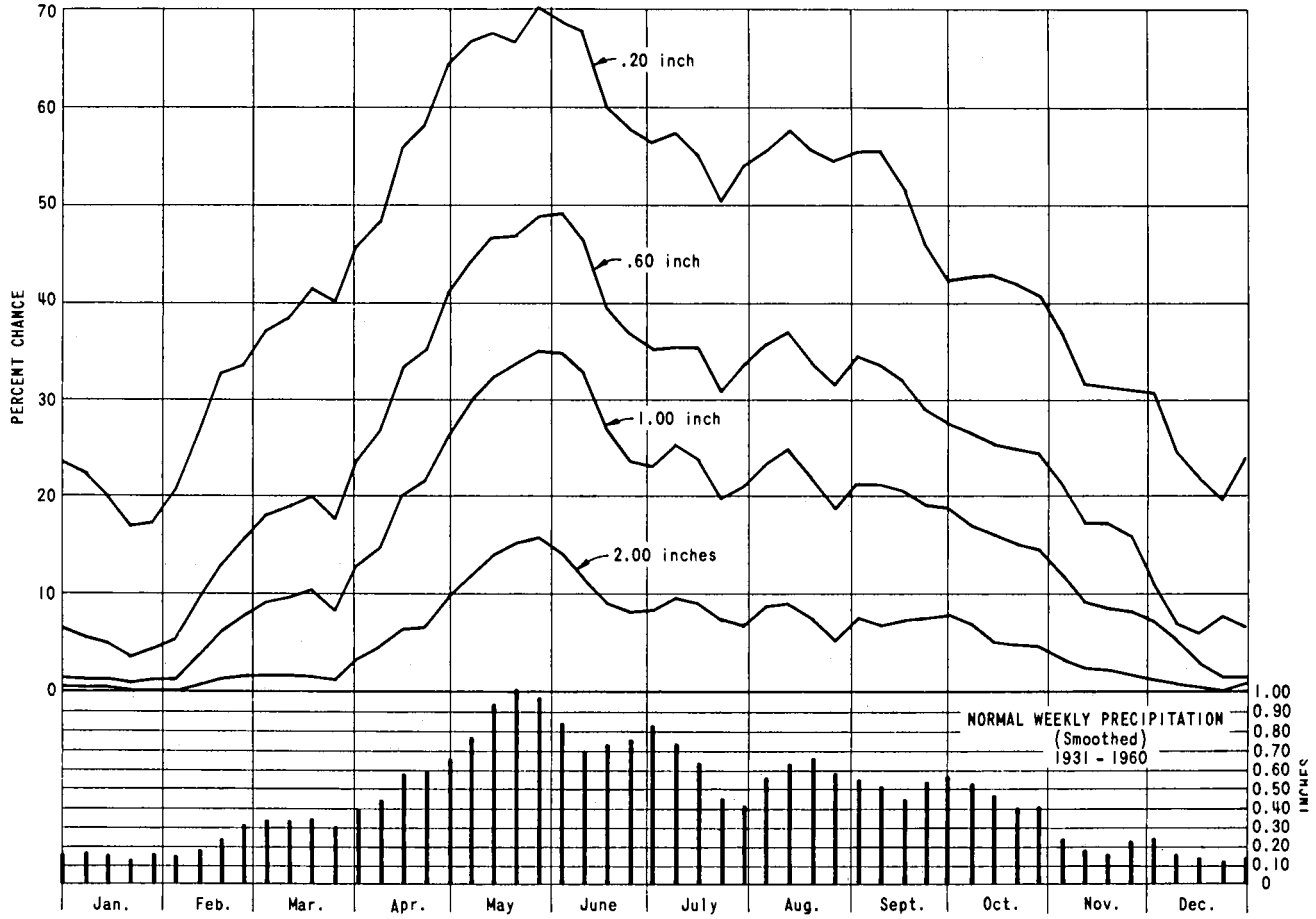

Figure 3.--Probabilities, in percent, of receiving at least the specified amount of precipitation by weeks. The normal amount of weekly precipitation is shown at the bottom of this figure.

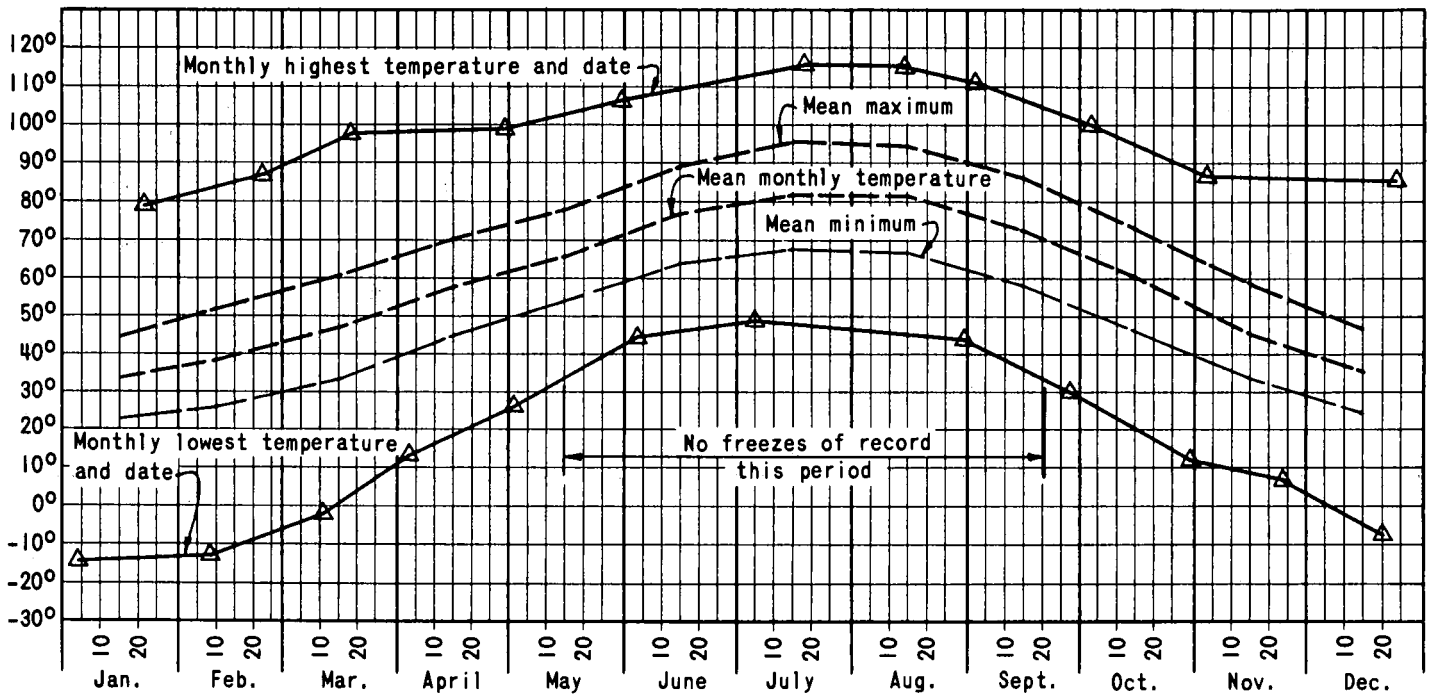

Figure 4.--Means and extremes in temperature at Anthony, Kans., in the period from 1907 through 1964.

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TABLE 11.--PROBABILITIES 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-------	March 23	March 30	April 7	April 18	April 29
2 years in 10 later than------	March 17	March 24	April 2	April 13	April 24
5 years in 10 later than------	March 5	March 14	March 24	April 3	April 14
Fall:					
1 year in 10 earlier than-----	November 18	November 14	November 2	October 21	October 12
2 years in 10 earlier than----	November 24	November 19	November 6	October 26	October 16
5 years in 10 earlier than----	December 6	November 30	November 16	November 4	October 26

WINDS AND STORMS: Surface winds in Harper County are moderate to strong. Wind velocity is highest in March and April when fairly intense low pressure storm centers are common. Soil blowing is a hazard, particularly during windy, dry periods in spring. The prevailing direction of the wind is southerly, though northerly winds are common in winter.

During the warmest half of the year, a few quite violent thunderstorms occur. These storms are accompanied by high winds, large hail, and heavy downpours. They generally last only a short time, but they cause sheet erosion and flash flooding in local areas.

Hail probably causes more damage to crops than any other kind of storm. Harper County has less hail and more rain than counties farther to the west. The hailstones generally range from a pea to a walnut in size, but they may be as large as a baseball.

Tornadoes occur from time to time, but they generally affect only a small area. They are most likely to occur in spring and early in summer, especially during May and June.

Farming

According to the U.S. Census of Agriculture, 936 farms were listed in Harper County in 1964. The average size of the farms was 542 acres. Dryfarmed crops were grown on most of the farms, but irrigated crops were grown on 9 of the farms. All irrigation water was applied by sprinkler systems. Of the farm operators 260 were full owners, 411 were part owners, 262 were tenants, and 3 were managers. The tenants commonly rent land on a crop-share basis. The landlord usually gets one-third of the crop.

Most of the farm machinery is mechanically powered. Harvesting of wheat and of grain sorghum is done with self-propelled combines. The machinery used in cultivating and in planting generally is owned by the operator. Many operators also own harvesting machinery. Others depend largely on custom harvesters, who may start harvesting in Texas or Oklahoma and follow the wheat harvest northward.

Farm labor generally is available locally for planting and tillage operations. At harvest time, additional labor commonly is required and generally is furnished by custom operators.

CROPS: Wheat and sorghum make up more than 90 percent of the total acreage of cultivated crops harvested in the county. Nearly all of the cultivated crops are dryfarmed, and the crops are grown year after year. In the 1968-69 crop year, according to the Kansas State Board of Agriculture, wheat was harvested from 242,000 acres. Also harvested was sorghum for grain from 10,000 acres; sorghum for forage and silage from 7,800 acres; corn from 700 acres; and oats, barley, and rye from 6,420 acres. Alfalfa was harvested from 11,500 acres, and all hay harvested accounted for 17,300 acres.

LIVESTOCK: Large ranches of the feeder-stocker or cow-calf type are in Harper County. On some ranches the two types of operations are combined. In addition many wheat farmers pasture their wheat in winter and maintain a small livestock operation (pl. IV). In 1969, according to the Kansas State Board of Agriculture, 1,400 milk cows were reported in the county. Also reported were 52,000 other cattle, 7,000 sheep, and 5,000 hogs. The number of chickens increased to 220,000. This increase was caused by the development of caged laying hen operations. Horses and mules were reported on a few farms and totaled 960.

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AC soil. A soil that has an A and a C horizon but no B horizon. Commonly such soils are immature, as those developing from alluvium or those on steep, rocky slopes.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

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

Blowout. An excavation produced by wind action in loose soil, generally sand.

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

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

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

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.

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.

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:

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 is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused by (1) 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.

Internal soil drainage. The downward movement of water through the soil profile. The rate of movement is determined by the texture, structure, and other characteristics of the soil profile and underlying layers, and by the height of the water table, either permanent or perched. Relative terms for expressing internal drainage are none, very slow, slow, medium, rapid, and very rapid.

Leaching. The removal of soluble materials from soils or other material by percolating water.

Loess. A fine-grained deposit laid down by wind and consisting mainly of silt-sized particles.

Parent material. The disintegrated and partly weathered rock from which soil has formed.

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

Perched water table. See Water table.

Permeability. The quality of a soil horizon that enables water or air to move through it. 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 relatively weak acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

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

Red beds. Sedimentary strata predominantly red in color and composed largely of sandstone and shale.

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

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

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

Slick spots. Small areas in a field that are slick when wet because they contain excess exchangeable sodium, or alkali.

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.

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

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

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

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."

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched water table may be separated from a lower one by a dry zone.

Weathering. All physical and chemical changes produced in rocks at or near the earth's surface by atmospheric agents. These changes result in more or less complete disintegration and decomposition of the rock.

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