SOIL SURVEY OF

Crawford County, Kansas

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

Issued December 1973

Major fieldwork for this soil survey was done in the period 1957–67. Soil names and descriptions were approved in 1968. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1957–67. 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 Crawford County Soil Conservation District.

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

HOW TO USE THIS SOIL SURVEY

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

Locating Soils

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

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

Finding and Using Information

The "Guide to Mapping Units" can be used to find information in the survey. This guide lists all of 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 kind of soil is described and the page for the 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 those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the range sites and woodland suitability groups.

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

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

Ranchers and others can find, under "Use of the Soils for Range," 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.

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

Engineers and builders can find, under the section "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, Morphology, and Classification of the Soils."

Newcomers in Crawford 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 at the beginning of the survey and in the section "Additional Facts About the County."

Cover: **Soybeans growing on a Dennis soil. This soil is terraced and is farmed on the contour.**

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SOIL SURVEY OF CRAWFORD COUNTY, KANSAS

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

CRAWFORD COUNTY is near the southeastern corner of Kansas (fig. 1). Girard, the county seat, is in the center of the county. Pittsburg, the largest city, is near the southeastern corner. The area of the county is 598 square miles, or 382,720 acres. The county was organized in 1867.

Farming and industry are important in the county. For more information, see the section "Industries, Transportation, and Markets."

According to the 1969 Census of Agriculture, there were 1,130 farms in Crawford County, averaging about 284 acres in size. About 84 percent of the land area of the county was in farms. Corn, wheat, sorghum, and soybeans are the most important farm crops. Beef cattle are the principal kind of livestock.

How This Survey Was Made

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

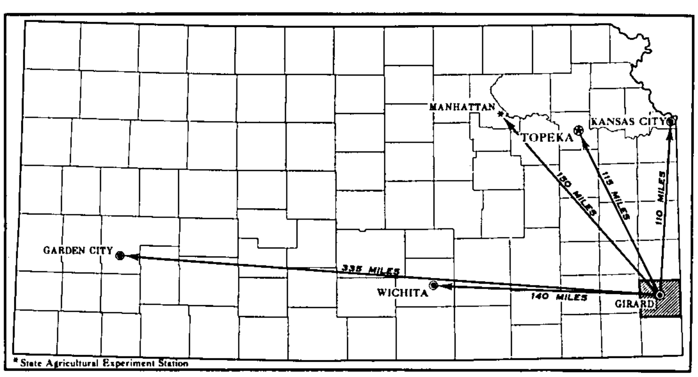

Figure 1.—Location of Crawford County in Kansas.

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. Parsons and Dennis, 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, Dennis silt loam, 1 to 4 percent slopes, is one of several phases within the Dennis 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 soil boundaries accurately. The soil map at the back of this survey was prepared from aerial photographs.

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

Some mapping units are made up of soils of different series, or of different phases within one series. One such kind of mapping unit, the soil complex, is shown on the soil map of Crawford County.

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 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. Breaks-Alluvial land complex 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 rather than soils and are given descriptive names. Mine pits and dumps is a land type in Crawford County.

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

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

On the basis of yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. Then 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 Crawford 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 seven soil associations in Crawford County are each described in the following pages.

1. Hepler-Radley association

Deep, nearly level, somewhat poorly drained to moderately well drained soils on bottom lands

This association is on bottom lands of larger creeks and their tributaries. It makes up about 7 percent of the county (fig. 2). Hepler soils make up about 40 percent of this association; Radley soils, about 34 percent; McCune soils, about 18 percent; Mine pits and dumps, about 6 percent; and Osage soils, about 2 percent.

Hepler soils occur throughout this association, except along the lower reaches of Cow Creek in the southeastern part of the county. They have a silt loam surface and subsurface layer and a subsoil of silty clay loam. They are somewhat poorly drained and have moderately slow permeability.

Radley soils occur throughout this association. They have a silt loam surface layer underlain by silt loam that is stratified with thin layers of loam and silty clay loam. Radley soils are moderately well drained and have moderate permeability. In most areas they occur nearer to the stream channel than Hepler soils.

McCune soils occur only along the lower reaches of Cow Creek and along Little Cow Creek. Mine pits and dumps are areas that have been strip mined for coal. Osage soils are poorly drained.

Most of this association is used for crops, and the rest is in pasture or is wooded. Corn, soybeans, small grains, and sorghum are the main crops. Some alfalfa is grown on the Radley soils. General cash-grain farming and livestock farming are the main enterprises. Occasional flooding and, in a few places, poor drainage are the major limitations. Principal management needs are maintaining an adequate supply of organic matter and plant nutrients. These soils are suitable for growing trees, although improved management is needed for the existing wooded areas.

2. Parsons-Cherokee association

Deep, nearly level, somewhat poorly drained soils on uplands

This association occurs on broad, nearly level landscapes. It makes up about 2 percent of the county. Parsons and Cherokee soils, in nearly equal proportions, make up about 90 percent of the association (see fig. 2); Dennis and Bates soils, about 5 percent; and Mine pits and dumps, the remaining 5 percent.

Both Parsons and Cherokee soils have a silt loam surface and subsurface layer underlain by a compact clay subsoil. Both Parsons and Cherokee soils have very slow permeability and are somewhat poorly drained.

The gently sloping Dennis and Bates soils are on uplands. Mine pits and dumps are areas that have been strip mined for coal.

Most of this association is used for crops. Corn, soybeans, wheat, and sorghum are the main crops. General cash-grain farming and livestock farming are the main enterprises. Seasonal wetness and water erosion are the major limitations in the use and management of these soils. Fertility is low.

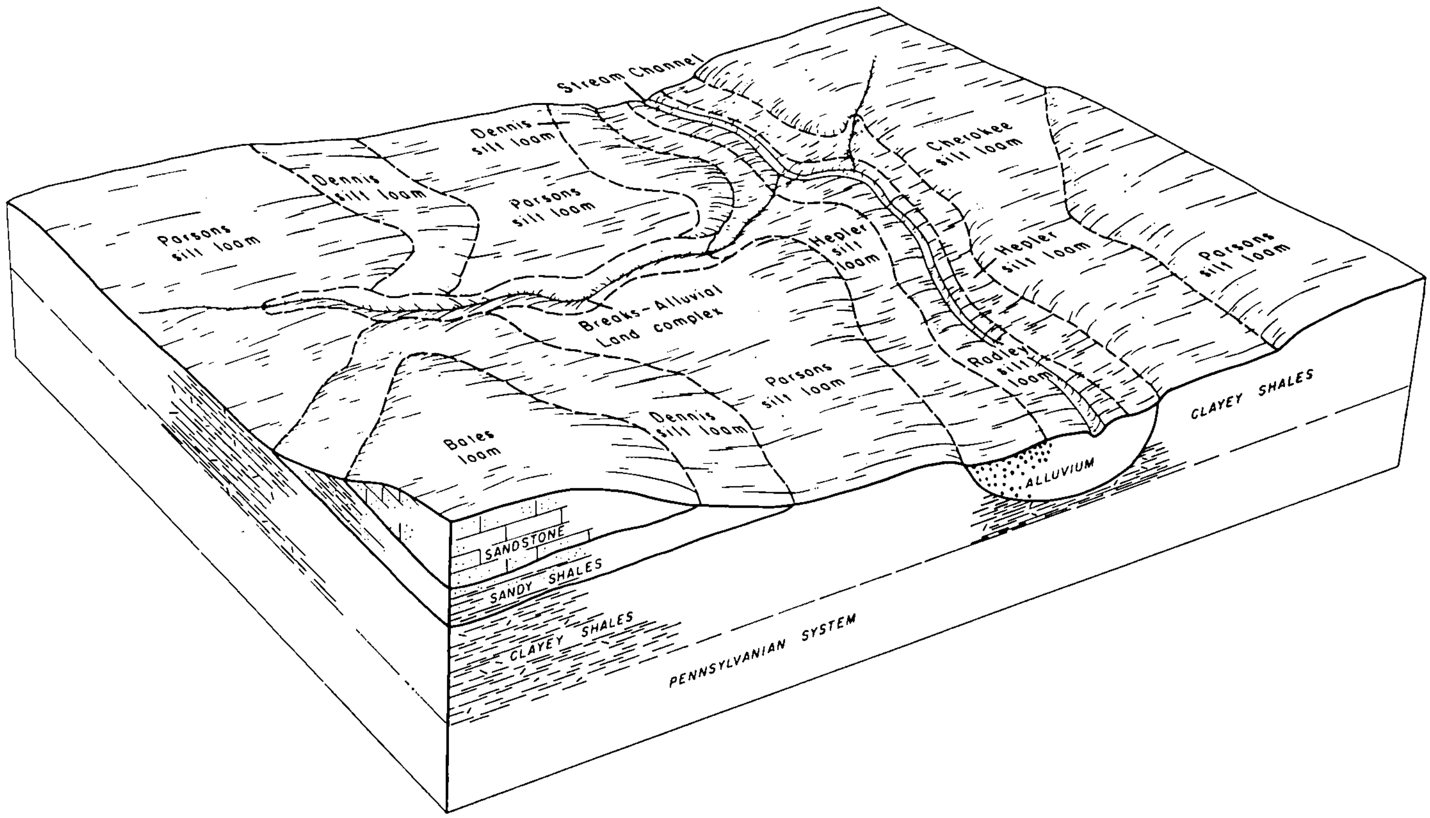

Figure 2.—**Typical cross section of the major soils that formed in material weathered from acid clayey and sandy shale or sandstone or in alluvium derived from these materials. These soils are in associations 1, 2, 3, and 4.**

3. Parsons-Dennis association

Deep, nearly level to gently sloping, somewhat poorly drained to moderately well drained soils on uplands

This association occurs on broad ridgetops and long side slopes. It is the most extensive of the associations and makes up about 59 percent of the county. Parsons soils make up about 64 percent of this association; Dennis soils, about 11 percent; Mine pits and dumps, about 10 percent; Breaks-Alluvial land, about 9 percent; and Bates and Cherokee soils and Eroded land, the remaining 6 percent.

Parsons soils (see fig. 2) have a silt loam surface and subsurface layer and a subsoil of compact clay. Permeability is very slow, and the soils are somewhat poorly drained. Dennis soils have a surface layer of silt loam and a subsoil of clay. Permeability is slow, and the soils are moderately well drained. The gently sloping Dennis soils occupy hilltops and side slopes.

Mine pits and dumps occur mainly in the eastern and southern parts of the county. Breaks-Alluvial land complex occurs along the side slopes and bottoms of the narrow upland drainageways. The nearly level Cherokee soils and the sloping Bates soils and Eroded land are on uplands.

Most of this association is cultivated. Corn, wheat, soybeans, and sorghum are the main crops. Some areas remain in native grass pasture or meadow. General cash-grain farming and livestock farming are the main enterprises. Water erosion and runoff are the major limitations. The Breaks-Alluvial land complex is mostly in grass and is used for pasture. In most places Mine pits and dumps have a mixed cover of trees, brush, weeds, and grass. These areas are used mainly for recreation, wildlife habitat, and some livestock grazing. Many of the water-filled pits have been stocked and are used for fishing.

4. Dennis-Bates association

Deep and moderately deep, gently sloping to sloping, moderately well drained to well drained soils on uplands

This association occurs on ridgetops and side slopes. It covers about 5 percent of the county. Dennis soils (see fig. 2) make up about 30 percent of this association; Bates soils, about 20 percent; Bolivar and Hector soils, about 14 percent; Mine pits and dumps, about 21 percent; and minor soils, the remaining 15 percent.

Dennis soils are gently sloping. These are deep soils that have a surface layer of silt loam and a subsoil of slowly permeable clay. They are moderately well drained. Bates soils are moderately deep and moderately permeable. They have a loam surface layer and a clay loam subsoil.

Bolivar and Hector soils are gently sloping to moderately steep. Slopes are somewhat dissected, and there are scattered outcrops of sandstone. Mine pits and dumps are areas that have been strip mined for coal.

Parsons soils, Breaks-Alluvial land complex, and Eroded land make up part of this association. The nearly level Parsons soils are on uplands. Breaks-Alluvial land complex occurs on both side slopes and narrow alluvial bottoms of upland drainageways. The sloping to strongly sloping Eroded land occupies dissected areas on uplands.

Most of this association is cultivated and is used mainly for corn, wheat, soybeans, and sorghum. Some areas are used for pasture or remain in native grass. The Bolivar-Hector complex is mostly grass or woodland that consists mainly of savannah-type vegetation. The Breaks-Alluvial land complex is mostly in grass and scattered trees. It is used for grazing. Mine pits and dumps have a mixed cover of trees, grass, and brush and are used mainly for wildlife habitat, recreation, and some livestock grazing. Many of the water-filled pits have been stocked and are used for fishing. In cultivated areas measures are needed to control water erosion and runoff. General cash-grain farming and livestock farming are the main enterprises.

5. Zaar-Ringo association

Deep and moderately deep, gently sloping to strongly sloping, moderately well drained to well drained soils on uplands

This association occurs mostly on side slopes adjacent to hills and ridgetops that are underlain by limestone. It makes up about 4 percent of the county. Zaar soils make up about 65 percent of this association; Ringo soils, about 20 percent; and Lula, Clareson, Girard, and Dennis soils, the remaining 15 percent.

Zaar soils (fig. 3) are deep soils that have a surface layer of silty clay and a subsoil of clay. Permeability is very slow, and the soils are moderately well drained. Ringo soils are moderately deep and have a silty clay surface layer and subsoil. Permeability is very slow, and the soils are well drained.

The gently sloping Clareson, Dennis, and Lula soils are on uplands. Girard soils are on narrow bottom lands.

Most of this association is cultivated. Corn, wheat, soybeans, and sorghum are the main crops. The strongly sloping Ringo soils and some of the Clareson soils are used as pasture or native grass meadow. General cash-grain farming and livestock farming are the main enterprises. Water erosion and runoff are major limitations. Small seepy spots and seasonal wetness may delay seedbed preparation and planting of crops in some years. In a small part of the association, these soils have a shallow root zone and are stony.

6. Zaar-Lula association

Deep, gently sloping, moderately well drained to well drained soils on uplands

This association occurs on side slopes and ridgetops. It makes up about 21 percent of the county. Zaar soils make up about 53 percent of this association (see fig. 3); Lula soils, about 20 percent; Dennis and Parsons soils, about 15 percent; and Clareson, Girard, and Ringo soils, the remaining 12 percent.

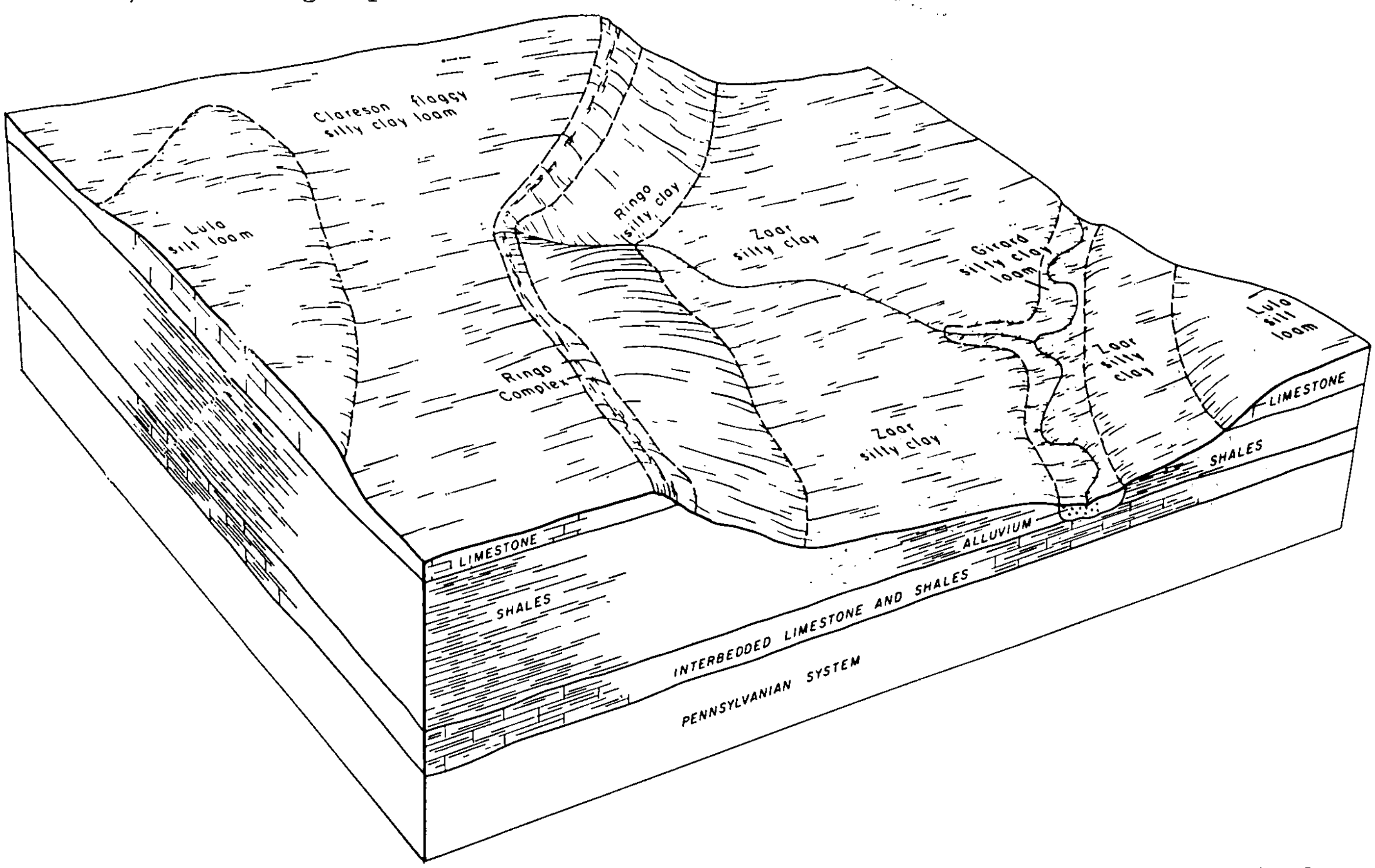

Figure 3.—Typical cross section of the major soils that formed in material weathered from clayey shale or limestone that is calcareous or is neutral in reaction. These soils are in associations 5, 6, and 7.

Zaar soils have a surface layer of silty clay and a subsoil of clay. Permeability is very slow, and the soils are moderately well drained. In most places Zaar soils are on the low slopes below the Lula soils. Lula soils have a surface layer of heavy silt loam and a subsoil of silty clay loam. They are well drained and have moderate permeability. In most places Lula soils are on broad ridgetops above the Zaar soils.

Dennis, Parsons, and Clareson soils are gently sloping and are on uplands. Girard soils are in small, narrow areas on bottom lands. The strongly sloping Ringo soils are on uplands.

Most of this association is cultivated. Corn, wheat, soybeans, and sorghum are the main crops. Some of the soils, especially the more sloping or the stony soils, are used for pasture or native grass meadow. General cash-grain farming and livestock farming are the main enterprises. Water erosion and runoff are major limitations. In some years small seepy spots and seasonal wetness may delay seedbed preparation and the planting of crops on Zaar soils.

7. *Clareson-Lula association*

Moderately deep and deep, nearly level to gently sloping, well-drained soils on uplands

This association occurs mostly on broad ridgetops (see fig. 3). It makes up about 2 percent of the county. Clareson soils make up about 80 percent of this association; Lula soils, about 15 percent; and Ringo and Zaar soils, the remaining 5 percent.

Clareson soils are moderately deep, contain flaggy limestone fragments through the profile, and are underlain by limestone at a depth of 20 to 40 inches. In places they are stony at the surface. Permeability is moderately slow. Lula soils are deep soils that have a surface layer of heavy silt loam and a subsoil of silty clay loam. They have moderate permeability.

The gently sloping Zaar soils and the strongly sloping Ringo soils are on uplands.

Most of this association is in native grass and is used for grazing, but some areas are used for meadow. A few small areas are cultivated. General livestock farming is the main enterprise. Proper range management is important in the use of these soils; brush and weeds invade if the grass is overgrazed.

Descriptions of the Soils

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

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series description has a short narrative description of a representative profile and a much more detailed description of the same profile, from which more precise interpretations can be made. Unless otherwise stated, the colors and consistence given in the descriptions are those of a moist soil.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Mine pits and dumps, for example, is a miscellaneous land type that does not belong in a soil series. Nevertheless, it is listed in alphabetic order along with the soil series.

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

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary at the end of this survey, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*12*).[1]

A given soil series in this county may be identified by a different name in a recently published soil survey of an adjacent county. Such differences in name result from refinements in the soil classification system. The characteristics of the soil series described in this county are considered to be within the range defined for that series. In those instances where a soil series has one or more soils that have features outside the defined range, the differences are explained.

Bates Series

The Bates series consists of moderately deep, loamy soils on uplands. These soils formed under prairie grasses in material weathered from thinly bedded sandstone and interbedded sandy and silty shale. Slopes are 1 to 7 percent. Depth to the underlying sandstone and shale ranges from 20 to 40 inches.

In a representative profile, the surface layer is very dark brown loam about 9 inches thick. The upper 7 inches of the subsoil is friable, very dark grayish-brown heavy loam that contains yellowish-brown mottles. The lower 17 inches of the subsoil is firm, dark yellowish-brown light clay loam that contains yellowish-brown, dark yellowish-brown, and yellowish-red mottles. The underlying material is soft, fine-grained, acid sandstone that contains thin beds of silty shale.

Bates soils are well drained. Permeability is moderate, and the available water capacity is low to moderate. Fertility is low.

Representative profile of a Bates loam, 1 to 4 percent slopes, in a native grass pasture, 3,300 feet west and 1,600 feet south of the northeast corner of sec. 1, T. 28 S., R. 23 E.

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[1] Italic numbers in parentheses refer to Ltierature Cited, p. 48.

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

Soil	Area	Extent
	Acres	*Percent*
Bates loam, 1 to 4 percent slopes	4, 184	1. 1
Bates loam, 1 to 4 percent slopes, eroded	534	. 1
Bates loam, 4 to 7 percent slopes	3, 132	. 8
Bates loam, 4 to 7 percent slopes, eroded	841	. 2
Bolivar-Hector complex, 5 to 12 percent slopes	2, 691	. 7
Breaks-Alluvial land complex	19, 547	5. 1
Cherokee silt loam	8, 764	2. 3
Clareson flaggy silty clay loam, 0 to 3 percent slopes	9, 442	2. 5
Dennis silt loam, 1 to 4 percent slopes	22, 479	5. 9
Dennis silt loam, 1 to 4 percent slopes, eroded	3, 099	. 8
Dennis silt loam, 4 to 7 percent slopes	3, 076	. 8
Dennis silt loam, 4 to 7 percent slopes, eroded	1, 902	. 5
Dennis-Parsons silt loams, 1 to 4 percent slopes	13, 801	3. 6
Eroded land, 3 to 10 percent slopes	1, 222	. 3
Girard silty clay loam	4, 091	1. 0
Hepler silt loam	11, 008	2. 9
Lula silt loam, 1 to 3 percent slopes	17, 642	4. 6
Lula silty clay loam, 1 to 3 percent slopes, eroded	587	. 2
Lula-Clareson complex, 1 to 3 percent slopes	6, 624	1. 7
McCune silt loam	4, 790	1. 2
Mine pits and dumps	25, 530	6. 8
Osage clay	574	. 2
Parsons silt loam, 0 to 1 percent slopes	45, 158	11. 8
Parsons silt loam, 1 to 3 percent slopes	91, 283	23. 9
Parsons silt loam, 1 to 3 percent slopes, eroded	8, 307	2. 2
Radley silt loam	6, 624	1. 7
Radley-Hepler silt loams	4, 750	1. 2
Ringo silty clay, 3 to 9 percent slopes	2, 325	. 6
Ringo silty clay, 3 to 9 percent slopes, eroded	2, 105	. 6
Ringo complex, 9 to 15 percent slopes	2, 007	. 5
Zaar silty clay, 1 to 3 percent slopes	51, 637	13. 5
Water (lakes, ponds, and creeks)	2, 964	. 7
Total	382, 720	100. 0

A1—0 to 9 inches, very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) when dry; weak, fine, granular structure; slightly hard when dry, friable when moist; abundant fine roots; strongly acid; gradual, smooth boundary.

B1—9 to 16 inches, very dark grayish-brown (10YR 3/2) heavy loam, dark grayish brown (10YR 4/2) when dry; few, fine, very faint, yellowish-brown (10YR 5/4) mottles; moderate, medium, granular structure; slightly hard when dry, friable when moist; many fine roots; few small fragments of soft sandstone; slightly acid; gradual, smooth boundary.

B2t—16 to 23 inches, dark yellowish-brown (10YR 3/4) light clay loam, yellowish brown (10YR 5/4) when dry, brown (7.5YR 4/4) when moist and rubbed; common, medium, faint, yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; hard when dry, firm when moist; few fine roots; thin, discontinuous clay films on many ped surfaces; few small fragments of soft, black shot concretions; medium acid; gradual, smooth boundary.

B3—23 to 33 inches, dark yellowish-brown (10YR 4/4) light clay loam, yellowish brown (10YR 5/4) when dry, strong brown (7.5YR 5/6) when moist and rubbed; coarse, distinct, yellowish-brown (10YR 5/6), dark yellowish-brown (10YR 4/6), and yellowish-red (5YR 5/6) mottles; weak, medium, subangular blocky structure; hard when dry, firm when moist; few fine roots; many, small, black shot concretions concentrated in the lower 2 inches; strongly acid; abrupt, wavy boundary.

R—33 inches, soft, fine-grained, acid sandstone that contains thin beds of sandy and silty shale.

The A1 horizon ranges from fine sandy loam to silt loam in texture, from very dark brown to very dark grayish brown in color when moist, and from 7 to 12 inches in thickness. Thickness of the solum ranges from 20 to 40 inches. Texture of the B2t horizon is dominantly light clay loam that does not contain more than 35 percent clay. In most places the sandstone bedrock is thinly bedded.

In mapping units Bb and Bd, the surface layer is thinner than is defined as the range for the series.

Bates soils are associated on the landscape with Dennis, Parsons, Cherokee, and Hector soils. They are not so deep as Dennis soils and have a less clayey Bt horizon. Bates soils are not so deep as Parsons and Cherokee soils and lack the compact, very slowly permeable Bt horizon of those soils. Their profile is somewhat similar to that of Bolivar and Hector soils. They have a darker colored and thicker A1 horizon than that of Bolivar soils. Bates soils are deeper than Hector soils, and they have a B2t horizon, which Hector soils lack.

Bates loam, 1 to 4 percent slopes (Ba).—This soil is on uplands. Slopes are convex. In most places this soil is above the level of surrounding soils, but in some places it is in narrow bands along the margins of ridgetops. This soil has the profile described as representative for the series.

Included in mapping were some small areas of Dennis silt loam. Also included were small eroded areas and a few small areas of soils that are less than 20 inches deep over sandstone.

This soil is suited to corn, wheat, soybeans, sorghum, alfalfa, and other crops commonly grown in the county. Surface runoff is medium, and erosion is a hazard. Good crop-residue management and such measures as terracing and contour farming help to control erosion. (Capability unit IIe-2; Loamy Upland range site; not in a woodland suitability group)

Bates loam, 1 to 4 percent slopes, eroded (Bb).—This soil has convex slopes and is on uplands. In most places it occurs in positions above the level of surrounding soils, but in some places it is in narrow bands along the margins of ridgetops.

The profile of this soil is similar to that of the soil described as representative for the series, except that erosion has thinned the surface layer. The present plow layer is firm, very dark grayish-brown or dark-brown heavy loam. Over much of the area it consists of part of the original surface layer mixed with material from the subsoil. The surface layer is less friable, lower in organic-matter content and fertility, and more difficult to keep in good tilth than the less eroded Bates soils.

Included in mapping were a few small areas of eroded Dennis soils. Also included were small severely eroded areas of yellowish-brown clay loam.

This soil is suited to most crops grown in the county. It is better suited to wheat, soybeans, and sorghum than to other crops. Surface runoff is medium, and erosion is a hazard. Terracing, contour farming, and good management of crop residue help to control erosion and maintain fertility. (Capability unit IIIe-7; Loamy Upland range site; not in a woodland suitability group)

Bates loam, 4 to 7 percent slopes (Bc).—This soil is on uplands. Slopes are plane to convex. The profile of this soil is similiar to that of the soil described as representative for the series, except that the surface layer is slightly thinner.

Included in mapping were small areas of Bates soils where the slope ranges from 7 to 10 percent. Also included were some small areas of Dennis silt loam.

This soil is suited to all crops commonly grown in the county, including corn, wheat, sorghum, soybeans, and alfalfa. Surface runoff is medium to rapid, and the erosion potentital is high. Conservation measures, such as terracing, contour farming, and crop-residue management, help to control erosion. (Capability unit IIIe-1; Loamy Upland range site; not in a woodland suitability group)

Bates loam, 4 to 7 percent slopes, eroded (Bd).—This soil is on uplands and side slopes. In most places the slopes are smooth and convex. There are a few small downslope drainageways.

The profile of this soil is similar to that of the soil described as representative for the series, except that erosion has thinned the surface layer. The present plow layer is firm, very dark grayish-brown or dark-brown heavy loam. In much of the acreage, it consists of part of the original surface layer mixed with material from the subsoil. The surface layer is less friable, lower in organic-matter content and fertility, and more difficult to keep in good tilth than the less eroded Bates soils.

Included in mapping were a few small areas of eroded Dennis soils. Also included were small severely eroded areas of yellowish-brown clay loam.

Wheat, soybeans, and sorghum are well suited to this soil. Surface runoff from cultivated fields is rapid, and the hazard of erosion is high. Seeding the areas to native grasses or use of such intensive conservation practices as terracing, contour farming, and crop-residue management help to control erosion. (Capability unit IVe-1; Loamy Upland range site; not in a woodland suitability group)

Bolivar Series

The Bolivar series consists of moderately deep, loamy soils on uplands. These soils formed in material weathered from shale and sandstone. They occupy narrow, rounded hilltops and side slopes. Slopes are 5 to 9 percent. Native vegetation is low-growing hardwood trees and grass. In this county these soils are mapped only in a complex with Hector soils.

In a representative profile the surface layer is very dark grayish-brown silt loam about 4 inches thick. The upper 6 inches of the subsoil is firm, dark grayish-brown heavy silt loam. Small sandstone or shale fragments are common in this layer. The lower 14 inches of the subsoil is firm, brown silty clay loam that contains some small shale fragments. The underlying material consists mostly of mixed, weathered, gray and yellowish-brown, platy shale that contains a few clayey seams of soil material.

Bolivar soils are well drained. Permeability is moderate. The available water capacity is low to moderate, and fertility is low.

Representative profile of Bolivar silt loam, in a wooded area of Bolivar-Hector complex, 5 to 12 percent slopes, 150 feet east and 150 feet north of the southwest corner of sec. 32, T. 27 S., R. 25 E.

O1—¼ inch to 0, partly decomposed leaves, twigs, and vegetative matter.

A1—0 to 4 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; weak, medium, granular structure; slightly hard when dry, friable when moist; many fine roots; slightly acid; clear, smooth boundary.

B1—4 to 10 inches, dark grayish-brown (10YR 4/2) heavy silt loam, light brownish gray (10YR 6/2) when dry; weak, medium, subangular blocky structure; hard when dry, firm when moist; many fine roots; common small sandstone and shale fragments; strongly acid; gradual, smooth boundary.

B2t—10 to 24 inches, brown (10YR 4/3) silty clay loam, brown (10YR 5/3) when dry; weak, medium, subangular blocky structure; very hard when dry, firm when moist; common fine roots; few small shale fragments; common shiny ped surfaces; strongly acid; gradual, smooth boundary.

C—24 to 31 inches, mixed gray (10YR 6/1) and yellowish-brown (10YR 5/6) shaly silty clay loam, light gray (10YR 7/1) and brownish yellow (10YR 6/6) when dry; weak, medium, platy structure; very hard when dry, firm when moist; few clayey seams; strongly acid; gradual, smooth boundary.

R—31 inches, consolidated shale with a few thin layers of sandstone.

Color of the A1 horizon ranges from very dark grayish brown to dark brown in hue 10YR when moist. Thickness of the A1 horizon ranges from 2 to 6 inches. The B1 horizon ranges from heavy silt loam to light silty clay loam in texture and from 4 to 10 inches in thickness. Texture of the B2t horizon ranges from silty clay loam to clay loam. Thickness of the solum ranges from 20 to 40 inches. The depth to bedrock ranges from 20 to 40 inches. Weathered sandstone or shale fragments are throughout the profile in some places, but make up less than 35 percent of the soil mass of any horizon. In wooded areas most of the soil surface is covered with a thin layer of partly decomposed vegetation.

Bolivar soils are on landscape similar to those of Hector soils, but they have a B2t horizon and are deeper than Hector soils. Bolivar soils have profiles similar to those of Bates soils, but their A1 horizon is lighter colored and thinner than that of Bates soils.

Bolivar-Hector complex, 5 to 12 percent slopes (Be).—This complex is on narrow, rounded hilltops and on side slopes. It consists of about 50 to 55 percent Bolivar soils, 25 to 30 percent Hector soils, and 20 to 25 percent inclusions of other soils. The Bolivar and Hector soils have the profiles described as representative for their respective series. About 10 percent of the included soils are similar to Bolivar soils, except that they have a thicker surface layer.

Soils of this complex are suited to grazing. Some of the areas are abandoned cropland that contains small eroded areas. Only a few small areas are cultivated. Surface runoff is rapid, and erosion is a hazard if the cover of plants is not maintained. Control of grazing helps to maintain the vegetation cover. (Capability unit VIe-2; Savannah range site; not in a woodland suitability group)

Breaks-Alluvial Land

Breaks-Alluvial land complex (Bk) is on broken side slopes and narrow bottoms of upland drainageways. Slopes are steep. Areas of this complex range from 75 to 300 feet in width. The bottom lands are not more than 125 feet wide in most places. Composition ranges from about 20 to 80 percent each of side slopes and bottom lands. Side slopes are the dominant part of the complex at the heads of drainageways.

The soil material on the side slopes is clayey in most places and is somewhat excessively drained. Slopes range from 5 to 25 percent. There are rock outcrops in places. In most places the bottom lands are loamy, nearly level, and somewhat poorly drained.

This complex is better suited to grazing than to other uses because of the erosion hazard on the slopes and flooding on the bottom lands. Areas that are bushy make good wildlife habitat. Most of the complex is in native grass and is used for grazing. The upper ends of a few of the areas are cultivated along with adjoining cropland. There are many farm ponds (fig. 4). (Capability unit VIe-1; Breaks part is in Clay Upland range site; Alluvial land is in Loamy Lowland range site; not in a woodland suitability group)

Cherokee Series

The Cherokee series consists of deep, loamy soils on uplands. Slopes are 0 to 1 percent. These soils formed under prairie grasses in material weathered from clayey shale. In some places they contain windblown material in the upper layers.

In a representative profile, the surface layer is dark grayish-brown silt loam about 8 inches thick (fig. 5). The subsurface layer is grayish-brown silt loam about 7 inches thick. The subsoil is very firm clay about 30 inches thick; the upper 20 inches is very dark gray, and the lower 10 inches is dark gray. The underlying material is very firm, coarsely mottled, grayish-brown silty clay loam.

Cherokee soils are somewhat poorly drained. Permeability is very slow, and the available water capacity is high. These soils have a temporary perched water table above the Bt horizon during wet seasons. Fertility is low.

Representative profile of Cherokee silt loam, in a cultivated field 300 feet south and 100 feet west of the northeast corner of the SE¼ of sec. 6, T. 31 S., R. 23 E.

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) when dry; weak, very fine, granular structure; slightly hard when dry, friable when moist; many fine roots; neutral (limed); clear, smooth boundary.

A2—8 to 15 inches, grayish-brown (10YR 5/2) silt loam, light gray (10YR 7/2) when dry; few, fine, faint, yellowish-brown (10YR 5/4) mottles; weak, fine, granular structure; slightly hard when dry, friable when moist; few, small, soft, black concretions; common very fine pores; many fine roots; strongly acid; abrupt, wavy boundary.

B2t—15 to 35 inches, very dark gray (10YR 3/1) clay, dark gray (10YR 4/1) when dry; common, medium, distinct, yellowish-brown (10YR 5/4) mottles; weak, medium, blocky structure; extremely hard when dry, very firm when moist; few roots; strongly acid; gradual, smooth boundary.

B3—35 to 45 inches, dark-gray (10YR 4/1) clay, light gray (10YR 6/1) when dry; many, coarse, distinct, yellowish-brown (10YR 5/6) and brown (7.5YR 5/4) mottles; weak, coarse, blocky structure; extremely hard when dry, very firm when moist; few ped faces coated with dark gray (10YR 4/1); strongly acid; gradual, smooth boundary.

C—45 to 60 inches, grayish-brown (10YR 5/2) silty clay loam, light brownish gray (10YR 6/2) when dry; many, coarse, distinct, yellowish-brown (10YR 5/6) mottles and common, medium, faint, dark grayish-brown (10YR 4/2) mottles; massive; extremely hard when dry, very firm when moist; medium acid.

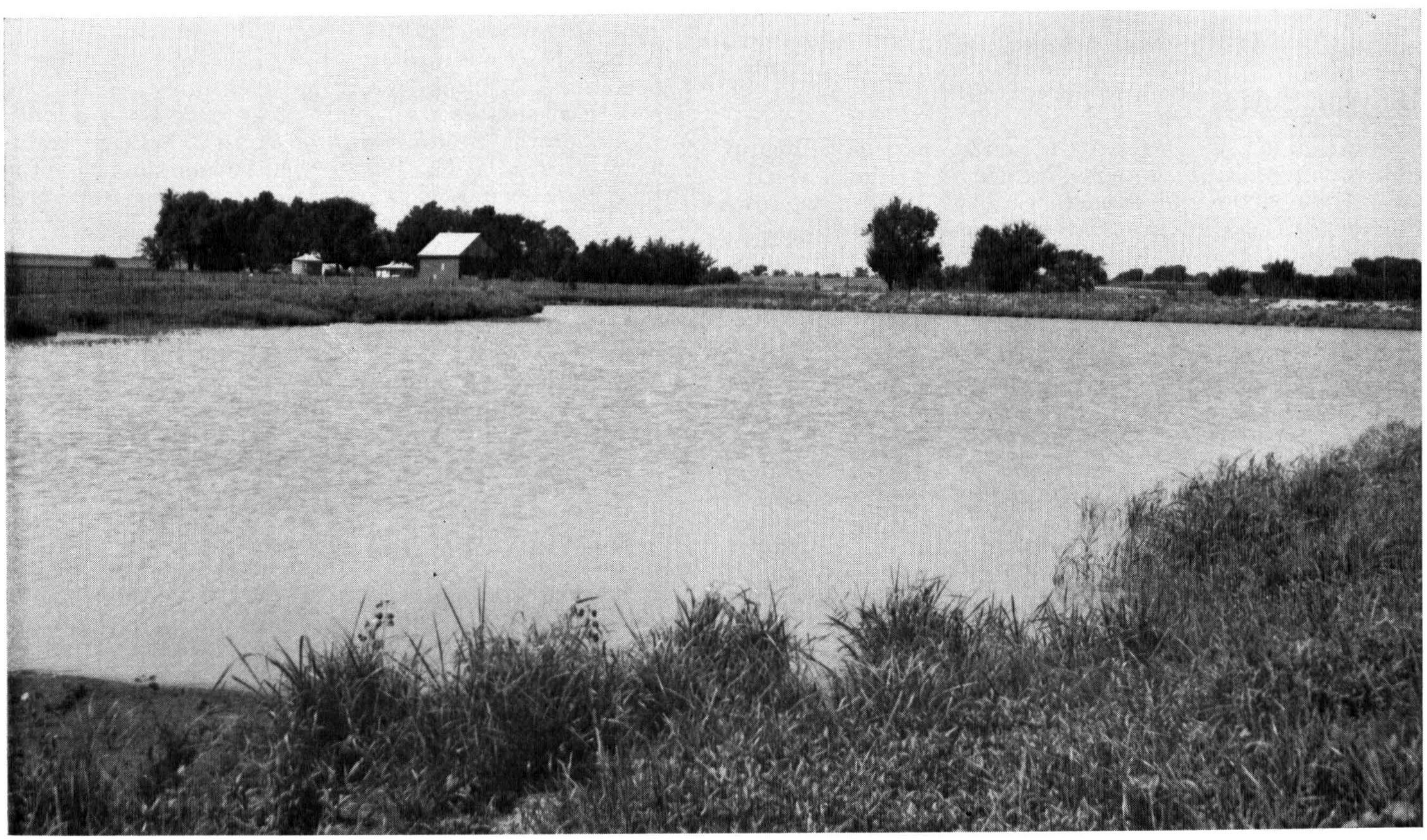

Figure 4.—A farm pond in an area of Breaks-Alluvial land complex. The pond supplies water for livestock and provides habitat for fish and other kinds of wildlife.

Figure 5.—**Soil profile of Cherokee silt loam.**

The A1 or Ap horizon ranges from dark gray (10YR 4/1) to grayish brown (10YR 5/2) in color when moist and from 4 to 10 inches in thickness. The A2 horizon ranges from gray to grayish brown or light gray in color when moist and from 3 to 8 inches in thickness. Texture of these two horizons is silt loam. The B horizon ranges from 15 to 40 inches in thickness. Thickness of the solum ranges from about 36 to 60 inches. Texture of horizons below the solum ranges from silty clay loam to clay.

Cherokee soils are associated on the landscape with Parsons, Bates, and Dennis soils. Cherokee and Parsons soils formed in similar material, but Cherokee soils have a lighter colored A1 or Ap horizon than Parsons soils. Cherokee soils are deeper and have a more clayey Bt horizon than Bates soils. They are lighter colored throughout the A horizon and have a more abrupt boundary between the A and B horizons than Dennis soils.

Cherokee silt loam (0 to 1 percent slopes) (Ce).—This soil is on uplands. Slopes are smooth to slightly convex. Included in mapping were a few small areas of Parsons soils.

This soil is better suited to soybeans and small grains than to other crops, but all the common crops can be grown. In some places it is difficult to maintain good stands of alfalfa because of the somewhat poor drainage. This soil is strongly acid unless limed. Plant roots have difficulty penetrating the compact subsoil and tend to concentrate along natural cleavage faces and cracks in the subsoil. In hot weather corn and sorghum tend to wilt, even though there is still some moisture in the soil. Crop-residue management helps to maintain soil tilth and organic-matter content. Terracing is needed in some fields that have long slopes. Surface runoff is slow, and drainage is needed in some flat areas. (Capability unit IIIw-3; Clay Upland range site; not in a woodland suitability group)

Clareson Series

The Clareson series consists of moderately deep, loamy soils on uplands. These soils formed under prairie grasses in material weathered from limestone. In most places they are on broad, convex hilltops and have slopes of less than 3 percent. In some places they are at lower levels along upland drainageways. The depth to limestone ranges from 20 to 40 inches.

In a representative profile, the surface layer is very dark grayish-brown flaggy silty clay loam about 8 inches thick. The subsoil is dark reddish brown and about 19 inches thick. The upper 4 inches of the subsoil is friable, flaggy silty clay loam. The middle 11 inches is firm, flaggy silty clay that contains about 40 to 50 percent limestone fragments. The lower 4 inches is very firm, flaggy silty clay that contains about 40 to 50 percent limestone fragments. The underlying material is limestone that has a few cracks and fracture seams.

Clareson soils are well drained. Permeability is moderately slow, and the available water capacity is low to moderate. Fertility is moderate.

Representative profile of Clareson flaggy silty clay loam, 0 to 3 percent slopes, in a native grass pasture, 800 feet south and 400 feet east of the northwest corner of the NE¼ sec. 5, T. 28 S., R. 24 E.

A1—0 to 8 inches, very dark grayish-brown (10YR 3/2) flaggy silty clay loam, dark grayish brown (10YR 4/2) when dry; moderate, medium, granular structure; hard when dry, friable when moist; many fine roots; limestone fragments make up 15 to 25 percent of the volume; medium acid; gradual, smooth boundary.

B1—8 to 12 inches, dark reddish-brown (5YR 3/2) flaggy silty clay loam, dark reddish gray (5YR 4/2) when dry; moderate, medium, granular structure; hard when dry, friable when moist; many fine roots; limestone fragments make up 20 to 30 percent of the volume; medium acid; gradual, smooth boundary.

B2t—12 to 23 inches, dark reddish-brown (5YR 3/3) flaggy silty clay, reddish brown (5YR 4/3) when dry; moderate, medium, subangular blocky structure; very hard when dry, firm when moist; common fine roots; limestone fragments make up 40 to 50 percent of the volume; slightly acid; gradual, smooth boundary.

B3—23 to 27 inches, dark reddish-brown (5YR 3/3) flaggy silty clay, reddish brown (5YR 4/3) when dry; common, medium, faint, dark-red (2.5YR 3/6) mottles; weak, medium, subangular blocky structure; very hard when dry, very firm when moist; few black shot concretions; common black stains; limestone fragments make up 40 to 50 percent of the volume; neutral; abrupt, wavy boundary.

R—27 inches, limestone that contains a few cracks and fracture seams.

The A1 horizon ranges from very dark brown to very dark grayish brown in hues 7.5YR and 10YR when moist, and from 6 to 10 inches in thickness. Texture of the A1 horizon is flaggy silty clay loam; the clay content ranges from about 27 to 35 percent. The B1 horizon is slightly more clayey than the A1 horizon and ranges from 2 to 10 inches in thickness. Clay content of the B2t horizon ranges from about 35 to 50 percent. Thickness of the solum and depth to bedrock range from 20 to 40 inches. The amount of flaggy and stony limestone fragments in the B2 and B3 horizons ranges from about 35 to 90 percent.

Clareson soils are associated on the landscape with Lula, Zaar, and Ringo soils. They are more stony and not so deep as Lula soils. They have a more granular A1 horizon than Zaar soils, are more stony, and are not so deep as those soils. Clareson soils are more stony and less sloping than Ringo soils.

Clareson flaggy silty clay loam, 0 to 3 percent slopes (Cf).—This soil has convex slopes and is on uplands. It occurs mostly in a position above the level of associated soils, but in some places it is below the level of Lula soils in areas where the upland hillcrest is wide.

Included in mapping were some small areas where slopes are up to 5 percent; some small areas of Lula, Ringo, and Zaar soils; and a few areas of shallow soils. Also included were a few areas of soils similar to Clareson soils, except that they lack flaggy limestone in the surface layer.

Nearly all of the acreage is used as range or meadow (fig. 6) because of the stones in the surface layer. Proper range use and management help to keep the range in good condition. Weeds and brush tend to invade the overgrazed areas. Surface runoff is medium. The high stone content and moderate depth of this soil limit the available water capacity. Only a few of the less stony areas are cultivated. (Capability unit VIe-3; Shallow Flats range site; not in a woodland suitability group)

Dennis Series

The Dennis series consists of deep, loamy soils on uplands. Slopes are 1 to 7 percent. These soils formed under prairie grasses in material weathered from intermixed clayey and sandy shale.

In a representative profile, the surface layer is very dark grayish-brown silt loam about 12 inches thick. The subsoil is 48 inches thick. In sequence from the top, the upper 5 inches of the subsoil is firm, dark-brown silty clay loam. The next 15 inches is very firm, brown clay. The next 14 inches is very firm, yellowish-brown and gray clay. The lower 14 inches is very firm, light brownish-gray light clay.

Dennis soils are moderately well drained, and their permeability is slow. The available water capacity is high. Fertility is moderate.

Representative profile of Dennis silt loam, 1 to 4 percent slopes, in a cultivated field, 600 feet north and 100 feet east of the southwest corner of sec. 15, T. 31 S., R. 24 E.

Figure 6.—A good stand of native grass on a Clareson flaggy silty clay loam.

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; weak, fine, granular structure; hard when dry, friable when moist; common fine roots; slightly acid; clear, smooth boundary.

A1—7 to 12 inches, very dark grayish-brown (10YR 3/2) silt loam; grayish brown (10YR 5/2) when dry; weak, fine, granular structure; hard when dry, friable when moist; few fine roots; strongly acid; gradual, smooth boundary.

B1—12 to 17 inches, dark-brown (10YR 3/3) silty clay loam, brown (10YR 5/3) when dry; few, fine, faint, yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; hard when dry, firm when moist; strongly acid; gradual, smooth boundary.

B21t—17 to 32 inches, brown (10YR 4/3) clay, brown (10YR 5/3) when dry; many, medium, distinct, yellowish-brown (10YR 5/6) and red (2.5YR 4/6) mottles; weak, medium, blocky structure; very hard when dry, very firm when moist; strongly acid; gradual, smooth boundary.

B22t—32 to 46 inches, mottled yellowish-brown (10YR 5/6) and gray (10YR 5/1) clay, brownish yellow (10YR 6/6) and gray (10YR 6/1) when dry; weak, medium, subangular blocky structure; very hard when dry, very firm when moist; common, medium, faint, dark-gray (10YR 4/1) stains; medium acid; gradual, smooth boundary.

B3—46 to 60 inches, light brownish-gray (10YR 6/2) light clay, light gray (10YR 7/2) when dry; many, coarse, distinct, yellowish-brown (10YR 5/6) mottles; very weak, subangular blocky structure; very hard when dry, very firm when moist; common black stains; medium acid; diffuse boundary.

The A horizon when moist ranges from very dark grayish brown to dark brown in hue 10YR; values and chromas range from 2 to 3. Texture of the A horizon is dominantly silt loam but ranges to loam. Total thickness of the A horizon ranges from about 8 to 15 inches. Mottling of the Bt horizon varies in both amount and color, but in most places is distinct in shades of yellowish brown and reddish brown. Texture of the B horizon ranges from clay loam to clay. In some places the lower part of the B horizon is underlain by a C horizon that is coarsely mottled with colors that range from gray to strong brown. In a few places there are thin strata of sandstone in the lower part of the profile. Depth to unweathered shale is more than 60 inches.

In mapping units Df and Dh, the surface layer is thinner than is defined as the range for the series.

Dennis soils are associated on the landscape with Bates, Parsons, Cherokee, and, in some places, Hector soils. They are deeper and more clayey in the Bt horizon than Bates soils. They lack the light-colored A2 horizon and abrupt A to Bt horizon boundary of Parsons and Cherokee soils. Dennis soils are deeper than Hector soils, and they have a B2t horizon that is lacking in Hector soils.

Dennis silt loam, 1 to 4 percent slopes (De).—This soil is on hilltops and side slopes. It has the profile described as representative of the series. Slopes are convex.

Included in mapping were a few small areas of Bates soils, as well as small areas of Parsons soils.

This soil is well suited to corn, wheat, soybeans, sorghum, alfalfa, and all the other crops commonly grown in the county. Surface runoff is medium, and erosion is a hazard. Crop-residue management, terracing, and contour farming help to control erosion. (Capability unit IIe–1; Loamy Upland range site; not in a woodland suitability group)

Dennis silt loam, 1 to 4 percent slopes, eroded (Df).—This soil has convex slopes and is on side slopes on uplands. The profile of this soil is similar to that of the soil described as representative for the series, except that the surface layer has been thinned by erosion. The present surface layer is firm, very dark grayish-brown or dark-brown light silty clay loam or heavy silt loam. It consists of part of the original surface layer mixed with material from the subsoil. The surface layer is less friable and more difficult to keep in good tilth than the surface layer of less eroded Dennis soils.

Included in mapping were a few small, severely eroded areas that have a surface layer of brown heavy silty clay loam.

This soil is suited to corn, wheat, soybeans, sorghum, alfalfa, and all the other crops commonly grown in the county. Surface runoff is medium, and erosion has caused this soil to be slightly difficult to till under some moisture conditions. Terracing, crop-residue management, and contour farming help to check additional erosion. Working crop residue into the soil improves tilth and helps maintain fertility. (Capability unit IIIe–8; Loamy Upland range site; not in a woodland suitability group)

Dennis silt loam, 4 to 7 percent slopes (Dg).—This soil has convex slopes and is on uplands. The profile is similar to that of the soil described as representative for the series, except that the A1 horizon is slightly thinner.

Included in mapping were some small areas where the slope range is less or greater than that described for this soil. Also included were a few small areas of Bates soils.

This soil is suited to corn, wheat, soybeans, sorghum, alfalfa, and all other crops commonly grown in the county. Surface runoff is medium to rapid. Because of the slope, intensive conservation measures, such as terracing, contour farming, and crop-residue management, are used to control erosion in cultivated fields. (Capability unit IIIe–3; Loamy Upland range site; not in a woodland suitability group)

Dennis silt loam, 4 to 7 percent slopes, eroded (Dh).—This soil has convex slopes and is on uplands. The profile is similar to that described as representative for the series, except that the surface layer has been thinned by erosion. The present surface layer is firm, very dark grayish-brown or dark-brown light silty clay loam or heavy silt loam. It consists of part of the original surface layer mixed with material from the subsoil. The surface layer is less friable and more difficult to keep in good tilth than the surface layer of less eroded Dennis soils.

Included in mapping were a few small, severely eroded areas that have a surface layer of brown heavy silty clay loam.

This soil can be used for all crops common in the county, but it is better suited to wheat, soybeans, and sorghum. Surface runoff is medium. Intensive conservation measures, such as terracing, contour farming, and crop-residue management, help to control erosion and maintain fertility. (Capability unit IIIe–9; Loamy Upland range site; not in a woodland suitability group)

Dennis-Parsons silt loams, 1 to 4 percent slopes (Dp).—This complex occupies uplands where the slopes are convex. Dennis soils make up about 45 percent of the acreage; Parsons soils, about 30 percent; Lula and similar soils, about 10 percent; and slickspot areas, about 6 percent. The rest consists of Zaar and Ringo soils and soils similar to Parsons soils, except that they lack an A2 horizon and are more shallow over the clay subsoil.

The Dennis soils in this complex have a profile similar to that described as representative for the series, except that they are more clayey and are slightly less sandy. Also, about one-fourth of the acreage of Dennis soils is underlain by limestone at a depth of about 55 to 60 inches. The Parsons soils in this complex have a profile similar to that described as representative for the series, except that the A horizon is less than 12 inches thick and the A2 horizon is thin or faint. About 20 percent of the acreage of these soils is underlain by limestone at a depth of 50 to 60 inches.

Runoff is medium. In some of the slickspot areas the subsoil is dispersed and is very slowly permeable. When these slickspot areas are dry, they have a thin, light-colored crust.

This complex is suited to corn, wheat, sorghum, soybeans, alfalfa, and most other crops commonly grown in the county. It is sometimes difficult to get good stands on the slickspot areas. Consequently, crop growth is uneven during the drier parts of the growing season. In most places the individual slickspots are less than 2 acres in size, occur in irregular patterns in the field, and are droughty and somewhat difficult to till. Terracing and contour farming help to control erosion. Management of crop residue helps to maintain tilth and control erosion. (Capability unit IIIe-5; Dennis soils are in Loamy Upland range site; Parsons soils are in Clay Upland range site; not in a woodland suitability group)

Eroded Land

Eroded land, 3 to 10 percent slopes (Er) consists of severely eroded, loamy soils on uplands. Texture of the surface layer is dominantly clay loam or silty clay loam. In a few places the texture is clay. The depth to shale or sandstone is variable, but in most places it is less than 30 inches. Shale or fragmented sandstone is exposed in places, and there are gullies in some areas. Slopes are dominantly 3 to 10 percent, but included are some areas where the slope is 10 to 15 percent. The landscape is similar to that on which the Bates, Dennis, Bolivar, Hector, and Ringo soils occur.

Most of the areas are abandoned cropland and are used for grazing or are idle. The major limitations are severe erosion, low fertility, excessive runoff, and limited soil depth. (Capability unit VIe-1; Eroded Loamy Upland range site; not in a woodland suitability group)

Girard Series

The Girard series consists of moderately deep, loamy soils on narrow bottom lands of drainageways. Slopes range from 0 to 1 percent. These soils formed under prairie grasses in clayey alluvial sediments. Depth to the underlying bedrock is 20 to 40 inches. In most places the bedrock is fragmented limestone, but in some places it is hard black shale.

In a representative profile, the surface layer is silty clay loam about 17 inches thick. The upper 6 inches is very dark gray, and the lower 11 inches is black. The subsoil is silty clay about 17 inches thick. The upper 11 inches is firm and black, and the lower 6 inches is very firm and very dark gray and contains some fine, distinct, yellowish-brown mottles. In some places the lower part of the subsoil contains small chert fragments and round concretionary nodules.

Girard soils are poorly drained and have low to moderate available water capacity. They are subject to flooding for short periods. Small local wet spots occur as a result of a perched water table over impervious rock. Permeability is slow. Fertility is moderate.

Representative profile of Girard silty clay loam, under grass, 1,200 feet south and 300 feet east of the northwest corner of sec. 13, T. 30 S., R. 23 E.

A11—0 to 6 inches, very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) when dry; weak and moderate, medium, granular structure; hard when dry, friable when moist; medium acid; gradual, smooth boundary.

A12—6 to 17 inches, black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) when dry; moderate, medium, granular structure; hard when dry, friable when moist; a few shiny ped surfaces; medium acid; gradual, smooth boundary.

B1—17 to 28 inches, black (10YR 2/1) silty clay, very dark gray (10YR 3/1) when dry; weak, medium, subangular blocky structure; very hard when dry, firm when moist; shiny ped surfaces; slightly acid; gradual, smooth boundary.

B2—28 to 34 inches, very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) when dry; few to common, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; very hard when dry, very firm when moist; shiny ped surfaces; few, faint, very thin, patchy clay films; common small chert or coral fragments less than 10 millimeters in diameter; few round concretionary nodules that do not react to 10 percent hydrochloric acid; few, small, black shot concretions; neutral; abrupt, wavy boundary.

R—34 inches, fragmented limestone.

The A1 horizon ranges from very dark gray to very dark brown or black in color and from silty clay loam to light silty clay in texture. The thickness of the A horizon ranges from 12 to 22 inches. The B horizon ranges from very dark gray to black when moist. Texture of this horizon ranges from silty clay to clay. The difference in clay content between any two adjoining horizons in these soils is generally less than 5 percent. Depth to fragmented limestone or interbedded shale ranges from 20 to 40 inches.

Girard soils are associated on the landscape with Osage, Zaar, Hepler, McCune, and Radley soils. Girard soils are not so deep or so clayey as Osage soils, which occur on the flood plains of larger streams. Girard soils are not so deep, so sloping, or so clayey in the B horizon as Zaar soils of the surrounding uplands. They are darker in color, more clayey, and not so deep as Hepler, McCune, and Radley soils of the larger flood plains.

Girard silty clay loam (0 to 1 percent slopes) (Gd).—This soil occupies long, narrow bottoms of small upland drainageways. In most places Zaar soils are on the adjoining uplands. Width of the areas is commonly 200 to 400 feet but is as much as 600 feet in areas where stream channels join or where meandering of stream channels is pronounced. In most places the channel is 2 to 3 feet deep and is underlain by fragmented limestone or hard black shale. This soil is subject to flooding.

Included in mapping were small areas of Zaar, Osage, Clareson, and Hepler soils. Also included were a few gently sloping streambanks.

This soil is used mainly for grazing. Little of the acreage is cultivated. Proper range use helps to keep brush, undesirable grasses, and weeds from invading. In cultivated areas limitations are poor drainage, flooding, and a seasonal perched high water table. Excessive wetness makes tillage difficult. (Capability unit IIIw-2; Clay Lowland range site; woodland suitability group 2)

Hector Series

The Hector series consists of shallow, loamy soils on uplands. Slopes are 5 to 12 percent. These soils formed in material weathered from sandstone and are on the fringes and tops of narrow rolling hills. The depth to bedrock is 4 to 20 inches. Native vegetation is low-growing hardwood trees and grasses. In this county these soils are mapped only in a complex with Bolivar soils.

In a representative profile, the surface layer is very dark grayish-brown silt loam about 2 inches thick. The subsoil is friable, brown heavy silt loam about 10 inches thick. The underlying material is hard, fragmented sandstone.

Hector soils are well drained to somewhat excessively drained. Permeability is moderate, and available water capacity is very low. Fertility is low.

Representative profile of Hector silt loam, in an area of Bolivar-Hector complex, 5 to 12 percent slopes, in a wooded area, 520 feet south and 1,400 feet west of the northeast corner of the SE¼ sec. 11, T. 28 S., R. 25 E.

O1—¼ inch to 0, partly decomposed leaves, twigs, and vegetative matter.

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

B2—2 to 12 inches, brown (10YR 4/3) heavy silt loam, pale brown (10YR 6/3) when dry; weak, medium subangular blocky structure; hard when dry, friable when moist; common fine roots; strongly acid; abrupt, wavy boundary.

R—12 inches, hard, fragmented sandstone.

Depth to underlying sandstone ranges from about 4 to 20 inches, but it is dominantly more than 10 inches. Scattered, irregularly shaped sandstone fragments are common on the surface.

Hector soils are associated on the landscape with Bolivar, Bates, Dennis, and, in some places, Ringo soils. They are not so deep as Bolivar, Bates, and Dennis soils, and they lack a B2t horizon. Hector soils are not so deep as Ringo soils and are generally more stony than those soils.

Hepler Series

The Hepler series consists of deep, loamy soils on bottom lands. Slopes are 0 to 1 percent. These soils formed in alluvium washed from the surrounding uplands. Native vegetation is grasses and hardwood trees.

In a representative profile, the surface layer is very dark grayish-brown silt loam about 8 inches thick. The subsurface layer is friable, dark grayish-brown silt loam about 14 inches thick. The subsoil is about 29 inches thick. The upper 13 inches of the subsoil is very firm, dark grayish-brown silty clay loam, and the lower 16 inches is very firm, dark-gray heavy silty clay loam. In most places the underlying material is massive heavy silty clay loam that is coarsely mottled with gray and yellowish brown.

Hepler soils are somewhat poorly drained, permeability is moderately slow, and available water capacity is high. Fertility is low. These soils are subject to flooding.

Representative profile of Hepler silt loam, in a cultivated field, 800 feet east and 900 feet north of the southwest corner of sec. 21, T. 29 S., R. 23 E.

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; weak, fine, granular structure; slightly hard when dry, friable when moist; slightly acid; clear, smooth boundary.

A21—8 to 18 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) when dry, grayish brown (10YR 5/2) when rubbed; common, medium, faint, gray (10YR 6/1) and brown (10YR 4/3) mottles; weak, medium, subangular blocky structure; slightly hard when dry, friable when moist; few, small, black concretions; strongly acid; gradual, smooth boundary.

A22—18 to 22 inches, dark grayish-brown (10YR 4/2) heavy silt loam, light brownish gray (10YR 6/2) when dry, grayish brown (10YR 5/2) when rubbed; few, fine, faint, dark yellowish-brown (10YR 4/4) mottles; weak, medium, subangular blocky structure; hard when dry, friable when moist; few shiny ped surfaces; strongly acid; gradual, smooth boundary.

B2t—22 to 35 inches, dark grayish-brown (10YR 4/2) silty clay loam, grayish brown (10YR 5/2) when dry; common, fine, faint, dark yellowish-brown (10YR 4/4) mottles; few, medium, distinct, gray (10YR 6/1) mottles; weak, medium, subangular blocky structure; very hard when dry, very firm when moist; strongly acid; gradual, smooth boundary.

B3—35 to 51 inches, dark-gray (10YR 4/1) heavy silty clay loam, gray (10YR 5/1) when dry; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; very weak, medium, subangular blocky structure; very hard when dry, very firm when moist; few, small, black shot concretions; medium acid; diffuse boundary.

C—51 to 60 inches, gray (10YR 5/1) heavy silty clay loam, little color change when dry; many, coarse, distinct, yellowish-brown (10YR 5/8) mottles; massive; very hard when dry, very firm when moist; slightly acid.

The surface layer ranges from very dark brown to very dark grayish brown in color and and from 6 to 10 inches in thickness. The A2 horizon ranges from dark grayish brown to grayish brown in color. The combined thickness of the Ap and A2 horizons ranges from about 16 to 30 inches. Texture of the Bt horizon is silty clay loam with a clay content slightly less than 35 percent. Texture of the B3 and C horizons ranges from silty clay loam to light silty clay. The C horizon is coarsely mottled and has black stains in places.

Hepler soils are associated on the landscape with McCune, Radley, Osage, and Girard soils. Hepler soils have a darker colored Ap horizon than McCune soils. Hepler soils differ from Radley soils by having a Bt horizon. Hepler soils are less clayey in all horizons than Osage and Girard soils.

Hepler silt loam (0 to 1 percent slopes) (He).—This soil is on flood plains and low stream terraces.

Included in mapping were some small areas of Radley and McCune soils. Also included were a few small areas where slopes are more than 1 percent.

This soil is suited to corn, wheat, sorghum, soybeans, and all other crops commonly grown in the county. It is subject to flooding, and some local areas need surface drainage. Good management practices, such as returning crop residue to the soil, help to maintain soil fertility and to improve tilth. (Capability unit IIw-1; Loamy Lowland range site; woodland suitability group 1)

Lula Series

The Lula series consists of deep, loamy soils on uplands (fig. 7). Slopes are 1 to 3 percent. These soils formed under prairie grasses in material weathered from limestone. Depth to limestone bedrock ranges from 40 to 60 inches, and the limestone ranges from 2 to 6 feet or more in thickness.

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

In a representative profile, the surface layer is heavy silt loam about 9 inches thick. The upper 6 inches is dark brown, and the lower 3 inches is very dark brown. The subsoil is about 36 inches thick and consists of three layers. In sequence from the top, the upper 6 inches is friable, dark reddish-brown silty clay loam; the next 8 inches is firm, yellowish-red silty clay loam; and the lower 22 inches is very firm, dark-red heavy silty clay loam and silty clay. The underlying material is limestone bedrock.

Lula soils are well drained and have high available water capacity. Permeability is moderate, and fertility is moderate.

Representative profile of Lula silt loam, 1 to 3 percent slopes, in a cultivated field, 660 feet north and 240 feet east of the southwest corner of the NW1/4 sec. 34, T. 30 S., R. 23 E.

Ap—0 to 6 inches, dark-brown (7.5YR 3/2) heavy silt loam, brown (7.5YR 4/2) when dry; weak, medium, granular structure; slightly hard when dry, friable when moist; slightly acid; clear, smooth boundary.

A1—6 to 9 inches, very dark brown (7.5YR 2/2) heavy silt loam, dark brown (7.5YR 3/2) when dry; strong, medium, granular structure; hard when dry, friable when moist; medium acid; gradual, smooth boundary.

B1—9 to 15 inches, dark reddish-brown (5YR 3/2) silty clay loam, dark reddish gray (5YR 4/2) when dry; few, fine, faint, dark-red (2.5YR 3/6) mottles; strong, medium, granular structure; hard when dry, friable when moist, medium acid; gradual, smooth boundary.

B21t—15 to 23 inches, yellowish-red (5YR 3/6) silty clay loam, reddish brown (5YR 4/4) when dry; few, fine, faint, dark-red (2.5YR 3/6) mottles; strong, medium, granular structure; hard when dry, firm when moist; few small coral fragments; thin, continuous clay films; few, very small, black shot concretions; medium acid; gradual, smooth boundary.

B22t—23 to 40 inches, dark-red (2.5YR 3/6) heavy silty clay loam, little color change when dry; weak, medium, subangular blocky structure; very hard when dry, very firm when moist; few small coral or chert fragments; common, small, black shot concretions; few black stains; continuous clay films; medium acid; gradual, smooth boundary.

B3—40 to 45 inches, dark-red (2.5YR 3/6) silty clay, no color change when dry; weak, medium, subangular blocky structure; very hard when dry, very firm when moist; many black stains and black shot concretions; common small chert fragments; neutral; abrupt, wavy boundary.

R—45 inches, limestone bedrock.

The A1 horizon ranges from very dark brown to very dark grayish brown or dark brown in hues 10YR through 5YR. The texture is dominantly silt loam but ranges to light silty clay loam. This horizon ranges from 6 to 14 inches in thickness. In most places the B1 horizon is dark reddish-brown silty clay loam that ranges from 4 to 12 inches in thickness. The A1 and B1 horizons have strong granular structure in most places. When moist, the B2t horizon ranges from dark brown or dark reddish brown to reddish brown, red, or yellowish red in color. Texture of the B21t horizon ranges from light silty clay loam to medium silty clay loam. Texture of the B22t horizon ranges from light silty clay loam to light silty clay. Reaction of the B2t horizon ranges from medium acid to neutral. The B3 horizon ranges from 2 to 8 inches in thickness, is dominantly neutral in reaction, and is slightly more compact than the horizon above. The solum is more than 40 inches thick, and depth to limestone bedrock is less than 60 inches.

Lula soils are associated on the landscape with Zaar and Clareson soils. They are more granular and have a less clayey A1 horizon than Zaar soils. Lula soils are deeper and less stony than Clareson soils.

Lula silt loam, 1 to 3 percent slopes (Ls).—This soil is on the upper crests of broad convex slopes of limestone uplands. In most places it occurs in a position slightly above adjacent soils. The profile is the one described as representative for the series.

Included in mapping were a few small areas of Clareson, Dennis, and Zaar soils.

This soil is suited to all crops commonly grown in the county, including corn, wheat, sorghum, soybeans, and alfalfa. Surface runoff is slow to medium. Erosion is a hazard on this soil, and crop-residue management, terraces, and contour farming are needed to control it. The soil takes in water well and is relatively easy to till. (Capability unit IIe-3; Loamy Upland range site; not in a woodland suitability group)

Lula silty clay loam, 1 to 3 percent slopes, eroded (Lt).—This soil occurs at the heads of small upland drainageways or in the more sloping areas of Lula soils. It commonly occurs along the edges of areas of Lula silt loam where the slightly increased slope has favored sheet erosion.

The profile of this soil is similar to that of the soil described as representative for the series, except that water erosion has thinned the original surface layer. The present plow layer consists of part of the original surface layer mixed with material from the subsoil. The dominant surface texture is silty clay loam. Included in mapping were some small areas of uneroded Lula soils and of Clareson soils.

This soil is suited to most crops commonly grown in the county, including corn, wheat, sorghum, soybeans, and alfalfa. Surface runoff is medium. Further erosion is a hazard on this soil. Intensive use of such conservation practices as terracing, contour farming, and crop-residue management help to control erosion and improve tilth. (Capability unit IIIe-4; Loamy Upland range site; not in a woodland suitability group)

Lula-Clareson complex, 1 to 3 percent slopes (Lu).—This complex is on the crests of ridgetops in limestone uplands. The average composition is 40 percent Lula soils; 40 percent Clareson soils; and 20 percent other soils, 15 percent of which is a soil similar to the Clareson soil except that the depth to limestone is less than 20 inches. The Clareson and Lula soils have profiles similar to those described as representative for their respective series. The included soil that is similar to the Clareson soil, in addition to having less depth to limestone, has a slightly less clayey surface layer than Clareson soils.

This complex is suited to most crops commonly grown in the county, including wheat, soybeans, sorghum, and alfalfa. Surface runoff is medium. Erosion is a hazard, and such measures as crop-residue management, terracing, and contour farming are needed to control it. (Capability unit IIIe-4; Lula soils are in Loamy Upland range site; Clareson soils are in Shallow Flats range site; not in a woodland suitability group)

McCune Series

The McCune series consists of deep, loamy soils on flood plains and low stream terraces. Slopes are 0 to 1 percent. These soils formed in alluvium washed from surrounding uplands. Native vegetation is mainly prairie grasses, but includes some hardwood trees along the stream channels.

In a representative profile, the surface layer is dark grayish-brown silt loam about 16 inches thick. In cultivated fields that have been limed, the upper 7 inches is medium acid and the lower 9 inches is strongly acid. The subsurface layer is light brownish gray and about 14 inches thick. The upper 9 inches of the subsurface layer is friable silt loam, and the lower 5 inches is friable to firm heavy silt loam. The subsoil is firm silty clay loam, about 30 inches thick, that is coarsely mottled with grayish brown, dark gray, gray, and yellowish brown.

McCune soils are somewhat poorly drained. Permeability is slow, and available water capacity is high. Fertility is low. These soils are subject to flooding.

Representative profile of McCune silt loam, in a cultivated field, 700 feet east and 200 feet north of the southwest corner of sec. 14, T. 30 S., R. 25 E.

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) when dry; weak, fine, granular structure; slightly hard when dry, friable when moist; few, small, gray-coated (10YR 5/1) concretions; medium acid; clear, smooth boundary.

A1—7 to 16 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) when dry; few, fine, very faint, dark yellowish-brown (10YR 4/4) mottles; weak, subangular blocky structure and fine, granular structure; slightly hard when dry, friable when moist; few, small, gray-coated (10YR 5/1) concretions; strongly acid; gradual, smooth boundary.

A2—16 to 25 inches, light brownish-gray (10YR 6/2) silt loam, light gray (10YR 7/2) when dry; common, medium, distinct, dark yellowish-brown (10YR 4/4) mottles; weak, medium, subangular blocky structure that crushes easily to weak, fine and medium, granular structure; slightly hard when dry, friable when moist; common, small, yellowish-brown (10YR 5/6) concretions coated with gray (10YR 5/1); few, small, ferromanganese concretions; common very fine pores; strongly acid; gradual, smooth boundary.

A&B—25 to 30 inches, light brownish-gray (10YR 6/2) heavy silt loam, light gray (10YR 7/2) when dry; common, medium, distinct, dark yellowish-brown (10YR 4/4) mottles; weak, medium, subangular blocky structure; hard when dry, friable when moist; few dark stains with indications of faint, very thin clay films; strongly acid; gradual, smooth boundary.

B2t—30 to 46 inches, coarsely mottled grayish-brown (10YR 5/2), dark-gray (10YR 4/1), and yellowish-brown (10YR 5/6) silty clay loam; light brownish gray (10YR 6/2), dark gray (10YR 4/1), and yellowish brown (10YR 5/6) when dry; weak, medium, blocky structure; hard when dry, firm when moist; strongly acid; gradual, smooth boundary.

B3—46 to 60 inches, coarsely mottled grayish-brown (10YR 5/2), gray (10YR 5/1), and yellowish-brown (10YR 5/6) silty clay loam; very weak, subangular blocky structure; hard when dry, firm when moist; strongly acid; diffuse, smooth boundary.

Color of the A1 horizon when moist ranges from dark grayish brown to grayish brown or brown in hue 10YR. Thickness of the A1 horizon, together with the Ap horizon where present, ranges from 10 to 20 inches. Color of the A2 horizon when moist ranges from grayish brown to light gray in hue 10YR. The A2 horizon is commonly mottled with dark yellowish brown. The A&B horizon ranges from 2 to 7 inches in thickness and is weak or lacking in some places. Dominant texture of the subsoil is silty clay loam, with a clay content of 27 to 35 percent. Thickness of the solum ranges from about 40 to 60 inches.

McCune soils are associated on the landscape with Hepler, Radley, and Osage soils. McCune and Girard soils are on somewhat similar landscapes. McCune soils have a lighter colored Ap horizon than Hepler soils. They have a lighter colored Ap or A1 horizon than Radley soils, and, in addition, have a B2t horizon, which Radley soils lack. McCune soils have a lighter colored and less clayey Ap or A1 horizon than Osage soils. They are deeper than Girard soils and have a lighter colored Ap or A1 horizon than those soils.

McCune silt loam (0 to 1 percent slopes) (Mc).—This soil is on low stream terraces of Cow Creek in the southeastern part of the county. It is subject to flooding. Included in mapping were small areas of Hepler and Radley soils.

This soil is suited to corn, sorghum, soybeans, wheat, and other cultivated crops. Surface runoff is slow, and drainage is needed in the lower areas at times. (Capability unit IIw-1; Loamy Lowland range site; woodland suitability group 1)

Mine Pits and Dumps

Mine pits and dumps (Md) consists of rough, irregular piles of waste shale, rock, overturned earth, pits, and associated disturbed areas that result from strip mining of coal. They are dominantly in the eastern and southern parts of the county (fig. 8).

Some of the larger areas cover several hundred acres. They vary greatly in the kind of material and its arrangement. The surface material is mixed, but the

***Figure 8.*—Strip mining of coal in an area southeast of Pittsburg.**

amount of rock, shale, or soil exposed at a given location depends on the kind of material that was dug up in the mining operation. Surface material and soil reaction vary greatly within short distances. Most of the larger strip mined areas have alternating elongated peaked ridges and steep V-shaped valleys. There are deep pits along the edge of the area where the excavations have been made. Included are small areas of dumps from deep-shaft coal mining and a few quarries and borrow pits.

This land type is used mainly for wildlife habitat, recreation, and limited livestock grazing. The water-filled pits (fig. 9) provide good fishing areas and, where accessible, water for livestock. Runoff is rapid on the ridges, with variable ponding of water between ridges. Natural vegetation on the older and more weathered areas consists of scattered patches of brush, weeds, grasses, and trees, such as cottonwood and elm. A few areas have been seeded to lespedeza and sweetclover, which grow reasonably well in some places. Most of the spoil banks are droughty. A few trial plantings of cedar, pine, and walnut trees have been made, but in most places tree growth is slow as compared to tree growth on undisturbed soils. (Capability unit VIIs-1; not in a range site or woodland suitability group)

Osage Series

The Osage series consists of deep, clayey soils on bottom lands. These soils formed in clayey alluvium. Slopes are 0 to 1 percent. Vegetation is mainly prairie grasses and sedges but includes some hardwood trees.

In a representative profile, the surface layer is black clay about 15 inches thick. The next layer is very firm, very dark gray clay about 15 inches thick. The underlying material has common, medium, distinct, dark yellowish-brown or yellowish-brown mottles, is extremely firm, and is neutral. It is dark-gray clay in the upper 12 inches and massive gray clay below that depth.

Osage soils are poorly drained, and permeability is very slow. They have high available water capacity and moderate fertility. These soils are subject to flooding.

Representative profile of Osage clay, in a tame grass pasture, 540 feet west and 150 feet north of the center of sec. 8, T. 30 S., R. 23 E.

A1—0 to 15 inches, black (10YR 2/1) clay, dark gray (10YR 4/1) when dry; weak, medium, granular structure; hard when dry, firm when moist; few worm casts; common fine roots; gradual, smooth boundary.

AC—15 to 30 inches, very dark gray (10YR 3/1) clay, gray (10YR 5/1) when dry; few, fine, faint, yellowish-brown (10YR 5/6) mottles at a depth below 24 inches; weak, medium, subangular blocky structure; very hard when dry, very firm when moist; few fine roots, neutral; diffuse boundary.

C1—30 to 42 inches, dark-gray (10YR 4/1) clay, gray (10YR 5/1) when dry; common, medium, distinct, dark yellowish-brown (10YR 4/4) mottles; very weak, subangular blocky structure; extremely hard when dry, extremely firm when moist; few, small (in most places, less than 5 millimeters), hard lime concretions; few black shot concretions; neutral; diffuse boundary.

C2—42 to 60 inches, gray (10YR 5/1) clay, gray (10YR 6/1) when dry; common, medium, distinct, yellowish brown (10YR 5/6) mottles; massive; extremely hard when dry, extremely firm when moist; few, hard, small lime concretions; neutral.

Figure 9.—Water-filled pit in an area that has been strip mined.

Color of the A1 horizon when moist ranges from black to very dark gray in hue 10YR. Texture ranges from silty clay to clay, and reaction ranges from slightly acid to neutral. The AC horizon is clay, with the moist color centering around very dark gray in hue 10YR. Color of the C horizon when moist ranges from dark gray to gray in hue 10YR or hue 2.5Y. The C horizon has faint or distinct mottles.

Osage soils are level to very slightly depressional and are on flood plains. They are associated on the landscape with Radley, Hepler, and McCune soils. The landscape is similar to that on which the Girard soils occur. Osage soils are more clayey throughout, especially in the A horizon, than Radley, Hepler, McCune, and Girard soils. They are deeper than Girard soils.

Osage clay (0 to 1 percent slopes) (Os).—This soil is on low flood plains and is subject to flooding.

Included in mapping were a few small areas of Hepler, Radley, and Zaar soils.

This soil is poorly suited to alfalfa, but it can be used for most other crops common in the county. In years of high rainfall, crops drown out in low spots. Drainage ditches or bedding helps remove excess water. High clay content, very slow permeability, and wetness make this soil difficult to cultivate. Vegetation in uncultivated areas is hardwood trees, grasses, and sedges. (Capability unit IIIw-1; Clay Lowland range site; woodland suitability group 2)

Parsons Series

The Parsons series consists of deep, loamy soils on uplands (fig. 10). Slopes are 0 to 3 percent. Parsons soils formed under prairie grasses in material weathered from clayey shale. In some areas they have loess material in the upper part of the profile.

In a representative profile, the surface layer is very dark grayish-brown silt loam about 8 inches thick. Unless it has been limed, it is strongly acid in most places. The subsurface layer is friable, dark grayish-brown silt loam about 6 inches thick. The subsoil is extremely firm clay about 24 inches thick. The upper 14 inches of the subsoil is very dark grayish brown, and the lower 10 inches is dark grayish brown. In most places the subsoil is mottled with strong brown in the upper few inches and with yellowish brown below. The underlying material is massive, coarsely mottled, gray, light brownish-gray, and yellowish-brown heavy silty clay loam.

Parsons soils are somewhat poorly drained, and permeability is very slow. They have high available water capacity and low fertility. In most places these soils have a temporary perched water table above the clay subsoil during rainy periods.

Figure 10.—Profile of a Parsons silt loam.

Representative profile of Parsons silt loam, 1 to 3 percent slopes, in a cultivated field, 1,000 feet east and 200 feet south of the northwest corner of sec. 19, T. 29 S., R. 25 E.

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; weak, medium, granular structure; hard when dry, friable when moist; medium acid; clear, smooth boundary.

A2—8 to 14 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) when dry; weak, medium, granular structure; hard when dry, friable when moist; few very fine pores; strongly acid; abrupt, wavy boundary.

B2t—14 to 28 inches, very dark grayish-brown (10YR 3/2) clay, dark grayish brown (10YR 4/2) when dry; common, medium, distinct mottles that are strong brown (7.5YR 5/6) above a depth of 20 inches and yellowish brown (10YR 5/6) below that depth; weak, coarse, blocky structure; extremely hard when dry, extremely firm when moist; common, shiny ped surfaces; common, fine, black stains and concretions; strongly acid; gradual, smooth boundary.

B3—28 to 38 inches, dark grayish-brown (10YR 4/2) clay, grayish brown (10YR 5/2) when dry; common, medium, distinct, yellowish-brown (10YR 5/6) and gray (10YR 5/1) mottles; very weak, coarse, blocky structure; extremely hard when dry, extremely firm when moist; few, fine, black concretions; medium acid; diffuse boundary.

C1—38 to 48 inches, coarsely mottled gray (10YR 6/1) and yellowish-brown (10YR 5/6) heavy silty clay loam, light gray (10YR 7/1) and brownish yellow (10YR 6/6) when dry; massive; extremely hard when dry, very firm when moist; few black stains; medium acid; diffuse boundary.

C2—48 to 60 inches, coarsely mottled yellowish-brown (10YR 5/6), gray (10YR 6/1), and light brownish-gray (10YR 6/2) heavy silty clay loam; brownish yellow (10YR 6/6) and light gray (10YR 7/1 and 10YR 7/2) when dry; massive; very hard when dry, very firm when moist; common, fine, black concretions; medium acid.

In most places color of the moist A1 horizon is very dark grayish brown in hue 10YR. The dominant surface texture is silt loam, but it is loam in places. Thickness of the A1 horizon ranges from about 6 to 10 inches. The A2 horizon ranges from dark grayish brown to grayish brown in color when moist. Total thickness of the A horizon ranges from about 10 to 16 inches. When moist, the B2t horizon ranges from very dark brown to dark grayish brown or dark brown in hue 10YR. In most places the B2t horizon has common or many, medium, distinct mottles that range from reddish brown to strong brown and yellowish brown in color. The C horizon is coarsely mottled and, in most places, is less clayey than the B3 horizon.

Parsons soils are associated on the landscape with Cherokee, Dennis, and Bates soils. They formed in material similar to that in which Cherokee soils formed, but they have darker surface colors. Parsons soils have more strongly contrasting textural horizons and a more clayey and compact Bt horizon than Dennis and Bates soils.

Parsons silt loam, 0 to 1 percent slopes (Pa).—This soil occupies broad upland tracts.

Included in mapping were some areas of Cherokee soils and a few small areas of Dennis soils. Also included, in the southeastern part of the county, were some areas of a soil simliar to Parsons, except that the thickness of the A horizon is more than 16 inches and ranges to 20 inches. A few small areas near Greenbush have a loam surface layer.

This soil is better suited to soybeans and small grains than to other crops, but it can be used for all the crops common in the county if properly managed. Somewhat poor surface drainage and very slow permeability make the soil wet for a few days after a rain. This soil is somewhat droughty, and crops tend to wilt in hot weather. Plant roots have difficulty penetrating the compact subsoil and tend to follow or concentrate along natural cleavage faces. There are a few small eroded spots on the longer slopes where runoff water concentrates. Terraces help to control erosion on these long slopes. Some flat or weakly concave areas may need surface drainage. Crop-residue management helps to maintain good tilth and permeability. (Capability unit IIs-1; Clay Upland range site; not in a woodland suitability group)

Parsons silt loam, 1 to 3 percent slopes (Pb).—This soil occupies broad, smooth upland areas. Slopes are gentle and convex. This soil has the profile described as representative for the series.

Included in mapping were a few small areas of Cherokee, Dennis, and Bates soils and a few small eroded areas. Also included, especially in the southeastern part of the county around Pittsburg, were areas of a soil that is similar to the Parsons soil, except that the total thickness of the two upper horizons exceeds 16 inches and ranges to 24 inches. Included in the northwestern corner of the county were a few small cherty areas. Also included were some small slickspot areas.

Most of this soil is cultivated. It can be used for all the crops common in the county, but it is better suited to soybeans and small grains. Plant roots have difficulty penetrating the compact subsoil and tend to concentrate along natural cleavage faces and cracks in the subsoil. In hot weather, corn and sorghum tend to wilt. Surface runoff is medium. Water erosion and low fertility are the major limitations in management. The surface layer, if bare, will puddle and seal over after rainfall. Terracing, contour farming, and crop-residue management help to control erosion and reduce runoff. Proper crop-residue management practices also help to maintain good tilth. (Capability unit IIIe-5; Clay Upland range site; not in a woodland suitability group)

Parsons silt loam, 1 to 3 percent slopes, eroded (Pc).—This soil is on broad uplands. Most of the mapping unit is in areas where water concentrates, such as at the heads of small upland drainageways or slight slope breaks. The profile of this soil is similar to that described as representative for the series, except that the surface layer has been thinned by erosion. There are a few rills. Depth to the clay subsoil ranges from 5 to 8 inches in much of the area. Surface texture is heavy silt loam in most places. A few small severely eroded areas were included; in these areas, material from the clay subsoil is mixed in the plow layer. Also included were a few small areas of Dennis soils.

Nearly all the areas are cultivated, or were formerly cultivated and are now idle. This soil is well suited to grass but can be cultivated if intensive measures are used to control further erosion. Other management limitations are droughtiness and poor tilth. If cultivated, this soil is better suited to small grains or soybeans than to other crops. Terracing, contour farming, and returning crop residue to the soil help to control erosion and improve tilth. (Capability unit IVe-2; Clay Upland range site; not in a woodland suitability group)

Radley Series

The Radley series consists of deep, loamy soils on bottom lands. Slopes are 0 to 1 percent. These soils formed in alluvium washed from the surrounding uplands. Vegetation is prairie grasses and some hardwood trees.

In a representative profile, the surface layer is very dark grayish-brown silt loam about 12 inches thick. The underlying material is about 30 inches thick. The upper 11 inches of the underlying material is friable, dark grayish-brown silt loam. The lower 19 inches is friable, brown light silt loam and has a few thin strata of contrasting alluvium. A friable, very dark grayish-brown silt loam A horizon, about 18 inches thick, is buried below the underlying material. It has common thin strata of contrasting alluvium.

Radley soils are moderately well drained, and permeability is moderate. They have high available water capacity and high fertility. These soils are subject to flooding.

Representative profile of Radley silt loam, in a cultivated field, 800 feet west and 200 feet south of the northeast corner of sec. 11, T. 31 S., R. 22 E.

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

C1—12 to 23 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) when dry; weak, medium, granular structure; hard when dry, friable when moist; medium acid; gradual, smooth boundary.

C2—23 to 42 inches, brown (10YR 4/3) light silt loam, pale brown (10YR 6/3) when dry; massive; hard when dry, friable when moist; few fine strata of material slightly lighter in color and slightly more sandy; medium acid; gradual, smooth boundary.

Ab—42 to 60 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; massive; hard when dry, friable when moist; common fine strata of material slightly lighter in color and slightly more sandy; medium acid.

The A horizon ranges from about 10 to 20 inches in thickness. It ranges from very dark brown to very dark grayish brown or brown in hue of 10YR when moist. The texture of the A and C horizons ranges from silt loam to light silty clay loam, with the clay content dominantly less than 27 percent. The C1 horizon ranges from very dark grayish brown to dark grayish brown or brown in hue 10YR when moist. Thin layers that contain more sand or more clay occur in the underlying material below a depth of about 40 inches.

Radley soils are on flood plain landscapes similar to those of Hepler, McCune, Osage, and Girard soils. They lack the clayey Bt horizon of Hepler and McCune soils. Radley soils are not so dark, so clayey, or so poorly drained as Osage and Girard soils.

Radley silt loam (0 to 1 percent slopes) (Ra).—This soil occupies flood plains. It has the profile described as representative for the series.

Included in mapping were a few small areas of Hepler and McCune soils. About 10 to 15 percent of the acreage consists of a soil that is similar to the Radley soil, except that it is silty clay loam.

This soil is suited to all locally grown crops. Occasional flooding damages crops or delays tillage. Good management practices, such as returning crop residue to the soil, help to maintain fertility and improve tilth. (Capability unit I-1; Loamy Lowland range site; woodland suitability group 1)

Radley-Hepler silt loams (Rh).—This complex is on narrow flood plains that are less than 400 feet wide in most places and are much dissected by meandering stream channels. The average composition is about 50 percent Radley silt loam, 40 percent Hepler silt loam, and 10 percent McCune soils and other soils that formed in alluvium. Composition varies considerably, depending on the area and on the nature of the surrounding uplands that furnish the alluvial sediments.

Radley and Hepler soils have profiles similar to those described as representative for their respective series, except that in most places the profile is thinner.

These soils are frequently flooded. Because of this frequent flooding and the dissection by meandering stream channels, these soils are better suited to grass and trees than to other uses. Most of the areas are wooded and have good potential for trees. Oak, elm, ash, and hackberry are the most common species. (Capability unit VIw-1; Loamy Lowland range site; woodland suitability group 1)

Ringo Series

The Ringo series consists of moderately deep, clayey soils on uplands. Slopes range from 3 to 15 percent. These soils formed in material weathered from calcareous shale. Depth to shale ranges from 20 to 40 inches. The native vegetation consists mainly of prairie grasses.

In a representative profile, the surface layer is black light silty clay about 10 inches thick. The subsoil is about

16 inches thick. The upper 6 inches of the subsoil is firm, very dark grayish-brown silty clay. The lower 10 inches is firm, olive-brown silty clay. The underlying material is grayish-brown and light olive-brown, soft, calcareous shale that ranges from one to several feet thick.

Ringo soils are well drained, and permeability is very slow. They have low to moderate available water capacity and moderate fertility.

Representative profile of Ringo silty clay, 3 to 9 percent slopes, in native grass, 300 feet north and 120 feet west of the southeast corner of sec. 4, T. 28 S., R. 24 E.

A1—0 to 10 inches, black (10YR 2/1) light silty clay, very dark gray (10YR 3/1) when dry; moderate, medium, granular structure; hard when dry, friable when moist; many small roots; slightly acid; gradual, smooth boundary.

B1—10 to 16 inches, very dark grayish-brown (2.5Y 3/2) silty clay, grayish brown (2.5Y 5/2) when dry; weak, medium, subangular blocky structure; hard when dry, firm when moist; few, small, light olive-brown (2.5Y 5/4) shale fragments; common small roots; weakly calcareous; mildly alkaline; gradual, smooth boundary.

B2—16 to 26 inches, olive-brown (2.5Y 4/3) silty clay, light olive brown (2.5Y 5/3) when dry; weak, medium, subangular blocky structure; hard when dry, firm when moist; few, weathered, light yellowish-brown (2.5Y 6/4) shale fragments; few, small lime concretions; few small roots; calcareous; moderately alkaline; gradual, smooth boundary.

C—26 to 40 inches, grayish-brown (2.5Y 5/2) and light olive-brown (2.5Y 5/4) soft shale; weak to moderate, fine and medium, platy structure; few black stains; common, thin, fine powdery films and small beadlike accumulations of white limy material between shale fragments; calcareous; moderately alkaline.

The A horizon ranges from black to very dark gray or very dark brown in hue 10YR when moist. It ranges from about 6 to 12 inches in thickness. Texture of the A horizon ranges from heavy silty clay loam to light silty clay, with a clay range of about 35 to 45 percent. In most areas colors of the C horizon are mixed or coarsely mottled grays and olive browns. The C horizon is calcareous; its pH value is about 8.0. Thickness of the solum ranges from about 15 to 35 inches. Depth to little-altered shale ranges from about 20 to 40 inches. In some places there are a few, small, thin, hard limestone fragments in the lower part of the solum. There are some seepy spots during the wetter seasons.

Ringo soils are neighbors on the landscape with Zaar and Clareson soils and, in some places, with Hector soils. They are more sloping and not so deep as Zaar soils. They are more sloping and less stony than Clareson soils. Ringo soils are deeper and more clayey than Hector soils.

Ringo silty clay, 3 to 9 percent slopes (Rn).—In most places this soil is on long, relatively narrow and winding, convex side slopes below limestone-capped hills. Areas of gently sloping Zaar soils occur downslope, and Clareson and Lula soils occur on the hilltops. The profile is the one described as representative for the series.

Included in mapping were some small areas of Zaar and Clareson soils. Also included were a few areas where the slope is more than 9 percent.

Many areas are in tame pasture or range. A small acreage is in native grass meadow. Some areas that are now in pasture were formerly cultivated fields. The main cultivated crops are soybeans, sorghum, and wheat. Management limitations in cultivated fields are water erosion, medium to rapid runoff, and very slow permeability. Terracing and contour farming help to control erosion. This soil tends to be cloddy and and is somewhat difficult to work into a good seedbed. (Capability unit IIIe–6; Clay Upland range site; not in a woodland suitability group)

Ringo silty clay, 3 to 9 percent slopes, eroded (Ro).—Most of this soil is on relatively long, narrow side slopes below limestone-capped hills. The profile is similar to that described as representative for the series, except that the surface layer has been thinned by erosion. In cultivated areas the plow layer consists of a mixture of the surface layer and subsoil. Downslope rills and a few shallow gullies are common.

Included in mapping were areas of severely eroded, calcareous heavy silty clay loam. Some of these areas have shale or limestone fragments on the surface. Also included were a few areas where slopes are more than 9 percent. The included areas make up about 10 percent of the acreage.

This soil is better suited to grass than to other crops because of the high erosion potential. Most of the areas were formerly cultivated but are now in grass. Runoff is rapid because of the slope. The available water capacity is limited by the depth of the soil over shale. Cultivated crops can be grown if intensive conservation measures are used. Terracing, contour farming, and crop-residue management can be used to help control erosion. (Capability unit IVe–3; Limy Upland range site; not in a woodland suitability group)

Ringo complex, 9 to 15 percent slopes (Rp).—This complex occurs mostly in areas that range in width from about 100 to 500 feet. It consists of about 40 to 80 percent Ringo silty clay; 20 to 40 percent of a soil that is similar to the Clareson soil, except that it is less than 20 inches deep over limestone; 5 to 15 percent shale or rock outcrops; and a few small areas of Dennis soils. The Ringo soils have a profile similar to that of the soil described as representative for their series, except that in most places depth to shale is less and the surface is stony, especially at the upper part of the slope.

Because of stoniness and moderately steep slopes, this complex is better suited to grazing and wildlife habitat than to other uses. The vegetation is native grasses and a few trees. (Capability unit VIe–4; Limy Upland range site; not in a woodland suitability group)

Zaar Series

The Zaar series consists of deep, clayey soils on uplands (fig. 11). Slopes range from 1 to 3 percent. These soils formed under prairie grasses in material weathered from clayey shale. They have smooth, gentle slopes and occupy areas below limestone-capped hills.

In a representative profile, the surface layer is black silty clay about 16 inches thick. The upper 8 inches has weak, fine and medium, granular structure and the lower 8 inches has weak, coarse, subangular blocky structure. The subsoil is extremely firm clay about 37 inches thick. The upper 22 inches of the subsoil is very dark grayish brown, and the lower 15 inches is dark grayish brown. The underlying material is coarsely mottled, extremely firm, grayish-brown silty clay.

Zaar soils are moderately well drained, and their permeability is very slow. They have high available water capacity and high fertility.

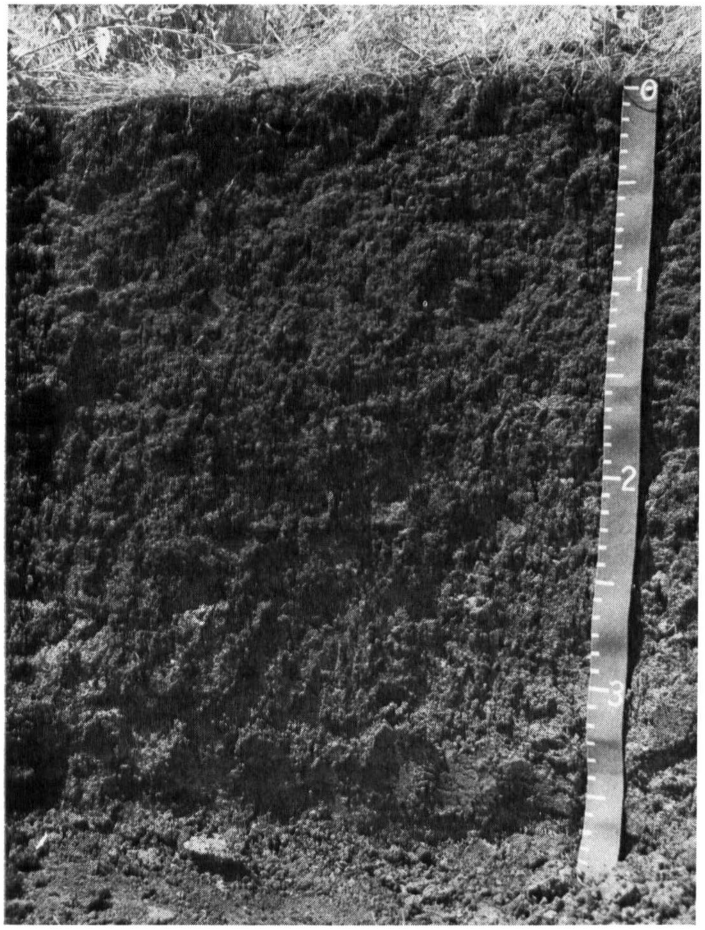

Figure 11.—**Profile of a Zaar silty clay.**

Representative profile of Zaar silty clay, 1 to 3 percent slopes, cultivated, 1,150 feet east and 60 feet south of the northwest corner of sec. 13, T. 29 S., R. 23 E.

Ap—0 to 8 inches, black (10YR 2/1) silty clay, very dark gray (10YR 3/1) when dry; weak, fine and medium, granular structure; hard when dry, firm when moist; slightly acid; clear, smooth boundary.

A1—8 to 16 inches, black (10YR 2/1) silty clay, very dark gray (10YR 3/1) when dry; weak, coarse, subangular blocky structure in place parting to moderate, fine and medium, blocky structure; very hard when dry, very firm when moist; few shiny ped faces; slightly acid; gradual, wavy boundary.

B21—16 to 26 inches, very dark grayish-brown (2.5Y 3/2) clay; dark grayish brown (2.5Y 4/2) when dry; few, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium and coarse, blocky structure; extremely hard when dry, extremely firm when moist; neutral; gradual, wavy boundary.

B22—26 to 38 inches, very dark grayish-brown (2.5Y 3/2) clay, grayish brown (2.5Y 5/2) when dry; common, fine, faint, light olive-brown (2.5Y 5/4) mottles; weak, coarse, blocky structure with faint indications of coarse, prismatic structure; extremely hard when dry, extremely firm when moist; a few, small shot concretions; few shiny slickenside faces; neutral; diffuse, wavy boundary.

B3—38 to 53 inches, dark grayish-brown (2.5Y 4/2) clay, grayish brown (2.5Y 5/2) when dry; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; weak, subangular blocky structure; extremely hard when dry; extremely firm when moist; common, small, black shot concretions with heaviest accumulation in pockets or streaks near base of horizon; some small, hard lime concretions ¼ to ½ inch in diameter; slickenside faces larger and more common than in B22 horizon; mildly alkaline; diffuse, wavy boundary.

C—53 to 60 inches, grayish-brown (2.5Y 5/2) silty clay, coarsely mottled with yellowish brown (10YR 5/6 and 10YR 5/8); little color change when dry; massive; extremely hard when dry, extremely firm when moist; some black shot concretions; some black stains; some weathered shaly fragments in lower part of horizon; mildly alkaline.

The A horizon is very dark gray or black when moist, generally in hue 10YR. Color values of less than 3.5 moist or 5.5 dry extend to a depth of about 18 to 40 inches. Texture of all horizons ranges from heavy silty clay loam to clay, with a clay content of about 38 to 60 percent. Reaction ranges from medium acid or slightly acid in the upper part to neutral or mildly alkaline in the lower part. The B horizon ranges from black to very dark grayish brown in hues centering around 2.5Y when moist. In some places there are small, hard, carbonate concretions in the B and C horizons. Depth to little-altered shale ranges from more than 40 inches to 80 inches or more. In a few places these soils are underlain by limestone at a depth of 40 inches or more.

Zaar soils are neighbors on the landscape with Ringo, Clareson, Lula, and Girard soils. They are not calcareous in the solum and are deeper than Ringo soils. They are deeper and less stony than Clareson soils. Zaar soils are darker and not so granular as Lula soils, which are underlain by limestone. They occupy gentle upland slopes, unlike Girard soils, which are on nearly level stream bottoms.

Zaar silty clay, 1 to 3 percent slopes (Za).—This soil has convex slopes and is at the base of limestone-capped hills. It is downslope from Ringo soils.

Included in mapping were some small areas of Ringo, Lula, Dennis, and Parsons soils. Small slickspot areas were also included.

The major crops are corn, soybeans, wheat, sorghums, and alfalfa. A few areas remain in native grasses and are used for grazing or for meadow. The main limitations are water erosion and difficulty of culitvation and seedbed preparation. This soil tends to remain wet in spring longer than other soils and it also has some small seepy spots. Terracing and contour farming help to control erosion. Returning crop residue to the soil helps to maintain soil tilth. (Capability unit IIIe-2; Clay Upland range site; not in a woodland suitability group)

Use and Management of the Soils

This section discusses management of soils used for crops and range, gives some facts about use of the soils for woodland, and discusses use of the soils for wildlife habitat. It also discusses use of the soils in engineering and for recreation.

Readers who wish to know the capability classification of a given soil can refer to the "Guide to Mapping Units" at the back of this survey. Those who want detailed information about management of the soils can refer to the section "Descriptions of the Soils."

Use of the Soils for Crops

The soils of Crawford County are used mostly for dryland farming and for range. This section explains the system of capability grouping, and discusses general management practices needed for growing dryland crops.

It also gives predicted average yields per acre of the commonly grown crops and fescue pasture to be expected under defined levels of management.

Capability grouping

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

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

In the capability system, all kinds of soil are grouped at three levels: the capability class, the subclass, and the unit. The capability classification of any soil in the county can be learned by referring to the "Guide to Mapping Units." Following is a descriptive outline of the system as it applies to Crawford County.

Class I soils have few limitations that restrict their use (no subclasses).
- Unit I–1. Deep, nearly level, well-drained soils that are loamy throughout; on bottom lands.

Class II soils have some limitations that reduce the choice of plants or require moderate conservation practices.
- Subclass IIe. Soils subject to moderate erosion if they are not protected.
  - Unit IIe–1. Deep, gently sloping, moderately well drained, loamy soils that have a clayey subsoil; on uplands.
  - Unit IIe–2. Moderately deep, gently sloping, well-drained soils that are loamy throughout; on uplands.
  - Unit IIe–3. Deep, gently sloping, well-drained soils that are loamy throughout; on uplands.
- Subclass IIw. Soils that have moderate limitations because of excess water.
  - Unit IIw–1. Deep, nearly level, somewhat poorly drained soils that are loamy throughout; on bottom lands.
- Subclass IIs. Soils that have moderate limitations because of restricted root zone.
  - Unit IIs–1. Deep, nearly level, somewhat poorly drained, loamy soils that have a clayey subsoil; on uplands.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.
- Subclass IIIe. Soils subject to severe erosion if they are not protected.
  - Unit IIIe–1. Moderately deep, sloping, well-drained soils that are loamy throughout; on uplands.
  - Unit IIIe–2. Deep, gently sloping, moderately well drained soils that are clayey throughout; on uplands.
  - Unit IIIe–3. Deep, sloping, moderately well drained, loamy soils that have a clayey subsoil; on uplands.
  - Unit IIIe–4. Deep and moderately deep, well-drained, loamy soils that have a heavy loam or clay subsoil; on uplands.
  - Unit IIIe–5. Deep, gently sloping, moderately well drained to somewhat poorly drained, loamy soils that have a clayey or claypan subsoil; on uplands.
  - Unit IIIe–6. Moderately deep, sloping, well-drained soils that are clayey throughout; on uplands.
  - Unit IIIe–7. Moderately deep, gently sloping, eroded soils that are loamy throughout; on uplands.
  - Unit IIIe–8. Deep, gently sloping, moderately well drained, eroded, loamy soils that have a clayey subsoil; on uplands.
  - Unit IIIe–9. Deep, sloping, moderately well drained, eroded, loamy soils that have a clayey subsoil; on uplands.
- Subclass IIIw. Soils that have severe limitations because of excess water.
  - Unit IIIw–1. Deep, nearly level, poorly drained soils that are clayey throughout; on bottom lands.
  - Unit IIIw–2. Moderately deep, nearly level, poorly drained, loamy soils that have a clayey subsoil; on bottom lands.
  - Unit IIIw–3. Deep, nearly level, somewhat poorly drained, loamy soils that have a claypan subsoil; on uplands.

Class IV soils have very severe limitations that reduce the choice of plants, require special conservation practices, or both.
- Subclass IVe. Soils subject to very severe erosion if they are not protected.
  - Unit IVe–1. Moderately deep, sloping, eroded, well-drained soils that are loamy throughout; on uplands.
  - Unit IVe–2. Deep, gently sloping, eroded, somewhat poorly drained, loamy soils that have a claypan subsoil; on uplands.
  - Unit IVe–3. Moderately deep, sloping, eroded, well-drained soils that are clayey throughout; on uplands.

Class V soils are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife food and cover (none in Crawford County).

Class VI soils have severe limitations that make them generally unsuited to cultivation without major reclamation and limit their use largely to pasture, range, woodland, or wildlife food and cover.
- Subclass VIe. Soils severely limited, chiefly by risk of erosion if protective cover is not maintained.

Unit VIe–1. Deep, moderately deep, and shallow, steep and eroded, sloping, well-drained and somewhat excessively drained, clayey and loamy soils that have a clayey or loamy subsoil; on uplands.

Unit VIe–2. Moderately deep and shallow, sloping, well-drained to somewhat excessively drained soils that are loamy throughout; on uplands.

Unit VIe–3. Moderately deep, stony, gently sloping, well-drained, loamy soils that have a clayey subsoil; on uplands.

Unit VIe–4. Moderately deep, strongly sloping to steep, well-drained soils that are clayey throughout; on uplands.

Subclass VIw. Soils severely limited by excess water and generally unsuited to cultivation.

Unit VIw–1. Deep, moderately well drained to somewhat poorly drained, loamy soils that formed in alluvium; on narrow flood plains.

Class VII soils have very severe limitations that make them unsuited to cultivation without major reclamation and restrict their use largely to range, woodland, or wildlife food and cover.

Subclass VIIs. Soils very severely limited by shallow root zone, low available water capacity, stones, or other soil features.

Unit VIIs–1. Variable soil and rock materials from strip mines and dumps.

Class VIII soils and landforms have limitations that preclude their use for commercial production of plants and restrict their use to recreation, wildlife habitat, water supply, or esthetic purposes (none in Crawford County).

General management of dryland soils

The soils in Crawford County were covered by grass and grass residue before cultivation began, and the surface layer of the soils contained many grass roots. Rainfall soaked in rapidly, and there was little runoff or erosion damage to the soil. Geologic erosion took place at a slow rate and did little damage to the soil. Soil erosion and soil formation were generally in balance.

Then came the plow. Land was broken out of sod and used to grow crops. After a few years of cultivation, the organic-matter content of the soils decreased and a general deterioration of soil structure and physical condition occurred. This poorer physical condition, combined with management that left the soil bare and unprotected, resulted in accelerated soil erosion.

Grassed waterways, terraces, contour farming, and providing vegetative cover between cropping seasons are some of the practices used to control erosion. A single practice may reduce some erosion or conserve some moisture, but a proper combination of these practices is more successful. In addition to controlling erosion, it is necessary to maintain fertility and good tilth of cultivated soils. Most soils in this county, unless recently limed, have a strongly acid to slightly acid reaction, and applications of lime are needed. Correcting or bringing the soil reaction to a desirable level will aid in getting better plant growth and more efficient use of commercial fertilizer. Many years of cultivation have lowered the fertility of the soils in the county, so most soils show a good response to fertilizer.

The amount and kind of fertilizer needed for optimum crop production depend in part on the kind of soil. Soil tests help the farmer determine his fertilizer needs. If there are two or more kinds of soil in a field, it is best to sample each one separately. There may be enough difference in fertilizer requirements to warrant separate rates of application or kinds of fertilizer. When sampling, avoid areas that are not typical of the field, such as eroded spots or areas that have collected silt.

Growing grain for sale or combining the growing of grain and the raising of livestock are the main farming enterprises in Crawford County. Crops commonly grown in the county are corn, wheat, soybeans, and alfalfa. Sorghums are grown both for ensilage and for grain. Tame grasses, mostly brome and fescue, are used for grazing.

Yield predictions

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

Crop yields on the same field sometimes vary from year to year. They are influenced by management practices, crop varieties, weather, and damage caused by insects and by plant diseases. Management practices sometimes vary from farm to farm. Weather, in the form of alternating years of drought and high rainfall, can cause great fluctuations in crop yields from year to year. Wind, hail, or heavy rains sometimes cause heavy local crop damage.

The yields in columns A are those that can be expected over a period of years under average management, the kind of management that is used by a majority of farmers in the county. The soils may be terraced but generally are not farmed on the contour. Drainage is not provided for wet soils. Fertilizer is used, but the amount applied is not enough for maximum yields. Farm operations are less timely than they ought to be. Usually, limited consideration is given to crop varieties.

Yields in column B are those obtained under improved management. On sloping soils, erosion is controlled by the use of such practices as terraces, contour farming, and crop-residue management. Drainage is provided where needed. Adequate fertilizer is used, usually on the basis of a soil test. The more productive crop varieties are planted, usually at rates heavier than in ordinary management. All tillage and seeding operations are timely.

A local representative of the Soil Conservation Service or the County Agricultural Extension Agent should be consulted for more information on cropping sequences and management practices needed on a specific tract of land.

TABLE 2.—*Predicted average yields per acre for principal dryland crops under two levels of managment*

[The land types Eroded land, 3 to 10 percent slopes (Er) and Mine pits and dumps (Md) are omitted from this table because they are not suited to crops. Yields in columns A are those that can be expected under ordinary management; those in columns B can be expected under improved management. Absence of a yield value indicates the crop is seldom grown or the soil is not suited to the stated crop]

Soil	Corn		Wheat		Soybeans		Grain sorghum		Alfalfa hay		Fescue pasture	
	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*A.U.M. per acre per year*[1]	*A.U.M. per acre per year*[1]
Bates loam, 1 to 4 percent slopes	40	60	26	38	18	28	42	62	2. 6	4. 0	3. 0	6. 0
Bates loam, 1 to 4 percent slopes, eroded	30	44	20	29	14	22	34	47	2. 2	3. 2	2. 5	5. 0
Bates loam, 4 to 7 percent slopes	32	48	22	32	14	22	36	54	2. 2	3. 2	2. 5	5. 0
Bates loam, 4 to 7 percent slopes, eroded	22	36	16	24	10	16	28	40	1. 8	2. 6	2. 0	4. 0
Bolivar-Hector complex, 5 to 12 percent slopes											1. 5	2. 5
Breaks-Alluvial land complex											2. 0	3. 5
Cherokee silt loam	36	58	26	39	20	29	43	62	2. 0	3. 1	2. 5	4. 5
Clareson flaggy silty clay loam, 0 to 3 percent slopes											2. 0	4. 0
Dennis silt loam, 1 to 4 percent slopes	48	67	28	40	22	32	50	74	2. 8	4. 6	3. 5	6. 0
Dennis silt loam, 1 to 4 percent slopes, eroded	36	54	22	31	18	24	39	58	2. 2	3. 4	2. 5	4. 0
Dennis silt loam, 4 to 7 percent slopes	40	58	22	30	18	26	45	64	2. 6	4. 0	2. 5	4. 0
Dennis silt loam, 4 to 7 percent slopes, eroded	28	46	17	26	12	18	35	50	2. 2	3. 2	2. 0	3. 5
Dennis-Parsons silt loams, 1 to 4 percent slopes	39	58	26	38	20	28	45	65	2. 2	3. 4	3. 0	5. 0
Girard silty clay loam	36	50	20	26	18	28	40	54	1. 6	2. 6	3. 0	5. 5
Hepler silt loam	52	76	30	40	22	32	52	76	3. 0	4. 6	2. 5	3. 5
Lula silt loam, 1 to 3 percent slopes	49	67	29	42	24	34	51	74	3. 1	4. 9	3. 0	5. 5
Lula silty clay loam, 1 to 3 percent slopes, eroded	36	52	22	31	16	24	39	58	2. 2	3. 6	2. 0	4. 0
Lula-Clareson complex, 1 to 3 percent slopes	38	54	22	31	18	25	39	58	2. 2	3. 6	2. 5	3. 5
McCune silt loam	54	78	32	40	24	32	54	78	3. 0	4. 6	2. 5	3. 5
Osage clay	39	56	22	34	18	29	44	62	1. 6	2. 6	2. 5	3. 5
Parsons silt loam, 0 to 1 percent slopes	39	62	28	40	22	31	45	65	2. 2	3. 2	2. 5	4. 5
Parsons silt loam, 1 to 3 percent slopes	39	62	28	40	22	31	45	65	2. 2	3. 2	2. 5	4. 5
Parsons silt loam, 1 to 3 percent slopes, eroded	26	42	18	28	16	24	38	51	1. 6	2. 5	2. 0	3. 0
Radley silt loam	60	84	32	42	26	34	60	80	3. 6	5. 6	4. 5	6. 5
Radley-Hepler silt loams												
Ringo silty clay, 3 to 9 percent slopes	34	48	22	34	18	28	40	54	2. 2	3. 2	2. 5	4. 0
Ringo silty clay, 3 to 9 percent slopes, eroded	22	40	16	24	12	16	32	48	1. 8	2. 6	1. 5	3. 0
Ringo complex, 9 to 15 percent slopes												
Zaar silty clay, 1 to 3 percent slopes	46	62	30	42	24	32	50	68	2. 8	4. 6	3. 0	4. 0

[1] Animal-unit-month per acre per year is a term used to express the carrying capacity of pasture. It is the number of animal units, 1,000 pounds live weight, that can be grazed on an acre of pasture each month throughout the year, without damage to the pasture.

Use of the Soils for Range[2]

Rangeland in Crawford County consists of native grassland and wooded areas used primarily for grazing. Most of the rangeland is concentrated in the northern part of the county. Smaller tracts of range are intermingled with cultivated fields throughout the rest of the county. These smaller areas are generally too rocky or too steep to be cultivated or are areas that have been set aside for native hay production.

Livestock production is an important segment of the farm economy in Crawford County. The sale of livestock and livestock products generally accounts for 45 to 50 percent of the annual farm income. Most livestock enterprises on rangeland are cowherd operations; some feeder and yearling operations are also carried on.

Forage for livestock is largely provided by rangeland and by perennial tame pastures. Cropland aftermath and annual forages are also used by many farmers and ranchers to supplement their feed supplies.

The original or climax vegetation in Crawford County consisted of four major types, determined mainly by the kind of soils. The deeper upland soils supported tall grass prairies, and the shallower upland soils grew a mixture of tall and mid grasses, along with some shrubs. The upland soils that developed over sandstone had vegetation that consisted of tall grasses and scattered trees. On the alluvial or bottom lands, the vegetation ranged from nearly pure stands of tall grasses to heavy stands of timber.

[2] **LEONARD J. JURGENS, range conservationist, Soil Conservation Service, Emporia, prepared this section.**

Much of the rangeland has deteriorated from its original condition and now produces only a fraction of its potential. However, with proper management, much of the original productivity can be restored.

Management of rangeland is most effective when the livestock operator understands both the potential and the limitations of the basic resource—soil and vegetation. To assist livestock operators in Crawford County, a system for evaluating range resources is discussed in the following paragraphs.

Range sites and condition classes

Different kinds of rangeland produce different kinds and amounts of grass. For proper range management, an operator needs to know the different kinds of land or range sites in his holdings and the plants each site can produce. Management can then be used that favors the growth of the best forage plants on each range site.

Range sites are distinctive kinds of rangeland that differ from each other in their ability to produce a distinct kind or amount, or both, of climax or native vegetation. Each range site produces significant differences in kind of forage or amount of forage produced. On natural grasslands, maximum sustained production is obtained when the native vegetation is in climax condition.

Climax vegetation is that combination of native vegetation that expresses the potential productivity of a range site. It is the most productive combination of plants that can grow and maintain itself on the range site. It must be remembered, though, that climax vegetation is not fixed, but fluctuates with changes in environmental conditions, such as drought or excessive rainfall.

Range condition is the present state of the vegetation of a range site in relation to the climax plant community for that site. Four range condition classes are recognized in determining range condition; they are *excellent*, *good*, *fair*, and *poor*. Excellent condition means that 76 to 100 percent of the climax vegetation is present on the range site; good, that 51 to 75 percent of the climax vegetation is still present; fair, that only 26 to 50 percent of the climax vegetation is left; and poor, that 25 percent or less of the climax vegetation is present.

The potential in forage production is reduced when range condition is less than excellent. The primary factor in range deterioration is continuous overgrazing. During droughts the effects of overgrazing become apparent, and the decline in range condition is accelerated. Fortunately, the declining process can be reversed; rangeland can be brought back to and maintained in excellent condition by proper management.

In the descriptions of range sites, native vegetation is referred to in terms of decreasers, increasers, and invaders. Range in excellent condition or near climax has vegetation that is made up primarily of decreasers and some increasers. Invaders are plants that normally are not present in significant quantities on rangeland that is in excellent condition.

Decreasers are the plant species that will be grazed too closely by livestock if the range is overstocked. They generally are the grasses and forbs that are the most productive, as well as the most palatable to livestock. The entire weight of the forage produced by decreaser species is counted in determining range condition.

Increasers are plants that produce some forage in addition to what is produced by the decreasers. These increasers usually are less palatable to livestock than decreasers or escape close grazing by having a shorter growth habit. By not being grazed as readily as the decreaser plants, increaser plants tend to increase under overgrazing at the expense of the decreaser plants. If grazing becomes too severe, increaser plants will also be overgrazed and will be replaced by invader plants. Only that portion of forage normally produced by the increaser species under excellent conditions is allowed to count toward the range condition rating.

Invaders are plants that cannot survive under the intense competition of the decreasers and increasers when the range is at or near climax condition. However, when the competition of the decreasers and increasers is reduced by overgrazing and occasionally by severe drought, these invader plants rapidly appear and fill in the voids in the plant community. Most species of invaders have little or no grazing value in this area. None of the forage produced by invaders is counted in determining range condition.

While all rangeland needs judicious management of grazing use, areas of range in poor or fair condition may also need practices, such as brush control and range seeding, that speed up range improvement. Range seeding is needed to restore production on many areas of abandoned or marginal cropland. Brush control is needed where the less desirable brush species have substantially increased. The need and feasibility of these practices vary by range site and soils and by range condition.

The major part of the rangeland in Crawford County is made up of Shallow Flats and Loamy Upland range sites. The major difference between Loamy Upland and Shallow Flats is in yields of forage. Other range sites in the county are Clay Lowland, Clay Upland, Limy Upland, Loamy Lowland, Savannah, and Eroded Loamy Upland. Although Mine pits and dumps are not considered a true range site, they have grazing potential and are discussed along with the other range sites.

Descriptions of range sites

The soils in Crawford County have been grouped into range sites according to their ability to produce similar kinds and amounts of climax vegetation. The nature of each site is described in the following paragraphs, along with the most common plants that are produced under different levels of management. Total annual production of herbage is shown for excellent condition class on each site. Because forage production varies from year to year, depending on rainfall, production is indicated both for years in which precipitation is above normal and for those in which it is below normal.

The mapping units in each range site are listed in the "Guide to Mapping Units."

CLAY LOWLAND RANGE SITE

Osage and Girard soils are in this range site. Osage soils are deep and poorly drained and are on flood plains. Slopes are nearly level or slightly concave. Permeability is very slow. Girard soils are poorly drained and are on the bottoms of narrow drainageways that are underlain by limestone at a depth of 20 to 40 inches. The limestone restricts internal drainage and causes the soil to remain wet for extended periods during the growing season.

If this range site is in excellent condition, prairie cordgrass, sedges, and associated forbs are the main vegetation. In the somewhat better drained areas, vegetation includes big bluestem, indiangrass, switchgrass, and eastern gamagrass. If this site is continually overgrazed, meadow dropseed and sedges increase. In areas that are in poor condition, barnyardgrass, meadow tall dropseed, weed trees, and buckbrush become the dominant vegetation.

If this range site is in excellent condition and rainfall is favorable, the average annual yield of air-dry herbage is 10,000 pounds per acre. In years when rainfall is unfavorable, the average annual yield is 4,000 pounds per acre.

CLAY UPLAND RANGE SITE

Soils of the Cherokee, Parsons, Ringo, and Zaar series and the Breaks part of the Breaks-Alluvial land complex are in this range site. These soils are nearly level to rolling and are on uplands. They have a clayey, very slowly or slowly permeable subsoil and are droughty during hot, dry weather. The vegetation is unable to withdraw the moisture rapidly enough to maintain vegetative growth. In years of adequate, well-distributed rainfall this range site is very productive, although its average production is somewhat below that of the Loamy Upland range site.

The major decreasers are big bluestem, little bluestem, indiangrass, and leadplant amorpha. Seventy-five percent or more of the total forage production is decreasers when the range is in climax condition. Some of the more important increasers are side-oats grama, tall dropseed, and slimflower scurf-pea.

Tall dropseed is usually the most prominent increaser. If overuse is severe, even tall dropseed will begin to decrease. If overuse persists to the point that poor range condition is reached, then the vegetation is mainly annual three-awn, lanceleaf ragweed, annual bromes, and brush, with remnants of tall dropseed and side-oats grama.

If this range site is in excellent condition and rainfall is favorable, the average annual yield of air-dry herbage is 7,500 pounds per acre. In years when rainfall is unfavorable, the average annual yield is 2,500 pounds per acre.

Some areas on this range site have been farmed and then abandoned. In these areas range seeding will be needed to restore productivity. Brush control is needed in areas where Osage-orange and buckbrush have invaded overused areas. Controlled burning at the correct time can be used effectively to help control buckbrush.

ERODED LOAMY UPLAND RANGE SITE

This range site consists only of Eroded land, 3 to 10 percent slopes. The soil material is severely eroded loam that occurs on uplands. Fragments of shale and sandstone are on the surface in many areas. Gullies have formed in a few areas.

Prior to cultivation, this site produced tall grasses, mainly big bluestem, little bluestem, indiangrass, and switchgrass. However, the vegetation that has become established since cultivation was abandoned is much less productive than the original grass cover. Unless it is artificially reseeded, the site is dominated in most places by less desirable vegetation, such as broomsedge bluestem, splitbeard bluestem, purple lovegrass, purpletop, scribners panicum, broomweed, and ragweed. Woody plants that invade these abandoned fields include blackberry, smooth sumac, post oak, and blackjack oak. In many areas artificial seeding of suitable native grasses is needed to improve forage production and control further erosion.

If this range site is in excellent condition and rainfall is favorable, the average annual yield of air-dry herbage is 3,500 pounds per acre. In years when rainfall is unfavorable, the average annual yield is 2,200 pounds per acre.

LIMY UPLAND RANGE SITE

Ringo soils that have been eroded or that have strong slopes are in this range site. The soils are limy, and there are numerous stones on the surface. The soils are moderately deep over shale.

If this range site is in excellent condition, more than 70 percent of the vegetation is decreasers. In most places there are numerous forbs. Up to 25 percent of the vegetation is forbs and shrubs.

The major decreasers are little bluestem, big bluestem, indiangrass, blacksamson, prairie clover, and compassplant. The increasers that become abundant on this site if the range condition declines are side-oats grama, willowleaf sunflower, Missouri goldenrod, and meadow tall dropseed. If the site is in poor condition, Missouri goldenrod, meadow tall dropseed, broomweed, annual bromes, and three-awn are the dominant vegetation. Brush species that invade the site are smooth sumac, aromatic sumac, buckbrush, and several tree species.

If this range site is in excellent condition, the total annual yield per acre of air-dry herbage is 4,500 pounds in years of favorable rainfall and 2,500 pounds in unfavorable years.

Brush control is frequently needed to restore excellent condition on this site. Range seeding is needed to restore satisfactory production on practically the entire acreage of the eroded Ringo soil.

LOAMY LOWLAND RANGE SITE

Soils of the Hepler, McCune, and Radley series and the Alluvial land part of the Breaks-Alluvial land complex are in this range site. These are deep, loamy, nearly level soils on flood plains. Hepler and McCune soils are somewhat poorly drained. Radley soils are moderately well drained.

If this site is in excellent condition, more than 90 percent of the vegetation is decreasers. The major decreasers are big bluestem, indiangrass, switchgrass, eastern gamagrass, wholeleaf rosinweed, compassplant, and maximilian sunflower. Increasers on this site are side-oats grama, tall dropseed, sedges, ironweed, buckbrush, and goldenrod. If this site is in poor condition, it is dominated by such invader plants as Kentucky bluegrass, barnyardgrass, weed trees, annual grasses and forbs, and tall dropseed.

If this range site is in excellent condition, it is the most productive in the county. The total annual production of air-dry herbage ranges from 10,000 pounds per acre in years of favorable rainfall to 6,000 pounds per acre in years of unfavorable rainfall.

Brush control is needed on most of this range site. In many places weed trees and buckbrush have practically replaced the decreaser species.

LOAMY UPLAND RANGE SITE

Soils of the Bates, Dennis, and Lula series are in this range site. These soils are on uplands. They are gently sloping and sloping, are moderately well drained or well drained, and have moderate to slow permeability. These soils release water readily for plant use.

In areas where this range site is in excellent condition, the vegetation is considered characteristic of the true prairie. Big bluestem and little bluestem are the predominant decreasers, and there are varying amounts of indiangrass, switchgrass, leadplant amorpha, and prairie clover. The principal increasers on this site are side-oats grama, tall dropseed, smooth sumac, and goldenrod. If the site is in poor condition, such invaders as buckbrush, Osage-orange, Kentucky bluegrass, and annuals, along with tall dropseed and smooth sumac, become the dominant vegetation. On the sandstone-derived soils, broomsedge and blackberry frequently become dominant if the range is in poor condition.

If this site is in excellent condition, the average annual yield per acre of air-dry herbage is 7,000 pounds in years of favorable rainfall and 4,000 pounds in years of unfavorable rainfall. Brush control can be used effectively in areas where woody species have become established. In addition, range seeding is needed to restore productivity on abandoned cropland.

MINE PITS AND DUMPS RANGE SITE

Mine pits and dumps are areas located mostly in the southern and eastern parts of the county that have been disturbed by heavy machinery used in surface mining for coal. They are composed of mixed shale, limestone, sandstone, and the original soil mantle. In most places the dump materials have been left in rough, steep, parallel ridges.

Although these areas are not considered a true range site, they do have grazing potential as rangeland. However, revegetation is slow unless it is encouraged. Landowners have been successful in sowing a mixture of native seed, consisting of switchgrass, indiangrass, big bluestem, little bluestem, and Illinois bundleflower, during favorable seasons. Proper grazing management is essential in restoring a vegetative cover on the mine dumps. Areas that have been seeded and properly managed have been restored to a good cover of native grasses, similar to that of the adjacent prairies.

SAVANNAH RANGE SITE

Soils of the Bolivar-Hector complex are in this range site. They are loamy and are moderately deep and shallow over sandstone and shale. They are sloping to strongly sloping and are on uplands. The original vegetation consisted mainly of a mixture of tall grasses and some scattered trees. The range has deteriorated, however, and the vegetation has reverted to a dense stand of shrubby trees.

Big bluestem, little bluestem, indiangrass, switchgrass, and Canada wildrye are the major decreasers on this range site. Some increaser species are post oak, blackjack oak, blackberry, buckbrush, tall dropseed, and scribners panicum. If this site is in excellent condition, a canopy of up to 20 percent is normal for the tree species. As this site is overgrazed, such trees as post oak, blackjack oak, and hickory form a dense canopy, and only small amounts of grass survive in the understory. In areas that are in poor range condition, invader plants that vegetate the understory are broomsedge, buckbrush, and purpletop, along with annual grasses and forbs.

If this site is in excellent condition, the total annual yield per acre of air-dry herbage is 5,500 pounds in years of favorable rainfall and 3,500 pounds in years of unfavorable rainfall. Of the total annual herbage produced in areas that are in climax condition, only about 70 percent is available to livestock. If this site has deteriorated to a heavy stand of brush, usually less than 20 percent of the herbage produced is available to livestock.

Brush control is usually necessary to reduce the tree canopy and to speed recovery of the better grasses.

SHALLOW FLATS RANGE SITE

Clareson soils are in this range site. They are nearly level and gently sloping and are on uplands. Fragments of limestone make up 35 to 90 percent of the subsoil, but moisture and plant roots follow the cracks in the limestone. Most areas have limestone fragments in the surface layer and on the surface of the soil. These soils are well drained and have moderately slow permeability, but they are somewhat droughty.

Little bluestem, big bluestem, indiangrass, pitcher sage, and prairie clover are the major decreasers on this range site (fig. 12). Side-oats grama, smooth sumac, aromatic sumac, and goldenrod are the major increasers. These plants spread rapidly if the soils are continually overgrazed. Common invaders are broomweed, annual bromes, silver bluestem, buckbrush, red haw, gray dogwood, and pricklypear cactus.

If this range site is in excellent condition, total annual yield per acre of air-dry herbage is about 5,000 pounds in years of favorable rainfall and 2,500 pounds in years of unfavorable rainfall.

If infestations of brush are heavy, brush control is necessary before rapid improvement can be expected.

Use of the Soils for Woodland

Approximately 33,000 acres of woodland is in Crawford County, and it is all privately owned. Most of the wooded areas are in small, irregular tracts along the streams. However, a small part of the woodland is in the hilly areas in the northeastern part of the county, and there are trees on some of the older strip-mined areas.

Only a small part of the woodland is managed for timber production. Nearly all of the woodland is grazed by livestock. Wooded areas also provide food and cover for wildlife, and some areas are used for recreation.

The principal native trees in the county are ash, hackberry, bur oak, red oak, white oak, pin oak, sycamore, maple, black walnut, pecan, hickory, and elm. Most of these trees are cut for saw logs when they reach adequate size. Operators of small sawmills have cut or are cutting most of the better trees in the county. A few trees are cut for fuel or for fenceposts.

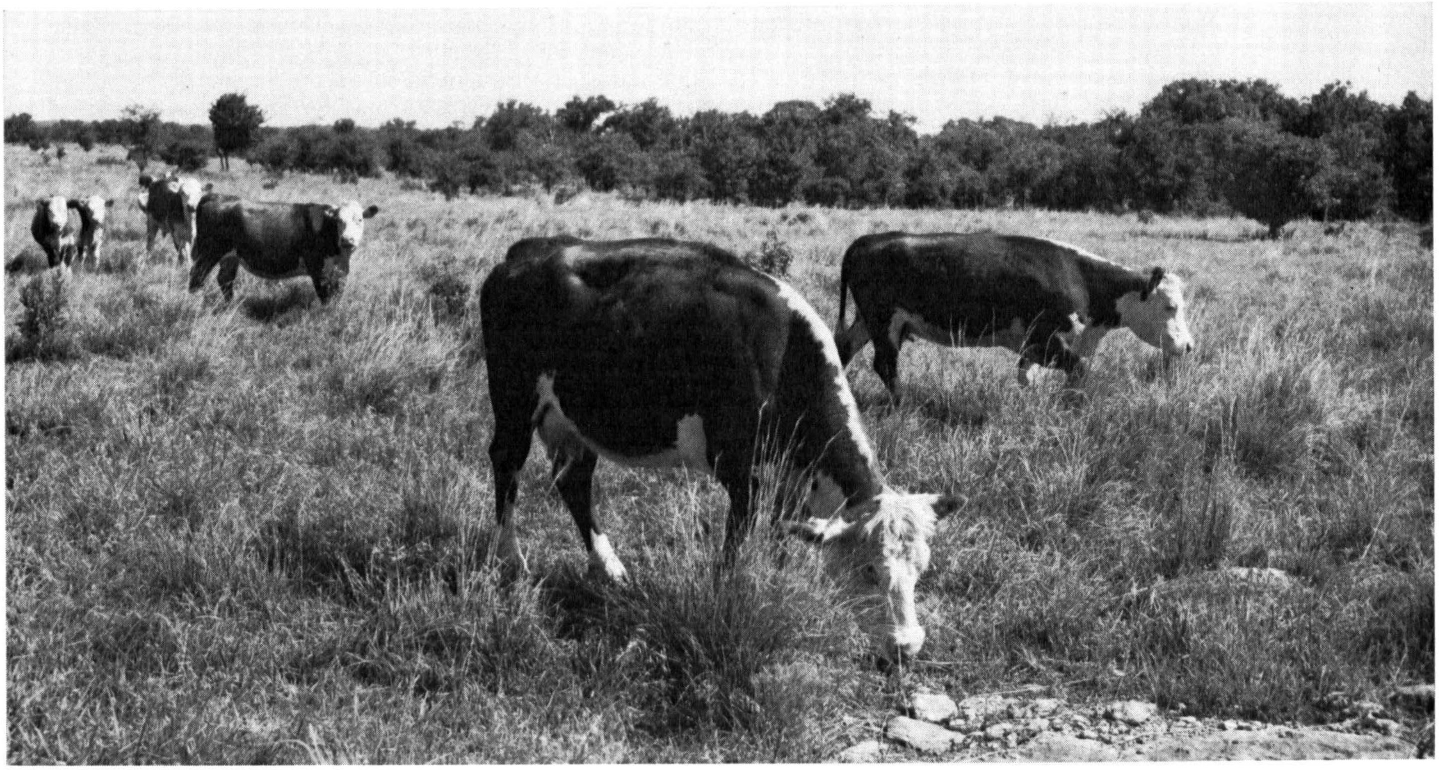

Figure 12.—Cattle grazing native grass on a Clareson flaggy silty clay loam.

Landowners have little interest in managing native woodland for the production of timber. Black walnut logs are in demand but are scarce. The bottom-land soils have a high potential for production of black walnut and trees that grow to timber size, but most of these soils are being used for small grains, row crops, and alfalfa. The upland soils have little potential for the production of saw logs, but trees on the hilly uplands provide protection to watersheds.

Some nuts are harvested from pecan and walnut trees, although the acreage of these trees in the county is small. In recent years the demand for pecans has made these trees more valuable as a source of farm income. In a few areas, groves of pecan trees have been cleaned of undesirable competitive trees and are managed for production of nuts.

Site index

The soils in the county differ in their ability to grow trees. The best soils for timber production are the soils on bottom lands along creeks and streams. These soils vary somewhat from place to place in texture, depth, drainage, and degree of wetness. This is reflected in tree growth and species suitability. The potential productivity of a soil for growing trees is expressed as site index, which is the height attained by the dominant and codominant species at the age of 50 years. For example, if a soil has a site index of 70, this means that trees grow 70 feet tall on that soil in 50 years. Potential productivity can be expressed in terms of board feet per acre per year. Site index can also be used to compare potential tree growth of a species on different kinds of soil. For example, in 50 years an ash tree can be expected to grow 70 to 75 feet tall on soils of group 1 as compared to only 65 to 70 feet tall on soils of group 2. Likewise, in 50 years a pin oak on soils of group 1 can be expected to grow about 10 feet taller than a pin oak on soils of group 2.

Woodland suitability groups

In this survey, soils that have about the same texture, depth, drainage, and wetness characteristics; that have about the same potential productivity; and that require about the same management for similar kinds of trees are placed in the same woodland suitability group. The soil-related hazards to growing timber are mentioned, and the site index and annual yield in board feet per acre (Doyle rule) are shown for native trees in each suitability group. Soils in each suitability group can be identified by referring to the "Guide to Mapping Units" at the back of this soil survey.

Soils that have low potential for woodland production or that are in use for the production of small grains, row crops, and pasture have not been placed in woodland suitability groups. Among those not placed in a woodland group are soils in the Bolivar-Hector complex and the Ringo complex of soils that occupy rolling and hilly uplands, mostly in the northeastern part of the county. The site index of these soils is low. Native oaks that grow on them produce less than 110 board feet per acre per year. The woodland suitability groups for Crawford County are discussed in the following paragraphs.

WOODLAND SUITABILITY GROUP 1

This group consists of deep, loamy, somewhat poorly drained and moderately well drained soils on bottom lands that are flooded part of the time. Permeability is moderate to slow. These soils are in the Hepler, McCune, and Radley series, and they have a high potential productivity as woodland. Site index and annual growth for native trees are as follows:

	Site index	*Annual growth per acre (Bd. ft., Doyle rule)*
Bur oak	60–75	130–220
Black walnut	65–85	155–260
Red oak	60–70	130–180
Green ash, hickory, and hackberry	70–75	180–220
Pin oak	80–85	260–300
Cottonwood	85–90	300–335

These are the preferred kinds of trees to plant and to favor in management in this group (fig. 13).

Spring flooding and drought can cause loss of 25 to 50 percent of naturally seeded trees. Floods and wetness can hinder logging. Competition from vines and weed trees can prevent the establishment of desirable trees unless cultural measures are applied. The hazards of windthrow and erosion are slight.

WOODLAND SUITABILITY GROUP 2

This group consists of deep, clayey, poorly drained soils on bottom lands that are occasionally flooded and are usually wet. These soils are in the Girard and Osage series, and they have a medium to high productivity rating. Site index and annual growth for native trees are as follows:

	Site index	*Annual growth per acre (Bd. ft., Doyle rule)*
Bur oak and hickory	55–60	110–130
Green ash	65–70	155–180
Pecan, pin oak, and hackberry	70–75	180–220

The species listed above are the best to manage for and to plant on the soils in this suitability group. Other species, such as black walnut, will also grow on these soils, but they will not do well because of the heavier soil and generally wetter conditions.

Flooding and wetness can cause loss of 25 to 50 percent of naturally seeded trees. Competition from weed trees and vines can prevent the establishment of desirable trees unless cultural measures are applied. Logging should be limited to the driest months to avoid compacting the soil and damaging tree roots. The hazard of windthrow is moderate, but it can be severe if individual trees are

***Figure 13.*—Bur oak and black walnut growing on a Hepler soil.**

exposed to wind after logging. The hazard of erosion is slight.

Use of the Soils for Wildlife [3]

The general soil map of Crawford County provides information of value in planning wildlife habitat developments for the maximum use and production of the various wildlife species.

In planning, it is important to consider inherent soil characteristics, such as permeability, drainage, topography, and fertility. Any of these might be limiting factors in the management of a particular fish or wildlife species.

The soils of Crawford County provide suitable habitat for a variety of game and nongame animals. Habitat suitable for prairie chickens is found on Parsons, Dennis, and other soils of association 3 in the northwestern corner of the county. At present, these birds are not abundant enough to allow a hunting season.

Bobwhite quail inhabit all soil associations in the county. Some of the best habitat is where good nesting and winter cover adjoin cultivated fields. The production of soybeans, corn, sorghum, and wheat interspersed with pastures and wooded areas provide good habitat for the bobwhite.

Coal has been strip mined in the areas of association 3 in the southern and eastern parts of the county. At the edge of a stripped area an excavation, or pit, remains which is about 40 to 45 feet deep, 100 to 200 feet wide, and up to 1 mile or more in length. Water collects in these pits from surface runoff or from springs. These waters vary considerably in their chemistry, depending on the geologic composition of the coalbeds. The pH value of these waters may range from 2.8 to 9.0 or more.

Investigation by the Kansas Forestry, Fish and Game Commission have shown that about 14 percent of all strip-mined waters are too acid for good fish production. The remainder, with proper management and development, can provide excellent game fishing.

Finding and establishing suitable plant materials on recently "stripped" areas and, thus, providing erosion control and wildlife habitat is a real challenge to the wildlife manager.

The Crawford County State Park and Lake No. 2 is located about 9 miles north of Girard, within the boundaries of association 7, which consists mainly of Clareson and Lula soils. In addition to providing fishing and other recreational opportunities to users in the area, the lake is a source of water for the Farlington National Fish Hatchery, located immediately below the dam. The warm water species of fish raised here provide fingerlings for stocking purposes for Kansas and surrounding states.

White-tailed deer are increasing throughout the county. Intermingled woodland and cropland provide favorable habitat, especially on Hepler, Radley, and other soils of association 1.

Furbearers, such as mink, muskrat, beaver, and raccoon, find habitat near water. Farm ponds, streams, and strip pits in all the soil associations provide adequate habitat for these animals. The Clareson and Lula soils of association 7 are the least desirable from the standpoint of pond construction, mainly because of rock and seepage problems.

Squirrels, both fox squirrels and gray squirrels, inhabit all soil associations throughout the county. The greatest numbers are in the wooded areas of Hepler, Radley, and other soils of association 1 along the streams. Mourning doves nest in the county and are most numerous near cultivated areas of Parsons, Dennis, Zaar, Lula, and other soils of associations 3 and 6.

Technical assistance in planning and development of fish and wildlife areas can be obtained at the county office of the Soil Conservation Service. Additional information and assistance can be obtained from the Kansas Forestry, Fish and Game Commission, from the Bureau of Sports, Fisheries, and Wildlife, and from the Agricultural Extension Service.

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

Engineering Uses of the Soils [4]

This section provides information of special interest to engineers, contractors, farmers, and others who use soil as structural material or as foundation material upon which structures are built. Listed in this section are those properties of the soils that affect construction and maintenance of roads, airports, pipelines, building foundations, water storage facilities, erosion control structures, drainage systems, and sewage disposal systems. Among the soil properties most important in engineering are permeability, shear strength, density, shrink-swell potential, available water capacity, grain-size distribution, plasticity, and reaction.

The information in this section can be used in—

1. Planning and designing agricultural drainage systems, farm ponds, irrigation systems, diversion terraces, and other structures for controlling water and conserving soil.
2. Selecting potential locations for highways, airports, pipelines, and underground cables.
3. Locating probable sources of sand, gravel, or rock suitable for use as construction material.
4. Selecting potential industrial, commercial, residential, and recreational sites.

The engineering interpretations reported here do not eliminate the need for sampling and testing at the site of specific engineering works that involve heavy loads and where the excavations are deeper than the depths of layers reported in this soil survey. Even in these situations, however, the soil map is useful in planning more detailed field investigations and for indicating the kinds of problems that may be expected.

Some terms used by soil scientists have different meanings in soil science than they have in engineering. Some of these terms are defined in the Glossary at the back of this soil survey.

Much of the information in this section is given in tables 3, 4, and 5. Additional information useful to engineers can be found in other parts of this soil survey, especially in the sections "Descriptions of the Soils" and "Use of the Soils for Recreation."

[4] CHARLES D. CHEEK, civil engineer, Soil Conservation Service, assisted in the preparation of this section.

Engineering classification of soils

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

The AASHO system (*1*) is used to classify soils according to those properties that affect use in highway construction. In this system, soils are placed in seven basic groups that range from A–1 through A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A–1 are gravelly soils of high bearing strength, or the best soils for road fill; and at the other extreme are clay soils that have low strength when wet. The best soils for road fill are therefore classified A–1, the next best A–2, and so on to the poorest, which are classified A–7. Where laboratory data are available to justify a further breakdown, the A–1, A–2, and A–7 groups are subdivided as follows: A–1–a, A–1–b; A–2–4, A–2–5, A–2–6, A–2–7; and A–7–5 and A–7–6. If soil material is near a classification boundary, it is given a symbol showing both classes; for example, A–2 or A–4. Within each group, the relative engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 for the poorest. The AASHO classification for tested soils, with index numbers in parentheses, and other engineering test data are shown in table 5. The estimated classification for all soils mapped in the survey area is given in table 3.

In the Unified system soils are classified according to particle size distribution, plasticity, and liquid limit (*14*). Soils are grouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH and OH; and one class of highly organic soils, identified as Pt.

Estimated properties of the soils

Estimates of soil properties important in engineering are provided in table 3. The estimates are based on field classification and descriptions, on physical and chemical tests of selected representative samples, on test data from comparable soils in adjacent areas, and on detailed experience in working with the kinds of soil in the survey area. The information is generalized for a soil, but it is the best available estimate. The properties of a given soil vary somewhat from place to place, and there might be some variance from the properties listed. In addition, some mapping units contain small spots of contrasting soils.

The textural classes in the USDA system of classification are determined by the proportional amounts of different sizes of mineral particles. In this system, sand, the largest grain size, is 2.0 millimeters in diameter and clay, the smallest, is 0.074 millimeter in diameter.

Permeability, as used in table 3, relates only to movement of water downward through undisturbed and uncompacted soil; it does not include lateral seepage. The estimates are based on structure and porosity of the soil. Plowpans, surface crusts, and other properties that result from use of the soils are not considered.

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Available water capacity is that amount of capillary water in the soil that is available for plant growth after all free water has drained away.

Reaction is the degree of acidity or alkalinity of a soil, expressed as a pH value. The relative terms used to describe soil reaction are given in the Glossary.

There are no true saline soils in Crawford County, and no salinity column is given in table 3. Some soils, however, do contain small, scattered slickspots. Dennis-Parsons silt loams, 1 to 4 percent slopes, for example, contains an estimated 6 percent of slickspots. Zaar, Parsons, and Dennis soils also have a few small slickspots. These slickspots are shown on the map by a symbol; each symbol represents an area as much as 1 acre in size.

The amount of sodium and soluble salts in the slickspots is variable. Plant growth is affected by the dispersed soil condition and by the poor moisture relationship. The surface layer generally is thin, is light colored, and has a thin crust when dry. The spots occur in irregular patterns on nearly level or gentle slopes where the gradient is generally not more than 4 percent.

Shrink-swell potential is an indication of the volume change that is to be expected of the soil material with changes in moisture content. Shrinking and swelling of soils cause much damage to building foundations, roads, and other structures. A high shrink-swell potential indicates hazards to the maintenance of structures built in, on, or with such materials.

Engineering interpretations

Table 4 contains selected information that is useful to engineers and to others who plan to use soil material in the construction of highways, farm facilities, buildings, and sewage disposal systems. The ratings and interpretations in this table are based on estimated engineering properties of the soils in table 3; on available test data, including those in table 5; and on field experience. Following are explanations of column headings in this table.

Topsoil is a term used to designate a fertile soil or soil material, ordinarily rich in organic matter, used to topdress lawns, gardens, roadbanks, and the like. Unless otherwise noted, only the surface layer is rated in table 5.

Road fill is the material used for embankments and subgrades. Ratings are based on the performance of soil if used as borrow material for these purposes.

Highway location rating refers to the in-place features of soil that affect its performance for the geographic location of highways. The entire soil profile of undisturbed soil is evaluated without artificial drainage, but with the organic surface layer having been removed.

Farm pond reservoir area rates those soil features that affect the seepage rate of water through undisturbed soils in impoundment areas.

Farm pond embankments considers the behavior of soil materials borrowed for earth embankments for farm ponds. Both the subsoil and substratum are considered where they have significant thickness.

Agricultural drainage considers features that affect the installation and performance of surface and subsurface drainage practices, such as permeability, texture, structure, depth to bedrock or water table, and flooding.

TABLE 3.—*Estimated soil properties*

[The land types Breaks-Alluvial land complex (Bk), Eroded land (Er), and Mine pits and dumps (Md) are omitted from table because series is made up of two or more kinds of soil. For this reason the reader should carefully follow the instructions for referring

Soil series and map symbols	Depth to—		Depth from surface of typical profile	Classification
	Bedrock	Seasonal high water table		USDA texture
	Inches	*Feet*	*Inches*	
Bates: Ba, Bb, Bc, Bd	20–40	(1)	0–16	Loam
			16–33	Clay loam
			33	Sandstone.
*Bolivar: Be (For Hector part, see Hector series.)	20–40	(1)	0–10	Silt loam
			10–31	Silty clay loam
			31	Shale.
Cherokee: Ce	>60	[2] 0–1	0–15	Silt loam
			15–45	Clay
			45–60	Silty clay loam.
Clareson: Cf	20–40	(1)	0–12	Flaggy silty clay loam
			12–27	Flaggy silty clay
			27	Limestone.
*Dennis: De, Df, Dg, Dh, Dp (For Parsons part of Dp, see Parsons series.)	>60	(1)	0–12	Silt loam
			12–17	Silty clay loam
			17–60	Clay.
Girard: Gd	20–40	[2] 0–1½	0–17	Silty clay loam
			17–34	Silty clay
			34	Limestone.
Hector (Mapped only in a complex with Bolivar soils.)	4–20	(1)	0–12	Silt loam
			12	Sandstone.
Hepler: He	>60	[3] 0–1½	0–22	Silt loam
			22–60	Silty clay loam
*Lula: Ls, Lt, Lu (For Clareson part of Lu, see Clareson series.)	40–60	(1)	0–9	Silt loam
			9–40	Silty clay loam
			40–45	Silty clay
			45	Limestone.
McCune: Mc	>60	[3] 0–1½	0–30	Silt loam
			30–60	Silty clay loam
Osage: Os	>60	[3] 0–1½	0–60	Clay
Parsons: Pa, Pb, Pc	>60	[3] ½–1½	0–14	Silt loam
			14–38	Clay
			38–60	Silty clay loam
*Radley: Ra, Rh (For Hepler part of Rh, see Hepler series.)	>60	(1 3)	0–60	Silt loam
Ringo: Rn, Ro, Rp	20–40	(1)	0–26	Silty clay
			26	Shale
Zaar: Za	>60	1–2	0–16	Silty clay
			16–53	Clay
			53–60	Silty clay

[1] No seasonal high water table.
[2] Soil has temporary perched water table above clay subsoil during wet seasons.

significant in engineering

their properties are variable and require onsite inspection. An asterisk in the first column indicates that at least one mapping unit in this to other series in the first column of this table. The symbol < means less than; the symbol > means more than]

Classification—Continued		Percentage less than 3 inches passing sieve—			Permea-bility	Available water capacity	Reaction	Shrink-swell potential
Unified	AASHO	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)				
					Inches per hour	*Inches per inch of soil*	*pH*	
ML or ML-CL	A-4	100	95–100	60–75	0.63–2.00	0.16–0.18	5.1–6.5	Low.
CL	A-6	100	95–100	60–75	0.63–2.00	0.17–0.19	5.1–6.0	Moderate.
ML-CL or CL	A-4 or A-6	100	90–100	70–90	0.63–2.00	0.16–0.18	5.1–6.5	Low.
CL	A-7	100	95–100	85–95	0.63–2.00	0.17–0.19	5.1–5.5	Moderate.
ML or ML-CL	A-4	100	90–100	70–90	0.63–2.00	0.16–0.18	5.1–5.5	Low.
CH	A-7	100	95–100	85–95	<0.06	0.16–0.18	5.1–5.5	High.
CL or CH	A-7	100	95–100	85–95	0.20–0.63	0.17–0.19	5.6–6.0	Moderate to high.
CL	A-7	100	95–100	85–95	0.20–0.63	0.17–0.19	5.6–6.5	Moderate.
CL or CH	A-7	100	95–100	90–95	0.20–0.63	0.16–0.18	5.6–7.3	Moderate to high.
ML-CL or CL	A-4 or A-6	100	90–100	70–90	0.63–2.00	0.16–0.18	5.1–6.5	Low.
CL	A-7	100	95–100	75–95	0.20–0.63	0.17–0.19	5.1–5.5	Moderate.
CL or CH	A-7	100	90–100	75–90	0.06–0.20	0.16–0.18	5.1–6.0	Moderate to high.
CL	A-7	100	95–100	85–95	0.20–0.63	0.17–0.19	5.6–6.0	Moderate.
CL or CH	A-7	100	95–100	90–95	0.06–0.20	0.16–0.18	6.6–7.3	Moderate to high.
ML-CL or CL	A-4 or A-6	100	90–100	70–90	0.63–2.00	0.16–0.18	5.1–6.5	Low to moderate.
ML or ML-CL	A-4 or A-6	100	90–100	70–90	0.63–2.00	0.16–0.18	5.1–6.5	Low.
CL	A-7	100	95–100	85–95	0.20–0.63	0.17–0.19	5.1–6.5	Moderate.
ML-CL or CL	A-4 or A-6	100	90–100	80–95	0.63–2.00	0.16–0.18	5.6–6.5	Low to moderate.
CL or CH	A-7	100	90–100	80–95	0.63–2.00	0.17–0.19	5.6–6.0	Moderate to high.
CH	A-7	100	90–100	80–95	0.63–2.00	0.16–0.18	5.6–7.3	High.
ML or ML-CL	A-4	100	90–100	70–90	0.63–2.00	0.16–0.18	5.1–6.0	Low.
CL	A-7	100	95–100	85–95	0.06–0.20	0.17–0.19	5.1–5.5	Moderate.
CH	A-7	100	90–100	75–95	<0.06	0.16–0.18	6.6–7.8	High.
ML-CL or CL	A-4 or A-6	100	90–100	70–90	0.63–2.00	0.16–0.18	5.1–6.0	Low.
CH	A-7	100	90–100	85–100	<0.06	0.16–0.18	5.1–6.0	High.
CL or CH	A-6 or A-7	100	95–100	85–95	0.20–0.63	0.17–0.19	5.6–6.0	Moderate to high.
ML or ML-CL	A-4 or A-6	100	90–100	70–90	0.63–2.00	0.16–0.18	5.6–7.3	Low to moderate.
CL or CH	A-7	100	95–100	90–95	0.06–0.20	0.16–0.18	6.1–7.8	High.
		100	95–100	85–95	<0.06	0.16–0.18	7.4–8.4	High.
CH	A-7	100	95–100	90–95	0.06–0.20	0.16–0.18	5.6–6.5	High.
CH	A-7	100	95–100	90–95	<0.06	0.16–0.18	6.6–7.8	High.
CH	A-7	100	95–100	90–95	0.06–0.20	0.16–0.18	6.6–7.8	High.

[3] Soil is subject to flooding.

TABLE 4.—*Engineering*

[The land types Breaks-Alluvial land complex (Bk), Eroded land (Er), and Mine pits and dumps (Md) are omitted from table because this series is made up of two or more kinds of soil. For this reason the reader should

Soil series and map symbols	Suitability as a source of—			Soil features affecting—		
	Topsoil	Road subgrade	Road fill [1]	Highway location [1]	Reservoir area for ponds	Embankments for ponds, dikes, and levees
Bates: Ba, Bb, Bc, Bd.	Good in upper 12 inches of soil material; fair at depth between 12 and 24 inches.	Fair: low to moderate shrink-swell potential.	Fair to good: fair stability; limited borrow material.	Some lateral seepage; sandstone at depth of 20 to 40 inches; gently sloping and sloping.	Sandstone at depth of 20 to 40 inches; some lateral seepage.	Fair stability and compaction; limited borrow material.
*Bolivar: Be (For Hector part of Be, see Hector series.)	Fair in upper 10 inches.	Fair to poor: moderate shrink-swell potential.	Fair: fair stability.	Limited depth to shale; sloping.	Shale at depth of 20 to 40 inches.	Fair stability and compaction; limited borrow material.
Cherokee: Ce	Good to fair in upper 15 inches; poor in subsoil because of high content of clay.	Poor: high shrink-swell potential.	Poor: poor stability; high shrink-swell potential.	Seasonal perched water table above clay subsoil; high shrink-swell potential.	Very slow permeability.	Poor stability and compaction; high shrink-swell potential; low shear strength.
Clareson: Cf	Poor: stones.	Poor: moderate to high shrink-swell potential.	Poor: fair to poor stability; moderate to high shrink-swell potential.	Limestone at depth of 20 to 40 inches; moderate to high shrink-swell potential.	Moderately slow permeability; stones in subsoil; limestone at depth of 20 to 40 inches.	Fair to poor stability and compaction; moderate to high shrink-swell potential; limited borrow material.
*Dennis: De, Df, Dg, Dh, Dp. (For Parsons part of Dp, see Parsons series.)	Good in upper 12 inches; fair in next 6 inches; poor in subsoil because of high content of clay.	Poor: moderate to high shrink-swell potential.	Fair: fair stability; moderate to high shrink-swell potential.	Moderately well drained; moderate to high shrink-swell potential.	Slow permeability; shale at depth below 60 inches.	Fair stability; fair compaction.
Girard: Gd	Fair in upper 18 inches; poor in subsoil because of high content of clay.	Poor: moderate to high shrink-swell potential.	Fair to poor: fair to poor stability; moderate to high shrink-swell potential.	Bedrock at depth of 20 to 40 inches; frequent flooding; some seepy areas.	Bedrock at depth of 20 to 40 inches.	Limited borrow material; moderate to high shrink-swell potential; fair to poor stability and compaction.
Hector (Mapped only in complex with Bolivar soils.)	Poor: shallow to sandstone.	Fair to poor: low to moderate shrink-swell potential.	Fair: fair stability; limited borrow material.	Shallow to sandstone; sloping.	Shallow to sandstone.	Shallow to sandstone; limited borrow material; fair stability and compaction.

See footnote at end of table.

interpretations of soil properties

their properties are variable and onsite inspection is required. An asterisk in the first column indicates that at least one mapping unit in follow carefully the instructions for referring to other series in the first column of this table]

Soil features affecting— Continued					Soil limitations for sewage disposal by—	
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter field	Sewage lagoons
Well drained	Sandstone restricts vertical drainage; gently sloping and sloping; sandstone at depth of 20 to 40 inches.	Moderately erosive; sandstone at depth of 20 to 40 inches.	Moderately erosive; sandstone at depth of 20 to 40 inches.	Sandstone at depth of 20 to 40 inches.	Severe: sandstone at depth of 20 to 40 inches.	Severe: sandstone at depth of 20 to 40 inches; some lateral seepage.
Well drained	Moderate permeability; shale at depth of 20 to 40 inches; sloping.	Shale at depth of 20 to 40 inches.	Shale at depth of 20 to 40 inches.	Shale at depth of 20 to 40 inches.	Severe: shale at depth of 20 to 40 inches.	Severe: shale at depth of 20 to 40 inches.
Somewhat poorly drained; seasonal perched water table above clay subsoil.	Somewhat poorly drained; very slow permeability.	Nearly level; very slow permeability: dense clay subsoil.	Nearly level; subject to wetness; fertility and soil structure problem if subsoil is exposed.	High shrink-swell potential.	Severe: very slow permeability; seasonal perched water table above clay subsoil.	Slight.
Well drained	Limestone at depth of 20 to 40 inches; surface grading limited due to stones.	Stones in subsoil; limestone at depth of 20 to 40 inches.	Stones in subsoil.	Stones in subsoil; limestone at depth of 20 to 40 inches; moderate to high shrink-swell potential.	Severe: moderately slow permeability; stones in subsoil; limestone at depth of 20 to 40 inches.	Severe: stones in subsoil; limestone at depth of 20 to 40 inches.
Moderately well drained.	Slow permeability.	Deep; gently sloping and sloping.	Deep	More than 5 feet to bedrock; moderate to high shrink-swell potential in subsoil.	Severe: slow permeability.	Moderate on slopes of 2 to 7 percent; slight on slopes of less than 2 percent.
Poorly drained; slow permeability.	Slow permeability; poorly drained; frequent flooding.	Nearly level; frequent flooding.	Nearly level; frequent flooding; difficulty in establishing and maintaining vegetation due to wetness.	Bedrock at depth of 20 to to 40 inches; wetness; frequent flooding; moderate to high shrink-swell potential.	Severe: slow permeability; frequent flooding.	Severe: bedrock at depth of 20 to 40 inches.
Well drained	Shallow to sandstone; sloping.	Shallow to sandstone.	Shallow to sandstone; low fertility; low available water capacity.	Shallow to sandstone.	Severe: shallow to sandstone.	Severe: shallow to sandstone.

TABLE 4.—*Engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—		
	Topsoil	Road subgrade	Road fill [1]	Highway location [1]	Reservoir area for ponds	Embankments for ponds, dikes, and levees
Hepler: He	Good to fair in the upper 22 inches; poor in subsoil because of high content of clay.	Fair to poor: low to moderate shrink-swell potential.	Fair: fair to poor stability.	Occasional flooding.	Occasional flooding.	Low to moderate shrink-swell potential; fair to poor stability and compaction.
*Lula: Ls, Lt, Lu (For Clareson part of Lu, see Clareson series.)	Good in upper 6 inches; fair in next 14 inches.	Poor: moderate to high shrink-swell potential in subsoil.	Fair to poor: fair to poor stability; high shrink-swell potential in subsoil.	Fair to poor stability; limestone at depth of 40 to 60 inches.	Limestone at depth of 40 to 60 inches; variable seepage.	Fair to poor stability; high shrink-swell potential in subsoil.
McCune: Mc	Good to fair in upper 30 inches; fair to poor in subsoil.	Fair to poor: low to moderate shrink-swell potential.	Fair: fair stability.	Occasional flooding.	Nearly level; occasional flooding; permeability is moderate above depth of 30 inches and slow below depth of 30 inches.	Fair stability and compaction.
Osage: Os	Poor: high content of clay.	Poor: high shrink-swell potential.	Poor: poor stability; high shrink-swell potential.	Poorly drained; frequent flooding.	Low seepage; nearly level.	Low shear strength; poor stability and compaction; high shrink-swell potential.
Parsons: Pa, Pb, Pc	Fair in upper 14 inches; poor in subsoil because of high content of clay.	Poor: high shrink-swell potential.	Poor: poor stability; high shrink-swell potential.	Seasonal perched water table above clay subsoil; high shrink-swell potential; nearly level to gently sloping.	Very slow permeability.	Poor stability and compaction; high shrink-swell potential.
*Radley: Ra, Rh (For Hepler part of Rh, see Hepler series.)	Good	Fair: low to moderate shrink-swell potential.	Fair to good: fair to good stability.	Occasional flooding.	Moderate permeability; nearly level.	Fair to good stability and compaction.
Ringo: Rn, Ro, Rp	Poor: high content of clay.	Poor: high shrink-swell potential.	Poor: poor stability; high shrink-swell potential.	Shale at depth of 20 to 40 inches; sloping; high shrink-swell potential; seasonal seepy spots.	Shale at depth of 20 to 40 inches; very slow permeability.	Poor stability; high shrink-swell potential.

See footnote at end of table.

interpretations of soil properties—Continued

Soil features affecting—Continued					Soil limitations for sewage disposal by—	
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter field	Sewage lagoons
Somewhat poorly drained; occasional flooding; moderately slow permeability.	Occasional flooding; moderately slow permeability; somewhat poorly drained.	Nearly level; subject to flooding.	Nearly level; subject to flooding.	Subject to flooding; low to moderate shrink-swell potential.	Severe: subject to flooding; moderately slow permeability.	Slight: moderately slow permeability.
Well drained	Depth of topsoil limits grading; gently sloping.	Limestone at depth of 40 to 60 inches.	Limestone at depth of 40 to 60 inches.	Limestone at depth of 40 to 60 inches; high shrink-swell potential in subsoil.	Moderate: limestone at depth of 40 to 60 inches.	Moderate: limestone at depth of 40 to 60 inches; moderate permeability; variable seepage.
Somewhat poorly drained; subject to flooding; permeability is moderate above depth of 30 inches and slow below depth of 30 inches.	Subject to flooding; permeability is moderate above 30 inches and slow below depth of 30 inches; somewhat poorly drained.	Nearly level; subject to flooding.	Nearly level; subject to flooding; wetness; low fertility.	Subject to flooding; low to moderate shrink-swell potential.	Severe: high water table; subject to flooding; seasonal wetness; permeability is moderate above 30 inches and slow below depth of 30 inches.	Moderate: moderate permeability above depth of 30 inches; slow permeability below depth of 30 inches.
Very slow permeability; poorly drained.	Very slow permeability; frequent flooding; poorly drained.	Nearly level; frequent flooding.	Difficult to establish vegetation; nearly level; poorly drained.	Poorly drained; high shrink-swell potential; frequent flooding.	Severe: poorly drained; frequent flooding; very slow permeability.	Slight.
Very slow permeability; somewhat poorly drained.	Very slow permeability; somewhat poorly drained; nearly level to gently sloping.	Nearly level to gently sloping; dense clay subsoil; very slow permeability.	Difficult to establish vegetation; clay is near surface after shaping.	Poor: high shrink-swell potential; somewhat poorly drained.	Severe: very slow permeability.	Slight.
Moderately well drained; occasional flooding.	Nearly level; moderate permeability; occasional flooding.	Nearly level; occasional flooding.	Nearly level; occasional flooding.	Low to moderate shrink-swell potential.	Moderate: occasional flooding; moderate permeability.	Moderate: moderate permeability.
Well drained; seasonal seepy spots; very slow permeability.	Shale at depth of 20 to 40 inches; sloping; very slow permeability.	Short slopes; 20 to 40 inches to shale.	Shale at depth of 20 to 40 inches; seasonal seepy spots.	Shale at depth of 20 to 40 inches; high shrink-swell potential; very slow permeability.	Severe: shale at depth of 20 to 40 inches; very slow permeability.	Severe: shale at depth of 20 to 40 inches.

TABLE 4. *Engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—		
	Topsoil	Road subgrade	Road fill [1]	Highway location [1]	Reservoir area for ponds	Embankments for ponds, dikes, and levees
Zaar: Za	Poor: high content of clay.	Poor: high shrink-swell potential.	Poor: poor stability; high shrink-swell potential.	High shrink-swell potential; seasonal seepy spots; gently sloping.	Very slow permeability.	High shrink-swell potential; poor stability and compaction.

[1] JOHN E. HUFFMAN, soils engineer, and HERBERT E. WORLEY, soils research engineer, Kansas State Highway Commission, assisted in

TABLE 5.—*Engineering*

[Tests were performed by the State Highway Commission of Kansas under a cooperative agreement with the U.S. Department of Com- (AASHO), except as explained

Soil name and location	Parent material	SCS sample No. S-65-Kans.	Depth from surface	Moisture-density data [1]	
				Maximum dry density	Optimum moisture
			Inches	*Lb. per cu. ft.*	*Percent*
Bates loam: 3,300 feet west and 1,600 feet south of the northeast corner of sec. 1, T. 28 S., R. 23 E. (Modal)	Sandstone or sandy shale.	19-4-1	0-9	107	17
		19-4-2	9-16	108	16
		19-4-3	16-23	104	18
		19-4-4	23-33	107	19
Dennis silt loam: 1,600 feet east and 1,100 feet south of the northwest corner of sec. 20, T. 29 S., R. 22 E. (Modal)	Silty shale.	19-7-1	0-13	100	18
		19-7-2	24-38	105	18
		19-7-3	38-51	105	19
		19-7-4	51-72	107	19
Lula silt loam: 180 feet south and 180 feet east of the northwest corner of the NE¼ sec. 10, T. 30 S., R. 22 E. (Modal)	Limestone.	19-1-1	0-6	105	18
		19-1-2	16-30	99	21
		19-1-3	30-43	96	24
Parsons silt loam: 1,590 feet south and 185 feet west of the north east corner of the NW¼ sec. 25, T. 29 S., R. 23 E. (Modal)	Clayey shale.	19-2-1	0-6	105	16
		19-2-2	15-25	90	27
		19-2-3	40-72	101	21

[1] Based on AASHO Designation T 99-57, Method A (*1*), with the following variations: (1) all material is ovendried at 230° F.; (2) all material is crushed in a laboratory crusher after drying; and (3) no time is allowed for dispersion of moisture after mixing with the soil material.

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

interpretations of soil properties—Continued

Soil features affecting—Continued					Soil limitations for sewage disposal by—	
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter field	Sewage lagoons
Moderately well drained; seasonal seepy spots; very slow permeability.	Very slow permeability; gently sloping.	Clayey surface soil and dense clay subsoil; gently sloping.	Moderately well drained; difficult to prepare seedbed; seasonal seepy spots.	High shrink-swell potential; very slow permeability.	Severe: very slow permeability.	Moderate to slight: 1 to 3 percent slopes.

preparing the information in these columns.

test data

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

Mechanical analysis [2]							Liquid limit	Plasticity index	Classification	
Percentage less than 3 inches in diameter passing sieve—			Percentage smaller than—						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.	*Percent*			
100	99	64	54	38	19	12	30	9	A-4(6)	ML-CL
100	99	66	58	43	26	18	30	11	A-6(7)	CL
100	96	70	63	48	32	26	37	17	A-6(10)	CL
100	96	67	59	45	32	26	37	17	A-6(9)	CL
100	99	80	68	44	18	10	37	10	A-4(8)	ML-CL
100	98	83	74	57	39	33	50	30	A-7-6(18)	CL-CH
100	99	85	77	59	39	35	54	38	A-7-6(19)	CH
100	99	88	82	64	44	37	55	38	A-7-6(19)	CH
100	99	91	83	57	27	17	33	12	A-6(9)	CL
100	99	95	91	70	46	38	51	27	A-7-6(17)	CH
100	98	91	88	74	55	47	57	32	A-7-6(19)	CH
100	98	83	74	50	21	13	32	11	A-6(8)	CL
100	99	93	89	77	58	50	62	35	A-7-6(20)	CH
100	99	88	82	65	44	36	49	30	A-7-6(18)	CL

servation 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 in this table are not suitable for use in naming textural classes for soils.

[3] Soil Conservation Service and Bureau of Public Roads have agreed to consider that all soils having plasticity indexes within two points from A-line are to be given a borderline classification. An example of a borderline classification obtained by this use is ML-CL

460-887—73——4

Irrigation is affected by such features as water intake rate, permeability, available water capacity, depth to bedrock, and susceptibility to flooding.

Terraces and diversions are affected by such soil features as depth to bedrock, texture, slope, and rock outcrops.

Grassed waterways are affected by such features as seepage, depth to bedrock, erodibility, difficulty in establishing vegetation, and fertility.

Foundations for low buildings considers those features of an undisturbed soil, to a depth of approximately 6 feet, that affect its suitability for supporting low buildings with normal foundation loads.

Septic tank filter field considers those features of the undisturbed soil that limit the absorption of effluent or that in other ways may be a hazard if the soil is used for this purpose.

Sewage lagoons rates the undisturbed soil for its ability to hold sewage for the time required for bacterial decomposition.

Engineering test data

Table 5 contains the results of engineering tests performed by the State Highway Commission of Kansas in cooperation with the U.S. Department of Commerce, Bureau of Public Roads, on several important soils in Crawford County. The table shows the specific location where samples were taken, the depth to which sampling was done, and the results of tests to determine particle-size distribution and other properties significant in soil engineering.

Maximum dry density is the maximum unit dry weight of the soil when it has been compacted with optimum moisture by the prescribed method of compaction. The moisture content that gives the highest dry unit weight is called the optimum moisture content for the specific method of compaction.

Mechanical analyses show the percentages, by weight, of soil particles that pass sieves of specified sizes. Sand and coarser materials do not pass the No. 200 sieve. Silt particles, which pass the No. 200 sieve, are larger than 0.002 millimeter in diameter. Clay particles, which also pass the No. 200 sieve, are smaller than 0.002 millimeter in diameter. The clay fraction was determined by the hydrometer method, rather than by the pipette method used by most soil scientists to determine the clay content of soil samples.

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a solid to a plastic state; if the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material passes from solid to plastic. The liquid limit is the moisture content at which the material changes from plastic to liquid. The plasticity index is the numerical difference between the liquid limit and the plastic limit; it indicates the range of moisture content within which a soil material is plastic.

Use of the Soils for Recreation[5]

Crawford County attracts many sportsmen because of the excellent hunting and fishing. The county has many good roads and recreation sites that are easily accessible. Further development of recreation areas is expected.

Strip mining operations in the eastern and southern parts of the county have created ribbonlike areas of water, many of which provide good fishing. These areas can be further developed for recreation, including water sports, hunting, cabin sites, picnic areas, and camping. The Crawford County State Lake and Park on U.S. Highway No. 69, 4 miles north of Pittsburg, is a good example of recreational use of strip mined areas. Private recreational facilities, including cabin sites, have been developed on some strip pit areas in the county.

Limitations of the soils that affect their suitability for use as recreational sites are rated in table 6. The ratings in this table are *slight*, *moderate*, and *severe*. A rating of *slight* means that the soil has few or no limitations for the use specified or that the limitations can be easily overcome. A rating of *moderate* indicates that some planning and engineering practices are needed to overcome soil limitations. A rating of *severe* indicates that the soil is poorly suited to the intended use and that intensive engineering practices are needed to overcome the limitations.

These ratings provide general information regarding soil suitability, but specific engineering construction generally requires a detailed onsite investigation. Soil suitabilities for specified recreational uses are discussed in the paragraphs that follow.

Intensive campsites.—These sites are used for tents, small camp trailers, and related activities. They should be suitable for heavy foot or vehicular traffic, since they are used frequently during the camping season. Suitability of the soil for producing vegetation should be considered separately in selecting sites for intensive camping.

Picnic areas.—These ratings in table 6 are based only on soil features. Other considerations, such as lakes, trees, or beauty, may also affect the desirability of the site.

Intensive play areas.—Areas for such uses as baseball diamonds, football fields, badminton courts, and playgrounds are considered in this category. The areas should have a nearly level, rock-free surface and good drainage. It is assumed that good vegetative cover can be established and maintained where needed.

Trails and paths.—Activities within this category require trails for cross-country hiking, bridle paths for horseback riding, and other sites for nonintensive uses. It is not anticipated that the soils will need much grading or shaping. Ratings are based on soil features only and do not include other features, such as beauty of the landscape, that are important in the selection of sites for trails and paths.

Table 6 does not include soil interpretations for sewage

[5] JACK W. WALSTROM, biologist, Soil Conservation Service, prepared this section.

disposal or for foundations for low buildings, such as cottages, washrooms, picnic shelters, and service buildings. Such interpretations are given in the section "Engineering Uses of Soils" in table 5, under "Soil Limitations for Sewage Disposal" and "Soil Features Affecting Foundations for Low Buildings."

TABLE 6.—*Limitations of soils used for recreational sites*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. For this reason the reader should carefully follow the instructions for referring to other series in the first column of this table]

Soil series and map symbols	Degree and kind of limitation if soils are used for—				
	Intensive campsites	Picnic areas	Intensive play areas	Trails and paths	Golf fairways
Bates: Ba, Bb, Bc, Bd	Slight	Slight	Moderate: slope; bedrock at depth of 20 to 40 inches.	Slight	Slight.
*Bolivar: Be (For Hector part, see Hector series.)	Slight where slopes are 8 percent or less. Moderate where slopes are more than 8 percent.	Slight where slopes are 8 percent or less. Moderate where slopes are more than 8 percent.	Severe: slope	Slight	Moderate to severe: slope.
Breaks-Alluvial land complex: Bk.	Severe: flooding; rough, irregular area.	Severe: flooding; rough, irregular area.	Severe: flooding; rough, irregular area.	Severe: flooding; rough, irregular area.	Severe: flooding; rough, irregular area.
Cherokee: Ce	Severe: somewhat poorly drained; very slow permeability.	Moderate: somewhat poorly drained.	Severe: very slow permeability; somewhat poorly drained.	Moderate: somewhat poorly drained.	Moderate: very slow permeability; somewhat poorly drained.
Clareson: Cf	Severe: rockiness or stoniness.	Moderate: rockiness or stoniness.	Severe: rockiness or stoniness.	Moderate: rockiness or stoniness.	Severe: rockiness or stoniness.
*Dennis: De, Df, Dg, Dh, Dp (For Parsons part of Dp, see Parsons series.)	Moderate: moderately well drained; slow permeability.	Slight	Moderate: slope; moderately well drained; slow permeability.	Slight	Slight.
Eroded land: Er	Moderate: texture of surface layer.	Moderate: texture of surface layer, slope.	Severe: slope; bedrock at depth of 30 inches or less.	Moderate: texture of surface layer.	Severe: slope; texture of surface layer.
Girard: Gd	Severe: flooding	Severe: flooding; poorly drained.	Severe: flooding; poorly drained.	Severe: poorly drained.	Severe: flooding; poorly drained.
Hector (Mapped only in a complex with Bolivar soils.)	Severe: rockiness and stoniness.	Slight where slopes are 8 percent or less. Moderate where slopes are more than 8 percent.	Severe: slope; bedrock at depth of less than 20 inches.	Slight	Severe: rockiness or stoniness.
Hepler: He	Severe: flooding; somewhat poorly drained.	Moderate: flooding; somewhat poorly drained.	Moderate: flooding; somewhat poorly drained.	Moderate: somewhat poorly drained.	Moderate: flooding; somewhat poorly drained.
Lula:					
Ls, Lu (For Clareson part of Lu, see Clareson series.)	Slight	Slight	Slight	Slight	Slight.
Lt	Moderate: texture of surface layer.	Moderate: texture of surface layer.	Moderate: texture of surface layer.	Moderate: texture of surface layer.	Moderate: texture of surface layer.

TABLE 6.—*Limitation of soils used for recreational sites*—*Continued*

Soil series and map symbols	Degree and kind of limitation if soils are used for—				
	Intensive campsites	Picnic areas	Intensive play areas	Trails and paths	Golf fairway
McCune: Mc	Severe: flooding; somewhat poorly drained.	Moderate: flooding; somewhat poorly drained.	Severe: somewhat poorly drained; slow permeability; flooding.	Moderate: somewhat poorly drained.	Moderate: flooding; somewhat poorly drained.
Mine pits and dumps: Md	Severe: stoniness; rough, irregular areas.	Severe: stoniness; rough, irregular areas.	Severe: stoniness; rough, irregular areas.	Moderate: rough, irregular areas.	Severe: stoniness; rough, irregular areas.
Osage: Os	Severe: flooding; poorly drained; texture of surface layer.	Severe: flooding; poorly drained; texture of surface layer.	Severe: flooding; poorly drained; texture of surface layer.	Severe: poorly drained; texture of surface layer.	Severe: flooding; poorly drained; texture of surface layer.
Parsons: Pa, Pb, Pc	Severe: very slow permeability.	Moderate: somewhat poorly drained.	Severe: very slow permeability; somewhat poorly drained.	Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained; very slow permeability.
*Radley: Ra, Rh (For Hepler part of Rh, see Hepler series.)	Severe: flooding	Moderate: flooding.	Moderate: flooding.	Slight	Moderate: flooding.
Ringo: Rn, Ro	Severe: texture of surface layer.	Severe: texture of surface layer.	Severe: slope; texture of surface layer; very slow permeability.	Severe: texture of surface layer.	Severe: texture of surface layer; very slow permeability.
Rp	Severe: texture of surface layer; rockiness.	Severe: texture of surface layer; rockiness.	Severe: texture of surface layer; rockiness; slope.	Severe: texture of surface layer; rockiness.	Severe: texture of surface layer; rockiness; slope.
Zaar: Za	Severe: texture of surface layer; very slow permeability.	Severe: texture of surface layer.	Severe: texture of surface layer.	Severe: texture of surface layer.	Severe: texture of surface layer.

Formation, Morphology, and Classification of Soils

This section explains how soils form and discusses the factors of soil formation. It also discusses morphology of the soils, describes briefly the system of soil classification, and places the soil series represented in Crawford County in some classes of that system.

Factors of Soil Formation

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

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

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

Parent material

Parent material is the unconsolidated mass from which the soil profile is formed. It determines to a large extent the mineralogical and chemical composition of the soil and the rate at which soil-forming processes take place. It affects the texture, structure, color, natural fertility, and other properties of the soil. Parent material is formed by mechanical and chemical weathering of rocks. Among the agents of mechanical weathering are temperature changes, freezing of water, growth of crystals, actions of plants and animals, wetting and drying, abrasion, and corrosion (*4*). Chemical weathering is more complex and generally results in the reduction of particle size; the addition of water, oxygen, and carbon dioxide, and the loss of soluble salts of such metallic elements as sodium and potassium. In a temperate climate, clay minerals commonly result from chemical weathering, and the color and general appearance of a deposit may be markedly altered.

In Crawford County the soils on uplands formed in material weathered from the underlying Pennsylvanian clayey shale, sandstone, limestone, and alkaline shale. The southeastern part of the county is underlain by shale and some sandstone of the Cherokee group. This group is defined to include strata from the base of the Pennsylvanian, north of the Kansas-Oklahoma line, upwards to the base of the Fort Scott limestone. Fifteen coalbeds have been identified in the Kansas Cherokee section (*7*). Other geological formations as they occur from the southeastern to the northwestern part of the county, and in order above the Cherokee group, are the Marmaton group, Pleasanton group, and the lower part of the Kansas City group (*8*). These formations contain mostly limestone and shale, but some sandstone is included.

Soils formed in material weathered from shale are the most extensive in the county. The Cherokee, Parsons, and Zaar soils formed in materials weathered from clayey shale. Material weathered from intermixed clayey and sandy shale is the parent material of Dennis soils. Ringo soils formed in material weathered from soft, calcareous shale. Bolivar soils formed in material from intermixed loamy shale and sandstone.

The Bates soils formed in material weathered from sandstone and interbedded sandy and silty shale. Hector soils formed in material weathered from sandstone. Material weathered from limestone is the parent material of the Clareson and Lula soils. These soils have a clayey subsoil.

Alluvium is the parent material of the Girard, Hepler, McCune, Osage, and Radley soils. Girard and Osage soils formed in clayey alluvium; the others formed in loamy alluvium.

Climate

The climate of Crawford County is continental and has wide seasonal variation. Temperatures below freezing in winter and of 90° F. in summer are common. The average annual rainfall is 42 inches, and the average annual air temperature is 57°. Seasonal winter snowfall ranges from light to heavy. Most of the rainfall comes in spring and fall. July and August are the driest and hottest months. Rainfall is sufficient to leach the surface layer of many of the soils in the county and to transport clay particles into the subsoil. This rainfall also stimulates the growth of plants, which in turn promotes the accumulation of organic matter and a dark-colored surface layer.

Plants and animals

Plant life and animal life are factors in soil development that have a definite effect on the characteristics of the upper part of the soil profile.

The climate of Crawford County favored the growth of tall prairie grasses, such as big bluestem, little bluestem, switchgrass, indiangrass, and others. Somewhat open stands of mixed hardwood trees grew along streams in the larger valleys.

Plants provide organic matter, which improves soil structure. They also provide a protective cover for the soil, which reduces runoff, improves water intake, and reduces the loss of soil moisture through evaporation. Plant cover adjusts itself to soil characteristics; therefore, the nature of the soil parent material in a specific climatic region determines to a large extent the kind of vegetation. The fibrous roots of grasses are near the soil surface and provide the organic matter and dark surface color characteristics of most prairie soils. Plant residue and channels made by plant roots help improve water percolation and aeration of the soil. Plant life also affects the animal life of a given region by furnishing favorable conditions for soil organisms and food and cover for larger burrowing animals and the like.

Bacteria, fungi, and other soil organisms help in the weathering of rocks and the decomposition of organic matter. They influence the chemical, physical, and biological processes of soil formation. Worms, as well as some larger burrowing animals, help modify the soil profile and soil development. Worm casts are common in many of the soils of Crawford County.

Relief

Relief, or the gradient, length, and shape of slopes and their pattern, influences soil formation primarily through its effects upon drainage, runoff, and erosion. Movement of water on the surface and into the soil is affected by relief. The steeper soils, other soil-forming factors being equal, generally have a thinner profile than less sloping soils, because much of the soil material is removed by erosion. Ringo soils are an example of this in Crawford County. In broad, nearly level areas water runs off more slowly, and, consequently, more can penetrate into the soil. The amount of water that soaks into the soil depends on permeability. In Crawford County many of the nearly level soils have well-developed soil profiles that have strongly contrasting horizons that reflect the effect of water in leaching clay particles and soil minerals deeper into the soil. Cherokee and Parsons soils are examples of these. Gently sloping Zaar soils have weak or immature profile development because water can soak into the clayey surface very slowly, and so the leaching effect is less. Gently sloping and moderately sloping soils that formed in permeable parent material generally have moderate profile development, such as that reflected by Bates, Dennis, and Lula soils.

Time

The formation of soils requires time for changes to take place in the parent material—a long time when measured in the space of years. Maturity of soils is expressed in terms of the degree of development of the profile. Those soils with little or no development are immature, and those with well-expressed horizons are mature soils, even though the parent materials from which they formed are the same age.

The soils in Crawford County range from immature to mature. Those on the bottom lands are subject to varying degrees of overflow and receive new sediments with each flooding. These soils generally have a relatively thick, dark-colored surface layer but only weak soil structure. The continual addition of sediment, and other conditions, have retarded soil formation. Radley is an example of an immature bottom-land soil. Zaar soils are considered immature upland soils because they lack well-developed horizons, even though they are of comparative age with Parsons and Dennis soils, which have well-developed horizons and are consequently considered mature soils.

Morphology of the Soils

This section contains two parts. The first gives a brief description of horizon nomenclature, and the second describes the processes involved in horizon development.

Major soil horizons

The results of soil-forming factors can be distinguished by the different layers, or soil horizons, in a soil profile. The soil profile extends from the surface of the soil downward to material that is little altered by the soil-forming processes.

Most soils contain three major horizons, called A, B, and C. These major horizons are further subdivided by the use of letters to indicate differences within one horizon. An example is the B2t horizon, which represents a layer within the B horizon that contains translocated clay illuviated from the A horizon.

The A horizon is the surface layer. It is the layer that has the largest accumulation of organic matter, called an A1 horizon. It is also the layer of maximum leaching or eluviation of clay and iron. If considerable leaching has taken place, an A2 horizon has formed. Parsons silt loam is an example of a soil that has both an A1 and an A2 horizon.

The B horizon lies underneath the A horizon and is commonly called the subsoil. It is the horizon of maximum accumulation, or illuviation, of clay and iron leached from the A horizon. The B horizon is generally more firm and more clayey than the A horizon and generally has blocky or prismatic structure. Most young soils have not developed a B horizon. Several soils in Crawford County have a B horizon; Dennis and Parsons soils are examples.

The C horizon is below the A or B horizon. It consists of material that is little altered by the soil-forming processes but is modified by weathering. Radley and Ringo are examples of soils in Crawford County that have a C horizon.

Processes of soil horizon differentiation

Several processes are involved in the formation of horizons in the soils of Crawford County. These include the accumulation of organic matter, the leaching or accumulation of soluble salts and lime carbonates, the formation and translocation of clay minerals, and the reduction and transfer of iron. These processes are continually taking place and generally at the same time throughout the profile. These processes are slow and take hundreds of thousands of years to reach equilibrium with the environment.

The accumulation of organic matter takes place with the decomposition of plant residue. This process darkens the surface layer and helps form the A1 horizon. Organic matter, once lost, takes a long time to replace. The soils of Crawford County range from low to medium in organic-matter content.

In order for soils to have distinct soil horizons, it is believed that lime and other soluble salts are leached before the translocation of clay minerals. Many factors affect this leaching, such as the kind of salts originally present, the depth to which the soil solution percolates, and the texture of the soil. Annual rainfall affects the depth of soil-solution percolation up to a certain point. Parsons and Cherokee are examples of soils in Crawford County that have distinct soil horizons.

An important factor in soil-horizon formation in Crawford County is the combination of leaching of soluble salts and translocation of clay minerals. The amount of clay minerals in a soil profile is inherent in the parent material, but clay amounts vary from one horizon to another. Clay minerals are usually eluviated, or leached, from the A horizon and illuviated, or accumulated, in the B horizon as clay films on ped faces and in pores and root channels. In some soils an A2 horizon has formed by considerable eluviation of clay minerals to the B horizon. The A2 horizon is light colored and generally has weak platy or weak granular structure. Parsons soils are an example of clay mineral translocation, in that they have both an eluviated A2 horizon and an illuviated B horizon. Dennis and Lula soils are examples of clay mineral translocation in soils that do not have an A2 horizon.

Poorly drained and very poorly drained soils have subsoil and underlying material that are grayish in color, indicating reduction and transfer of iron. Osage soils are an example of this. Well-drained soils that have good aeration are subject to oxidation, the reverse process of reduction, where oxygen combines with iron elements in the soil to produce rust-colored mottles and colors in the soil horizon. Dennis and Bates are examples of soils that have profiles that indicate oxidation.

Classification of Soils

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

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (*11*) and revised later (*10*). The system currently used by the National Cooperative Soil Survey was developed in the early sixties and was adopted in 1965 (*13*). It is under continual study. Therefore, readers interested in development of the current system should refer to the available literature (*9*).

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

Table 7 shows the classification of each soil series of Crawford County by family, subgroup, and order, according to the current system.

ORDER.—Ten soil orders are recognized. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate these soil orders are those that tend to give broad climatic groupings of soils. The two exceptions to this are Entisols and Histosols, which occur in many different climates. Table 7 shows that the three soil orders represented in Crawford County are Mollisols, Alfisols, and Inceptisols.

Mollisols are mineral soils that have a thick, dark-colored surface horizon that contains colloids dominated by bivalent cations. They do not have features that reflect soil mixing caused by shrinking and swelling.

Alfisols are mineral soils that contain horizons of clay accumulation. Unlike the Mollisols, they lack the dark-colored surface horizon dominated by bivalent cations. However, the base saturation of the lower horizons is moderate to high.

Inceptisols are mineral soils that have weakly expressed genetic horizons. The surface layer is generally lighter colored than that of the Mollisols, and they do not have features that reflect soil mixing caused by shrinking and swelling.

SUBORDER.—Each order is divided into suborders, primarily on the basis of those soil characteristics that seem 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 climate or vegetation. The suborder is not shown separately in table 7, because it is part of the last word in the name of the subgroup.

GREAT GROUP.—Suborders are divided into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus has accumulated or those that contain a pan that interferes with 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 7, because it is the last word in the name of the subgroup.

SUBGROUP.—Great groups are divided into subgroups, one that represents the central (typic) segment of the group and others, called intergrades, that have properties of one 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 great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group.

FAMILY.—Families are divided within a subgroup primarily on the basis of properties important to 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 7.—*Soil series classified according to the current system*

Series	Family [1]	Subgroup	Order
Bates	Fine-loamy, siliceous, thermic	Typic Argiudolls	Mollisols.
Bolivar	Fine-loamy, mixed, thermic	Ultic Hapludalfs	Alfisols.
Cherokee	Fine, mixed, thermic	Typic Albaqualfs	Alfisols.
Clareson	Clayey-skeletal, mixed, thermic	Typic Argiudolls	Mollisols.
Dennis	Fine, mixed, thermic	Aquic Paleudolls	Mollisols.
Girard	Fine, mixed, noncalcareous, thermic	Cumulic Haplaquolls	Mollisols.
Hector	Loamy, siliceous, thermic	Lithic Dystrochrepts	Inceptisols.
Hepler	Fine-silty, mixed, thermic	Udollic Ochraqualfs	Alfisols.
Lula	Fine-silty, mixed, thermic	Typic Argiudolls	Mollisols.
McCune	Fine-silty, mixed, thermic	Aeric Glossaqualfs	Alfisols.
Osage	Fine, montmorillonitic, noncalcareous, thermic	Vertic Haplaquolls	Mollisols.
Parsons	Fine, mixed, thermic	Mollic Albaqualfs	Alfisols.
Radley	Fine-silty, mixed, thermic	Fluventic Hapludolls	Mollisols.
Ringo	Fine, mixed, thermic	Typic Hapludolls	Mollisols.
Zaar	Fine, montmorillonitic, thermic	Vertic Hapludolls	Mollisols.

[1] The placement of some soil series in the current system, particularly in families, may change as more precise information becomes available. The classification used here is as of March 1970.

Additional Facts About the County

In this section some of the general characteristics of the county are discussed that should be useful to those not familiar with the county. Among these are relief and drainage, climate, farming, and other subjects of general interest.

Crawford County was organized in 1867, shortly after the Civil War, but permanent settlement did not begin until about 1872. Industry played an important part in the original settlement and prosperity of the county. The chief industry, along with farming, was coal mining. It was centered mainly in the eastern part of the county, but some mines were located in the southern part of the county near the towns of Cherokee and Monmouth. Deepshaft coal mines ceased operation many years ago, but surface strip mining still takes place. The largest coal mining activities in the county at the present time are southeast of Pittsburg and near Arcadia. The coal industry was indirectly responsible for considerable railroad activity. Trains were needed to haul the coal to the markets. Pittsburg at one time had substantial railroad employment for a town of its size and was an important railroad center in the southeastern part of Kansas. However, reduced coal shipments and other economic factors have cut back considerably the volume of railroad shipping and employment.

Just as the coal mining at its peak brought prosperity and population to the county, it later tended to create an economic problem. As the demand for coal declined because of economic factors and competition from other fuels, many mines shut down. This caused unemployment, which later resulted in a loss of population. In some places there now remains only small settlements or towns in areas that once were booming mining centers and camps.

In 1970 Girard, the county seat, had a population of 2,591, and Pittsburg, the largest town, had a population of 20,171. In that year Crawford County had a population of 37,850, according to records of the U.S. Bureau of the Census.

Crawford County has two State parks. One is near Pittsburg; it consists of small strip pit lakes and has facilities for picnicking, camping, and fishing. The other is near Farlington. It consists of a 160-acre lake and has fishing, boating, and camping facilities. Also located at this lake is the National Fish Hatchery, the oldest Federal fish hatchery in the State. The State Quail hatchery is located on strip-mined land near Pittsburg and has fishing facilities in the strip pit lakes.

Relief and Drainage

Crawford County is in the Cherokee Prairies land resource area. Geology is of the lower Pennsylvanian system. The southeastern part is underlain mainly by shale, with minor amounts of sandstone and sandy shale. The rest of the county is underlain by limestone, sandstone, and associated shale. Relief is gently rolling and consists of low hills and broad flats, with breaks and narrow bluffs adjacent to the larger stream valleys. Slopes of 2 to 6 percent are dominant, but slopes of 0 to 2 percent and 6 to 15 percent are common. The southeastern part of the county has the smoothest relief; the rest of the county is more undulating. Elevations range from 823 feet in the northeastern part at Arcadia to 1,001 feet at Hepler in the northwestern part of the county. McCune, in the southwestern part of the county, has an elevation of 921 feet, and Pittsburg, in the southeastern part, has an elevation of 932 feet.

The county contains several large creeks, but no rivers. Drywood Creek and Cox Creek, in the northeastern part of the county, drain northward into the Osage River, which in turn flows into the Missouri River Basin. Walnut, Hickory, Lightning, Limestone, and Cow Creeks drain southward into the Neosho River, which then flows into the Arkansas River Basin. Surface drainage in the county is generally good, but underdrainage is relatively poor. The larger creeks flow intermittently during the summer. The deeper waterholes seldom go dry.

Climate [6]

The humid, continental climate of Crawford County is characterized by abundant precipitation, warm to hot summers, generally mild winters, moderate to high humidity, light to moderate winds, and low annual snowfall. Table 8 gives temperature and precipitation data.

The Gulf of Mexico is the principal source region for precipitation in Kansas (*3*). The eastern part of the State is frequently in a flow of warm, moist air that moves northward from the Gulf. The interaction of this air with occasional surges of cooler, drier air from northern latitudes produces heavy precipitation at times. The frequency of moist airflow is greater in the southeastern part of Kansas than in any other part of the State. Thus, Crawford County is in the wettest part of Kansas.

Winter is the driest season; late spring and early summer are usually the wettest. Heaviest precipitation is in May and June. In each of these months precipitation averages more than 5 inches.

A large part of the precipitation falls during the warm season. An average of three-fourths of the annual rainfall occurs during the 7-month period of April through October. This distribution, which coincides closely with the average freeze-free period, favors the growth of crops and grasses.

Precipitation, although usually adequate, varies considerably from month to month and from year to year. During the period 1913–66 annual precipitation has ranged from 21.50 inches in 1963 to 63.11 inches in 1941. It is not unusual for a very dry year to follow a very wet year. One of the wettest years of record was 1951, when a total of 56.69 inches was recorded. During the next year, however, precipitation dropped to 25.32 inches. Droughts of several years' duration seldom occur in Crawford County. Precipitation in a particular year may be unusually low, but a period of dry weather rarely lasts more than a year.

Temperature variations are typical of mid-latitude, continental locations. Mean monthly temperatures at Columbus range from 34° F. in January to 79° in July and August. Temperature extremes for the period of

[6] By MERLE J. BROWN, climatologist for Kansas, National Weather Service, U.S. Department of Commerce.

TABLE 8.—*Temperature and precipitation data*

[Temperature recorded at Columbus (Cherokee County). Precipitation recorded at Pittsburg]

Month	Temperature				Precipitation		
	Average daily maximum [1]	Average daily minimum [1]	Two years in 10 will have at least 4 days with—		Average total [3]	One year in 10 will have—	
			Maximum temperature equal to or higher than [2]—	Minimum temperature equal to or lower than [2]—		Monthly totals less than [4]—	Monthly totals more than [4]—
	° F.	° F.	° F.	° F.	Inches	Inches	Inches
January	44. 0	24. 2	64	6	1. 84	0. 27	3. 90
February	47. 8	26. 6	67	12	1. 64	. 38	2. 72
March	58. 3	35. 2	77	19	2. 82	. 98	5. 16
April	68. 6	45. 7	83	31	4. 22	1. 90	7. 82
May	77. 2	54. 8	88	43	5. 30	2. 12	8. 86
June	86. 0	63. 8	97	54	5. 74	1. 58	10. 33
July	90. 9	67. 3	102	60	3. 56	. 77	7. 68
August	91. 1	66. 4	103	57	3. 37	. 82	7. 00
September	83. 8	59. 0	98	45	4. 59	. 96	9. 80
October	72. 6	47. 6	88	34	3. 50	. 32	6. 44
November	58. 2	35. 4	74	20	2. 33	. 35	4. 86
December	46. 8	27. 1	66	12	1. 68	. 32	3. 28
Year	68. 8	46. 1	[5] 102	[6] −4	40. 59	27. 84	53. 67

[1] For period 1894–1960.
[2] For period 1931–1960.
[3] For period 1909–1960.
[4] For period 1913–1966.
[5] Average of annual highest temperature for period 1894–1967.
[6] Average of annual lowest temperature for period 1894–1967.

record at that location are −28° and 117°. Columbus is in Cherokee County, but temperature data for that location are considered generally representative of conditions in Crawford County.

Winters are usually mild, and summers are warm to hot. The average number of days per year that have maximum temperatures equal to or higher than 90° is 71. August, which has an average of 23 days with maximum temperatures of 90° or above, has more such days than any other month.

Crawford County is in the area that has the longest growing season in Kansas. The freeze-free period averages 6½ months in length and extends from about April 10 to October 25 (*2*). The probabilities for the last freeze in spring and the first in fall in central Crawford County are given for five thresholds in table 9.

Snowfall is light, or 12 to 14 inches per year. Snow that accumulates on the ground usually melts within a few days. Blizzards are infrequent and are generally short.

The prevailing wind direction is southerly. Winds are generally light to moderate in all seasons, but strong winds occur occasionally, especially in spring.

Tornadoes and severe windstorms strike occasionally in Crawford County. These storms are usually local in extent, are of short duration, and produce damage in a variable and spotty pattern. Hail is reported at times in the warmer part of the year, but such storms occur in an irregular pattern and affect relatively small areas. In contrast to precipitation, which increases from west to east over Kansas, the probability of damaging hail is less over the eastern part of Kansas than over the western part.

TABLE 9.—*Probabilities of critical temperatures in spring and fall*

Probability	Dates for given probability and temperature				
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower
Spring:					
1 year in 10 later than	March 16	March 26	April 3	April 15	April 25
2 years in 10 later than	March 10	March 20	March 29	April 10	April 20
5 years in 10 later than	February 26	March 10	March 20	March 31	April 10
Fall:					
1 year in 10 earlier than	November 20	November 13	November 2	October 20	October 11
2 years in 10 earlier than	November 26	November 18	November 6	October 25	October 15
5 years in 10 earlier than	December 8	November 29	November 16	November 3	October 25

Farming

Farming was the main interest of the first settlers of Crawford County. There were large expanses of native prairie and trees along the channels of the major streams. Only the better soils were cultivated. These were mainly on the stream bottoms and the uplands that adjoined the valleys. Livestock was the dominant farming enterprise until about 1877, when commercial coal mining began.

Coal was discovered in the southeastern part of the county before the Civil War. Later, much of the eastern part of the county was bought by coal companies and leased to farmers and men employed in the mines, who farmed as a sideline.

According to the early history of the county, some cotton, tobacco, and flax were grown. Because of the uncertainty of the growing season, small returns, and plant diseases, these gave way to the currently grown crops, mainly wheat, corn, sorghums, soybeans, and alfalfa. Minor crops are oats, rye, barley, and sweetclover. Tame grass pastures of brome or fescue are commonly used for grazing. A combination of raising livestock and growing cash-grain crops is the dominant farming enterprise today. Little of the acreage is irrigated because, in most years, rainfall is adequate for crop growth. There are a few cattle feedlot operations and some dairy farms. Other livestock are hogs, sheep, and poultry.

The following trends in the harvested acreage of the main crops in the county are based on reports of the Kansas State Board of Agriculture (*5*, *6*). Corn acreage declined from 60,000 in 1946 to 33,080 in 1966. Wheat has remained relatively constant, from 39,700 acres in 1946 down to 36,000 acres in 1966. The acreage of soybeans has increased from 11,370 acres in 1946 to 57,400 acres in 1966, and alfalfa, from 1,120 acres in 1946 to 4,300 acres in 1966. The total acreage of sorghum for all uses—grain, forage, and silage—was 16,460 acres in 1946 and 14,000 acres in 1966. However, sorghum for grain has risen from 7,310 acres in 1946 to 12,500 acres in 1966, forage sorghum has declined from 5,130 acres in 1946 to 500 acres in 1966, and sorghum for silage has dropped from 4,020 acres in 1946 to 1,000 acres in 1966.

Statistics from the Kansas State Board of Agriculture reports indicate the following changes in the number of livestock in Crawford County. Beef cattle have increased from 26,200 head in 1946 to 44,200 head in 1966, but milk cows have decreased from 8,500 head in 1946 to 3,800 head in 1966. Hogs numbered 12,400 in 1946 and 10,000 in 1966. The number of sheep and lambs decreased from 5,900 in 1946 to 1,200 in 1966.

In 1946 the farmers and landowners organized the Crawford County Soil Conservation District. The purpose of this district is to promote soil and water conservation.

Industries, Transportation, and Markets

Many important nonfarm industries are located in Crawford County. Coal is mined in the eastern part of the county near Pittsburg and Arcadia. Located at Pittsburg are a clay-tile manufacturing plant, a livestock slaughter and meatpacking plant, a soft-drink bottling plant, a feed and livestock supplement manufacturing firm, a branch of the Bureau of the Census, a garment factory, an aircraft manufacturing firm, and some trucking firms. At Girard there is a business-form printing plant that has more than 100 employees and is expanding its operations. Some feed mills manufacture and market various kinds of livestock feed. There are several small oilfields, nurseries, wholesale produce and mercantile businesses, and limestone quarries that produce agricultural limestone and road-surfacing materials. A fertilizer plant, a tire factory, a gunpowder and explosives plant, and lead and zinc mines are within a 50-mile radius of Girard.

Crawford County is served by several Federal and State highways. Nearly all of the rural roads are surfaced, all-weather roads that follow section lines.

Several railroads provide adequate freight service, but passenger service has been severely curtailed in recent years.

The municipal airport near Pittsburg has facilities for both commercial and private airplanes. Bus service is also available at Pittsburg.

Most farm grain products, chiefly corn, wheat, grain sorghum, and soybeans, are marketed locally. Several towns in the county have facilities to store and handle grain, which is later shipped by railroad or truck to terminal elevators and markets elsewhere. Some beef cattle and hogs are sold and processed locally, but most of the livestock is marketed outside the county.

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Glossary

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

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

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

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.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Concretions. Hard grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds that cement the soil grains 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; will not hold together in a mass.

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

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

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

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

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

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

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

Cover crop. A close-growing crop grown primarily to improve and to protect the soil between periods of regular crop production; or a crop grown between trees and vines in orchards and vineyards.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil; opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have low water-holding capacity.

Somewhat excessively drained soils are very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

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

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

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Eluviation. The movement of material from one place to another within the soil, in either true solution or colloidal suspension. Soil horizons that have lost material through eluviation are said to be eluvial; those that have received material are alluvial.

Erosion, soil. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors, such as light, moisture, temperature, and the physical condition of the soil, are favorable.

Gravel. Rounded or angular rock fragments that are not prominently flattened and are up to 3 inches in diameter.

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

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

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

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused by (1) accumulation of clay, sesquioxides, humus, or some combination of these; (2) prismatic or blocky structure; (3) redder or stronger colors than the A horizon; or (4) some combination of these. The 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.

Illuviation. The accumulation of material in a soil horizon through the deposition of suspended material and organic matter removed from horizons above. Since part of the fine clay in the B horizon (or subsoil) of many soils has moved into the B horizon from the A horizon above, the B horizon is called an illuvial horizon.

Loam. The textural class name for a soil having a moderate amount of sand, silt, and clay. Loam soils are 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand.

Loamy soil. A general expression for soils of intermediate texture between the coarse-textured or sandy soils on the one hand, and the fine-textured or clayey soils on the other. Sandy loam, loam, silt loam, and clay loam are regarded as loamy soils.

Loess. Fine-grained material that consists dominantly of silt-size particles that have been deposited by wind.

Organic matter. A general term for plant and animal material, in or on the soil, in all stages of decomposition. Readily decomposed organic matter is often distinguished from the more stable forms that are past the stage of rapid decomposition.

Parent material. The disintegrated and partly weathered rock from which soil has formed.

Permeability, soil. 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.*

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 degree of acidity or alkalinity are expressed thus:

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

Sand. As a soil separate, 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 of any mineral composition. As a soil textural class, soil material that is 85 percent or more sand and not more than 10 percent clay.

Silt. As a soil separate, 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). As a soil textural class, soil material that 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.

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

Subsoil. Technically, the B horizon in soils that have a distinct profile; roughly, the part of the solum below plow depth.

Substratum. Technically, the C or R horizon; roughly, the part of the soil beneath the solum.

Surface layer. A term used in nontechnical soil descriptions for one or more upper layers of soil; includes the A horizon and part of the B horizon; has no depth limit.

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

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

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surplus runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

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

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

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. The suitability of the soils for use as cropland is discussed in the soil descriptions. The capability classification system is explained and general management of dryland soils is discussed in the section "Use of the Soils for Crops," beginning on page 21. For use of soils for woodland, see the section beginning on page 27. Other information is given in tables as follows:

Acreage and extent, table 1, page 6.
Predicted yields of dryland crops, table 2, page 24.
Engineering uses of the soils, tables 3, 4, and 5, pages 32 through 39.
Limitations of soils used for recreation, table 6, page 41.

Map symbol	Mapping unit	Described on page	Capability unit	Range site	
			Symbol	Name	Page
Ba	Bates loam, 1 to 4 percent slopes	6	IIe-2	Loamy Upland	27
Bb	Bates loam, 1 to 4 percent slopes, eroded	6	IIIe-7	Loamy Upland	27
Bc	Bates loam, 4 to 7 percent slopes	6	IIIe-1	Loamy Upland	27
Bd	Bates loam, 4 to 7 percent slopes, eroded	7	IVe-1	Loamy Upland	27
Be	Bolivar-Hector complex, 5 to 12 percent slopes	7	VIe-2	Savannah	27
Bk	Breaks-Alluvial land complex	7			
	Breaks	--	VIe-1	Clay Upland	26
	Alluvial land	--	VIe-1	Loamy Lowland	26
Ce	Cherokee silt loam	9	IIIw-3	Clay Upland	26
Cf	Clareson flaggy silty clay loam, 0 to 3 percent slopes	10	VIe-3	Shallow Flats	27
De	Dennis silt loam, 1 to 4 percent slopes	11	IIe-1	Loamy Upland	27
Df	Dennis silt loam, 1 to 4 percent slopes, eroded	11	IIIe-8	Loamy Upland	27
Dg	Dennis silt loam, 4 to 7 percent slopes	11	IIIe-3	Loamy Upland	27
Dh	Dennis silt loam, 4 to 7 percent slopes, eroded	11	IIIe-9	Loamy Upland	27
Dp	Dennis-Parsons silt loams, 1 to 4 percent slopes	11			
	Dennis soil	--	IIIe-5	Loamy Upland	27
	Parsons soil	--	IIIe-5	Clay Upland	26
Er	Eroded land, 3 to 10 percent slopes	12	VIe-1	Eroded Loamy Upland	26
Gd	Girard silty clay loam 1/	12	IIIw-2	Clay Lowland	25
He	Hepler silt loam 2/	13	IIw-1	Loamy Lowland	26
Ls	Lula silt loam, 1 to 3 percent slopes	14	IIe-3	Loamy Upland	27
Lt	Lula silty clay loam, 1 to 3 percent slopes, eroded	14	IIIe-4	Loamy Upland	27
Lu	Lula-Clareson complex, 1 to 3 percent slopes	15			
	Lula soil	--	IIIe-4	Loamy Upland	27
	Clareson soil	--	IIIe-4	Shallow Flats	27
Mc	McCune silt loam 2/	15	IIw-1	Loamy Lowland	26
Md	Mine pits and dumps	15	VIIs-1	Mine Pits and Dumps	27
Os	Osage clay 1/	17	IIIw-1	Clay Lowland	25
Pa	Parsons silt loam, 0 to 1 percent slopes	18	IIs-1	Clay Upland	26
Pb	Parsons silt loam, 1 to 3 percent slopes	18	IIIe-5	Clay Upland	26
Pc	Parsons silt loam, 1 to 3 percent slopes, eroded	19	IVe-2	Clay Upland	26
Ra	Radley silt loam 2/	19	I-1	Loamy Lowland	26
Rh	Radley-Hepler silt loams 2/	19	VIw-1	Loamy Lowland	26
Rn	Ringo silty clay, 3 to 9 percent slopes	20	IIIe-6	Clay Upland	26
Ro	Ringo silty clay, 3 to 9 percent slopes, eroded	20	IVe-3	Limy Upland	26
Rp	Ringo complex, 9 to 15 percent slopes	20	VIe-4	Limy Upland	26
Za	Zaar silty clay, 1 to 3 percent slopes	21	IIIe-2	Clay Upland	26

1/ This soil in woodland suitability group 2.

2/ This soil in woodland suitability group 1.

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Nondiscrimination Statement

Nondiscrimination Policy

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

To File an Employment Complaint

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

To File a Program Complaint

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

Persons with Disabilities

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

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

Supplemental Nutrition Assistance Program

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

All Other Inquiries

For information not pertaining to civil rights, please refer to the listing of the USDA Agencies and Offices (http://directives.sc.egov.usda.gov/33086.wba).