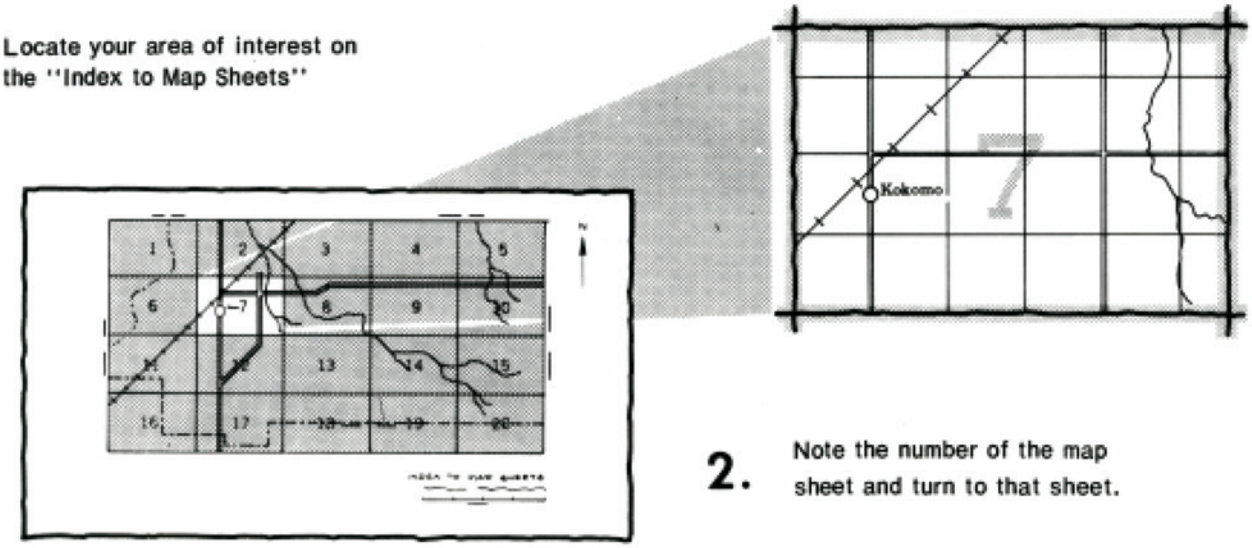
soil survey of

Ottawa County, Kansas

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

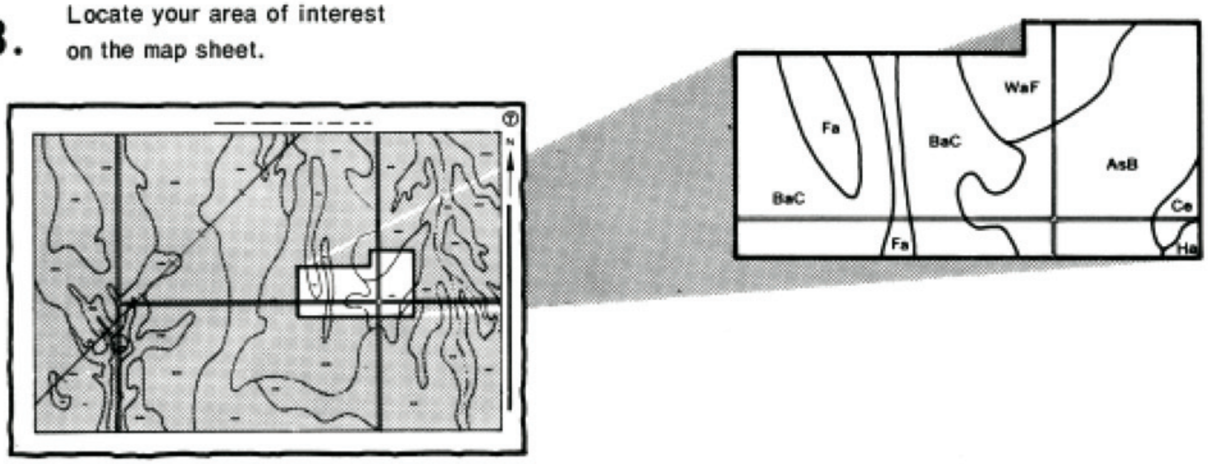
HOW TO USE

1. Locate your area of interest on the "Index to Map Sheets"



2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



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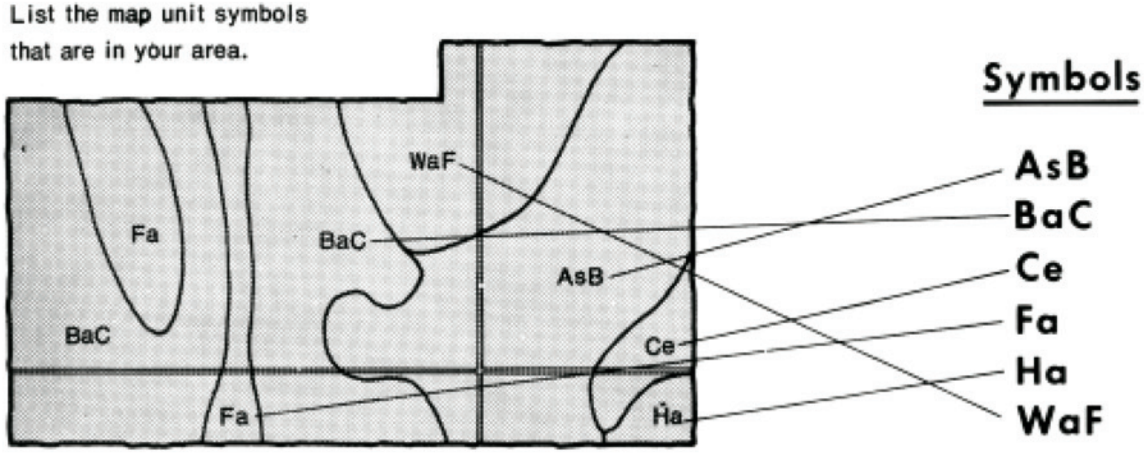
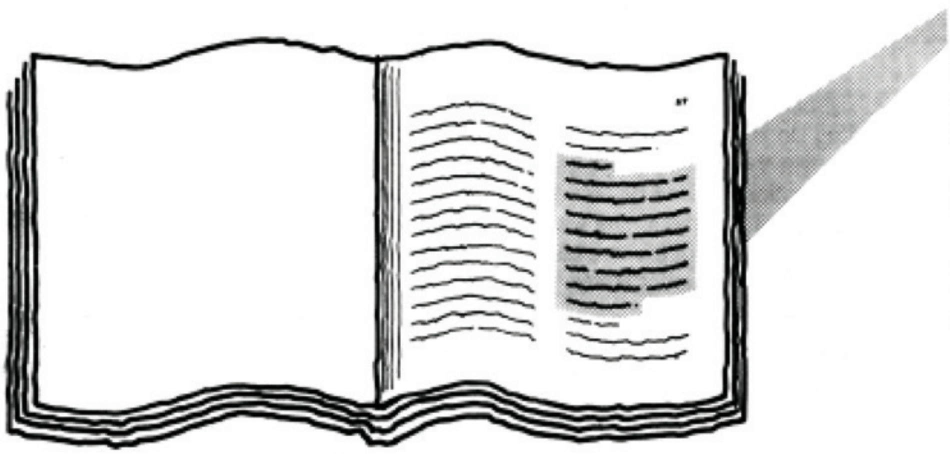
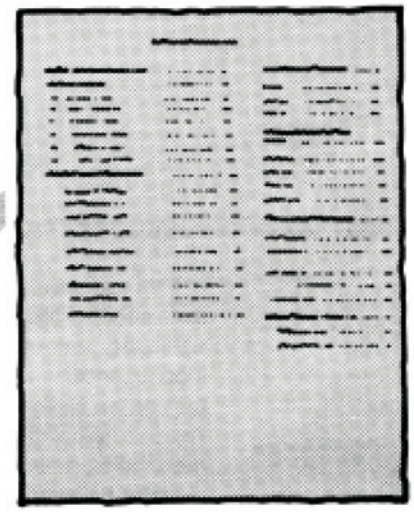


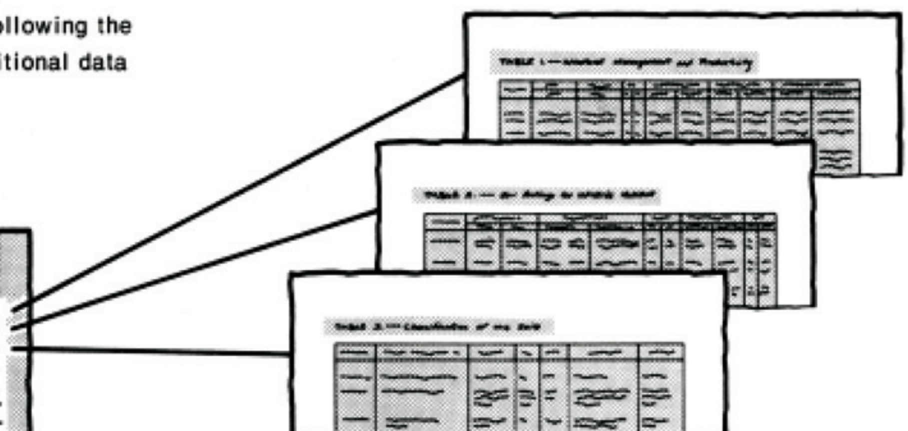
THIS SOIL SURVEY

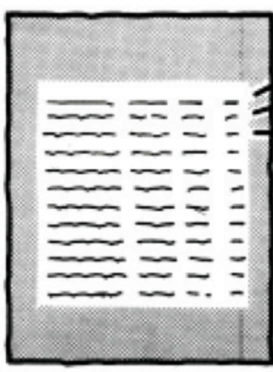
5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.





6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.





7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

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 Ottawa County Conservation District. Major fieldwork was performed in the period 1971 to 1976. Soil names and descriptions were approved in 1977. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1976.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Contents

Issued July 1980

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Summary of tables

Foreword

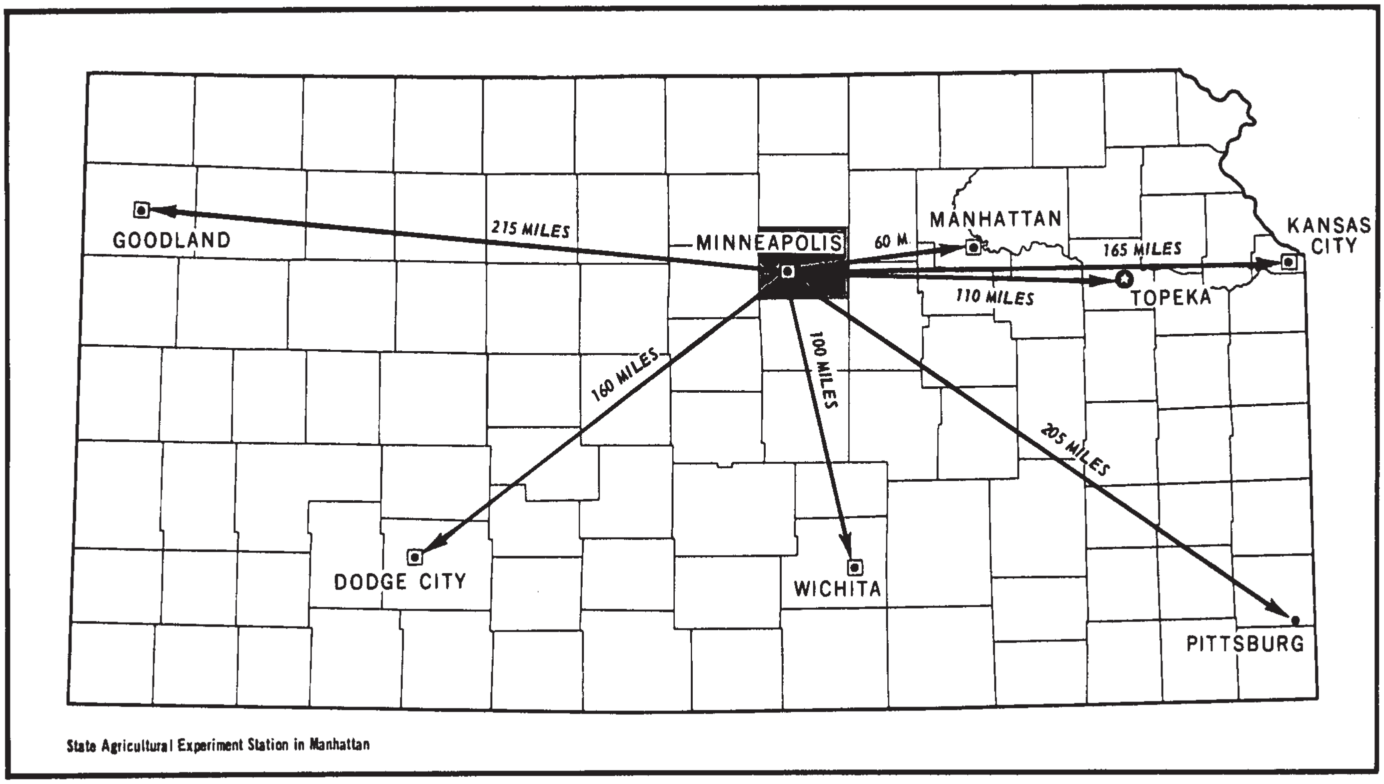
This soil survey contains information that can be used in land-planning programs in Ottawa County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations inherent in the soil or hazards that adversely affect the soil, improvements needed to overcome the limitations or reduce the hazards, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

John W. Tippie
State Conservationist
Soil Conservation Service



Location of Ottawa County in Kansas.

soil survey of

Ottawa County, Kansas

By C. H. Atkinson and Thomas D. Grimwood,
Soil Conservation Service

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

OTTAWA COUNTY is in north-central Kansas. It has a total area of 723 square miles, or 462,720 acres. The population was 6,419 in 1975. Minneapolis, the county seat, has a population of 2,152. The county was organized in 1866.

Most of the county is in the Central Kansas Sandstone Hills land resource area, except for the southeast corner, which is in the Central Loess Plains land resource area. The Central Kansas Sandstone Hills are cut by entrenched drainageways. The soils are generally deep or moderately deep, are gently sloping to steep, and have a clayey or loamy subsoil. Elevation ranges from 1,170 to 1,627 feet above sea level.

Most of the county is drained by the Solomon River. The southwestern part, however, is drained by the Saline River and the northeastern corner by Chapman Creek.

The main enterprises in the county are farming and ranching. Wheat, sorghum, and alfalfa are the main crops.

General nature of the county

The paragraphs that follow describe the climate and the natural resources in the county.

Climate

By L. Dean Bark, climatologist, Kansas Agricultural Experiment Station, Manhattan, Kansas.

The climate of Ottawa County is typically continental, as can be expected of a location in the interior of a large land mass in the middle latitudes. Such a climate is characterized by large daily and annual variations in temperature. Winters are cold because polar air frequently moves into the area, but it lasts only from December through February. Warm summer temperatures last for about 6 months every year. They provide a long growing season for crops. Spring and fall usually are short.

Ottawa County is generally along the western edge of the flow of moisture-laden air from the Gulf of Mexico. Shifts in this current result in a large range in the amount of precipitation. Precipitation is heaviest from May through September, a large part of it occurring as late evening or nighttime thunderstorms. In dry years the amount is marginal for crops, and even in wet years prolonged periods without rain often are harmful to crops.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Minneapolis in the period 1941 to 1970. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 32.2 degrees F, and the average daily minimum temperature is 21.2 degrees. The lowest temperature, which occurred at Minneapolis on February 12, 1899, is -29 degrees. In summer the average temperature is 78.6 degrees, and the average daily maximum temperature is 91.3 degrees. The highest temperature, which occurred on August 12, 1936, is 119 degrees.

Of the total annual precipitation, 22.14 inches, or 77 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 14.96 inches. The heaviest 1-day rainfall during the period of record was 6.34 inches at Minneapolis on September 3, 1942.

Average seasonal snowfall is 18.5 inches. The greatest snow depth at any one time during the period of record was 21 inches. On an average of 22 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year.

The sun shines 75 percent of the time possible in summer and 60 percent in winter. The prevailing wind is from the south. Average windspeed is highest, 13 miles per hour, in April.

Tornadoes and severe thunderstorms occur occasionally. These storms are usually local in extent and of short duration, so that the risk of damage is slight. Hail falls infrequently during the warmer part of the year. It also is of local extent. It causes less crop damage in this part of the state than in the parts to the west.

Natural resources

Soil is the most important natural resource in the county. It provides a growing medium for cultivated crops, for forage crops, and for the grasses grazed by livestock.

The valley of the Solomon River is a source of sand and gravel for construction or road improvement. The northwest corner of the county is a minor source of limestone and shale for road surfacing. The thicker limestone layers have been used in the construction of farm houses and other buildings. Extensive clay and shale deposits in the Dakota Formation are suitable as material used in manufacturing ceramic products.

How this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study 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 been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map for broad land use planning" and "Soil maps for detailed planning."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, rangeland and woodland managers, engineers, planners, developers and builders, home buyers, and others.

General soil map for broad land use planning

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each association on the general soil map is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The names and descriptions of the soils identified on the general soil map for this county do not fully agree with those of the soils identified on the maps for adjacent counties. Differences result from a better knowledge of the soils, modifications in series concepts, a higher or lower intensity of mapping, and variations in the extent of the soils in the counties.

Descriptions of associations

1. Crete-Geary association

Deep, nearly level to moderately sloping, moderately well drained and well drained soils on uplands

This association is on ridgetops and side slopes in the uplands. It is dissected by drainageways and creeks.

This association makes up about 41 percent of the county. It is about 45 percent Crete soils, 30 percent Geary soils, and 25 percent minor soils (fig. 1).

The nearly level and gently sloping, moderately well drained Crete soils formed in loess on ridgetops and side slopes. Typically, the surface soil is gray silt loam about 15 inches thick. The subsoil is about 29 inches thick. The upper part is gray, friable silty clay loam; the next part is dark grayish brown and grayish brown, very firm silty clay; the lower part is light brownish gray, calcareous, firm silty clay loam. The substratum to a depth of about 60 inches is very pale brown, mottled, calcareous silt loam.

The gently sloping and moderately sloping, well

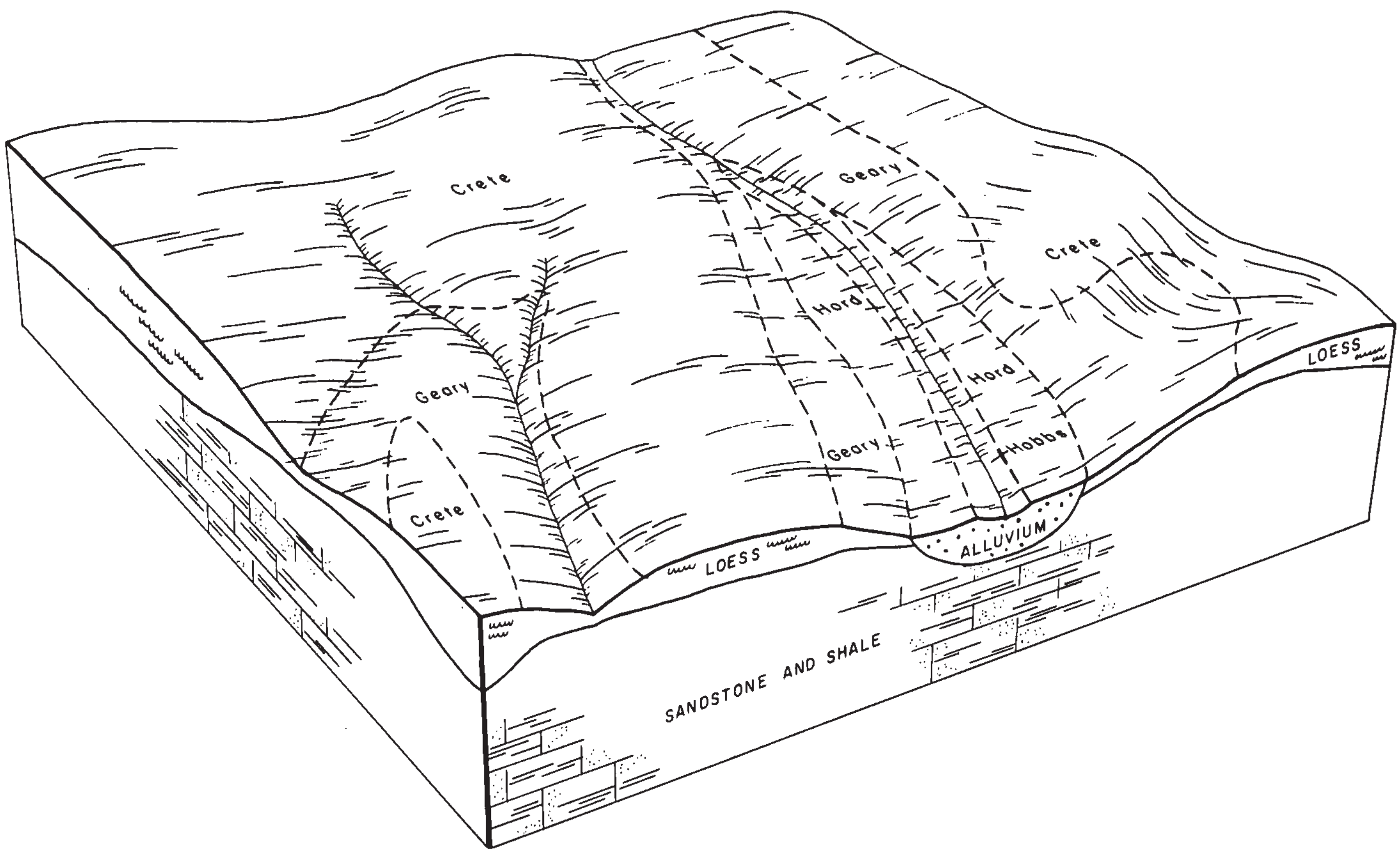


Figure 1.—Typical pattern of soils in the Crete-Geary association.

drained Geary soils formed in reddish loess on ridgetops and side slopes. Typically, the surface layer is dark grayish brown silt loam or silty clay loam about 10 inches thick. The subsoil is silty clay loam about 38 inches thick. The upper part is dark grayish brown and friable; the next part is brown and reddish brown and firm; the lower part is reddish yellow and friable. The substratum to a depth of about 60 inches is reddish yellow clay loam.

Minor in this association are Edalgo, Hedville, Hobbs, and Hord soils. The moderately deep Edalgo soils and the shallow Hedville soils are on ridgetops. The deep, frequently or occasionally flooded Hobbs soils are on flood plains. The rarely flooded Hord soils are on alluvial terraces.

This association is used mainly for cultivated crops. Some small areas are rangeland. Wheat, sorghum, and legumes are the main crops. Controlling erosion and maintaining tilth and fertility are concerns in managing these soils.

This association has good potential for cultivated crops and for range and poor to fair potential for building site development and sanitary facilities.

2. Geary-Edalgo-Hedville association

Deep to shallow, gently sloping to steep, well drained and somewhat excessively drained soils on uplands

This association is on ridgetops and side slopes in the uplands. It is dissected by drainageways and creeks.

This association makes up about 26 percent of the county. It is about 37 percent Geary soils, 21 percent Edalgo soils, 12 percent Hedville soils, and 30 percent minor soils (fig. 2).

The deep, gently sloping to strongly sloping, well drained Geary soils formed in reddish loess on ridgetops and side slopes. Typically, the surface layer is dark grayish brown silt loam and silty clay loam about 8 inches thick. The subsoil is silty clay loam about 36 inches thick. The upper part is dark grayish brown and friable, the next part is brown and reddish brown and firm, and the lower part is reddish yellow and friable. The substratum to a depth of about 60 inches is reddish yellow clay loam that contains small sandstone pebbles.

The moderately deep, moderately sloping and strongly

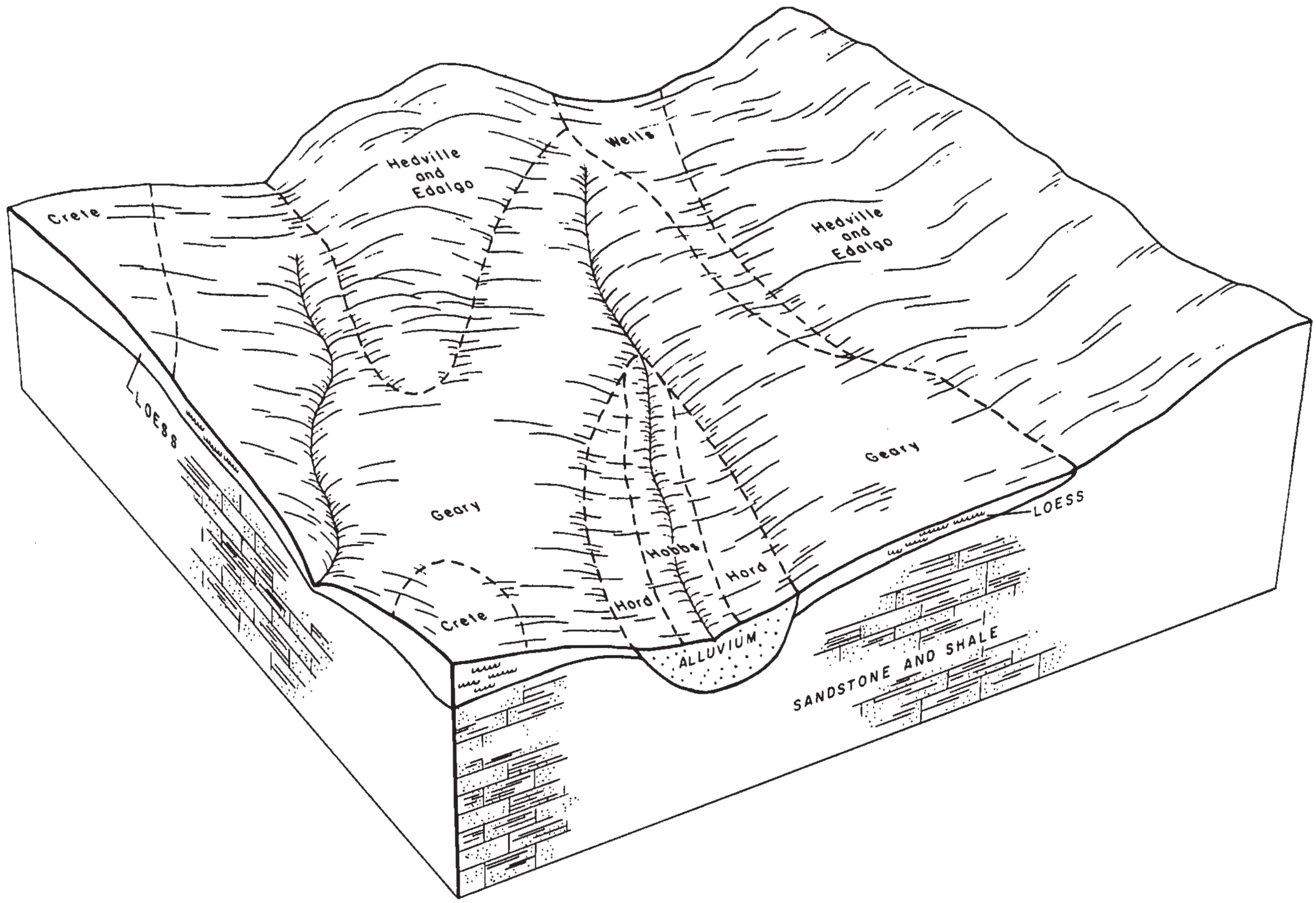


Figure 2.—Typical pattern of soils in the Geary-Edalgo-Hedville association.

sloping, well drained Edalgo soils formed in clayey residuum of noncalcareous silty and clayey shale on side slopes and ridgetops. Typically, the surface layer is grayish brown silt loam about 6 inches thick. The subsoil is about 24 inches thick. The upper part is grayish brown, friable silty clay loam; the next part is grayish brown, firm silty clay; the lower part is grayish brown, mottled, very firm silty clay. The substratum is light gray and grayish brown, mottled, calcareous silty clay. Clayey shale is at a depth of about 36 inches.

The shallow, moderately sloping to steep, somewhat excessively drained Hedville soils formed in residuum of noncalcareous sandstone on ridgetops and side slopes. Typically, the surface layer is grayish brown stony loam about 10 inches thick. The subsurface layer is brown, very friable loam about 6 inches thick. Sandstone bedrock is at a depth of about 16 inches.

Minor in this association are Crete, Hobbs, Hord, Lancaster, and Wells soils. The deep, moderately well drained Crete soils are on ridgetops and the upper side slopes. The deep, frequently or occasionally flooded Hobbs soils are along narrow drainageways. The deep Hord soils are on alluvial terraces. The moderately deep, well drained Lancaster soils are on ridgetops and side slopes. The deep, well drained Wells soils are on foot slopes.

About half of this association is used for cultivated crops. The rest is mainly rangeland. Wheat, sorghum, and alfalfa are the main crops. Controlling erosion and maintaining good tilth are the main concerns in managing cultivated areas. Maintaining the growth and vigor of grasses is the main concern in managing rangeland.

This association has fair potential for cultivated crops. It has good potential for range and fair to poor potential for building site development and sanitary facilities.

3. Edalgo-Wells-Hedville association

Deep to shallow, moderately sloping to steep, well drained and somewhat excessively drained soils on uplands

This association is on ridgetops, side slopes, and foot slopes in the uplands. It is dissected by drainageways and small creeks.

This association makes up about 13 percent of the county. It is about 31 percent Edalgo soils, 20 percent Wells soils, 19 percent Hedville soils, and 30 percent minor soils (fig. 3).

The moderately deep, moderately sloping and strongly sloping, well drained Edalgo soils formed in clayey residuum of noncalcareous silty and clayey shale on side slopes and ridgetops. Typically, the surface layer is grayish brown loam about 10 inches thick. The subsoil is about 14 inches thick. The upper part is grayish brown, friable clay loam, and the lower part is pale brown, very firm silty clay. The substratum is gray silty clay. Shale is at a depth of about 30 inches.

The deep, moderately sloping, well drained Wells soils formed in residuum of noncalcareous sandstone and sandy shale on side slopes and foot slopes. Typically, the surface layer is dark grayish brown loam about 10 inches thick. The subsoil is clay loam about 40 inches thick. The upper part is brown and friable, the next part is yellowish red and reddish yellow and friable and firm, and the lower part is reddish yellow and friable. The substratum to a depth of about 60 inches is reddish yellow loam.

The shallow, strongly sloping to steep, somewhat excessively drained Hedville soils formed in residuum of noncalcareous sandstone on ridgetops and side slopes. Typically, the surface layer is grayish brown stony loam about 10 inches thick. The subsurface layer is brown, very friable loam about 6 inches thick. Sandstone bedrock is at a depth of about 16 inches.

Minor in this association are Crete, Geary, Hobbs, and Lancaster soils and areas where sandstone crops out. The deep, moderately well drained Crete soils are on ridgetops and the lower side slopes. The deep, well drained Geary soils are on the lower side slopes. The deep, occasionally flooded Hobbs soils are along narrow

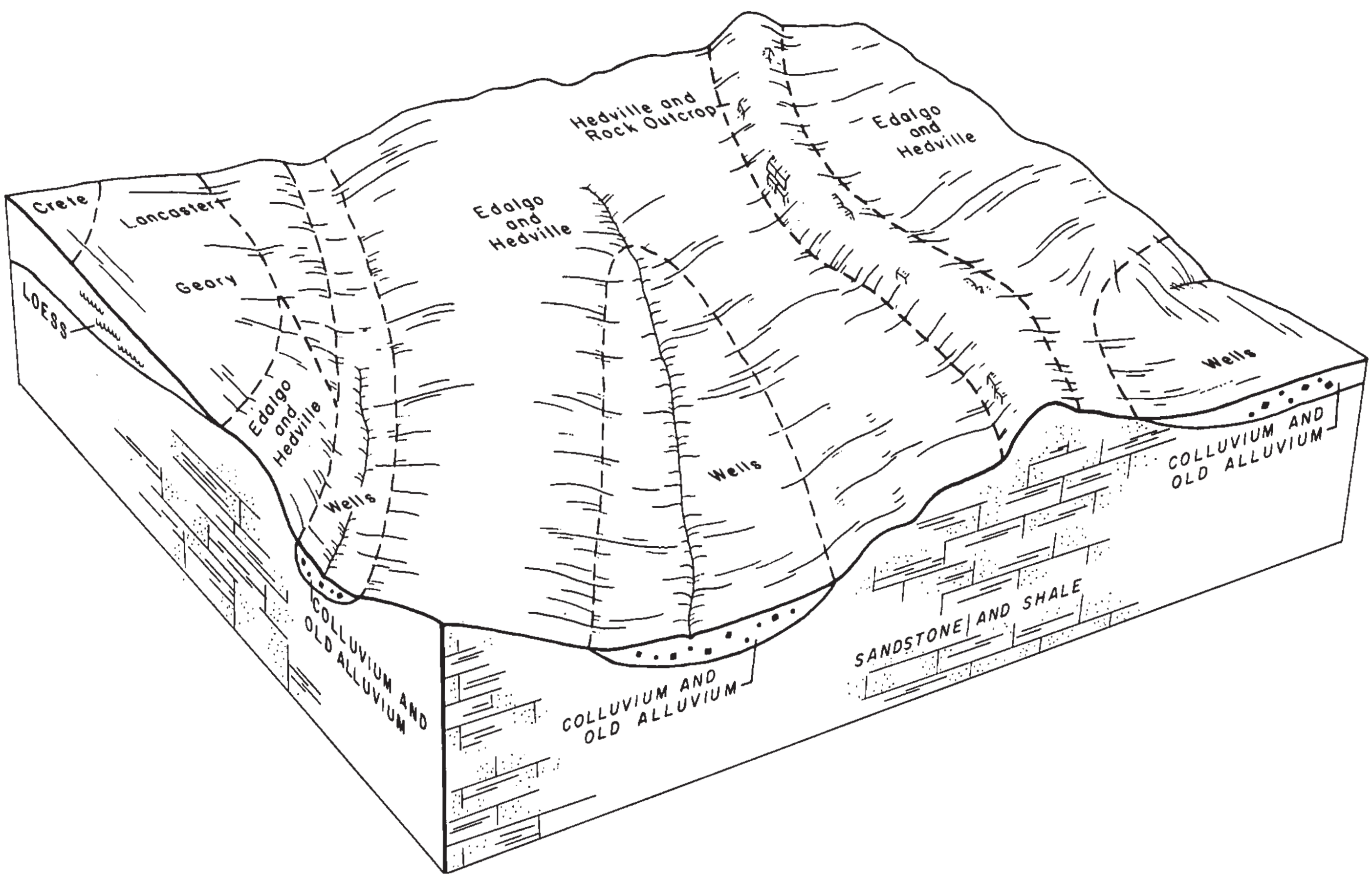


Figure 3.—Typical pattern of soils in the Edalgo-Wells-Hedville association.

drainageways. The moderately deep, well drained Lancaster soils are on the upper side slopes. The sandstone rock outcrop is steep.

Most of this association is rangeland. Some areas are cropland. Maintaining the growth and vigor of grasses is the main concern in managing rangeland. Wheat, sorghum, and alfalfa are the main cultivated crops. Controlling erosion and maintaining good tilth and productivity are the main concerns in managing cropland.

This association has poor potential for cultivated crops. It has fair potential for range and poor to fair potential for building site development and sanitary facilities.

4. Kipson-Armo-Harney association

Shallow and deep, moderately sloping to steep, somewhat excessively drained and well drained soils on uplands

This association is on narrow or broad ridgetops and on side slopes and foot slopes in the uplands. It is dissected by drainageways.

This association makes up about 3 percent of the county. It is about 45 percent Kipson soils, 25 percent Armo soils, 23 percent Harney soils, and 7 percent minor soils (fig. 4).

The shallow, moderately sloping to steep, somewhat excessively drained Kipson soils formed in residuum of silty calcareous shale on narrow ridgetops and side slopes. Typically, the surface soil is gray, calcareous stony silt loam about 12 inches thick. The substratum is light brownish gray, calcareous shaly silt loam. Silty shale is at a depth of about 16 inches.

The deep, moderately sloping, well drained Armo soils formed in calcareous colluvium on foot slopes. Typically, the surface soil is dark gray, calcareous silt loam about 12 inches thick. The subsoil is friable, calcareous silty clay loam about 22 inches thick. The upper part is gray, and the lower part is grayish brown. The substratum to a depth of about 60 inches is grayish brown, calcareous clay loam.

The deep, moderately sloping, well drained Harney soils formed in loess on broad ridgetops and the upper

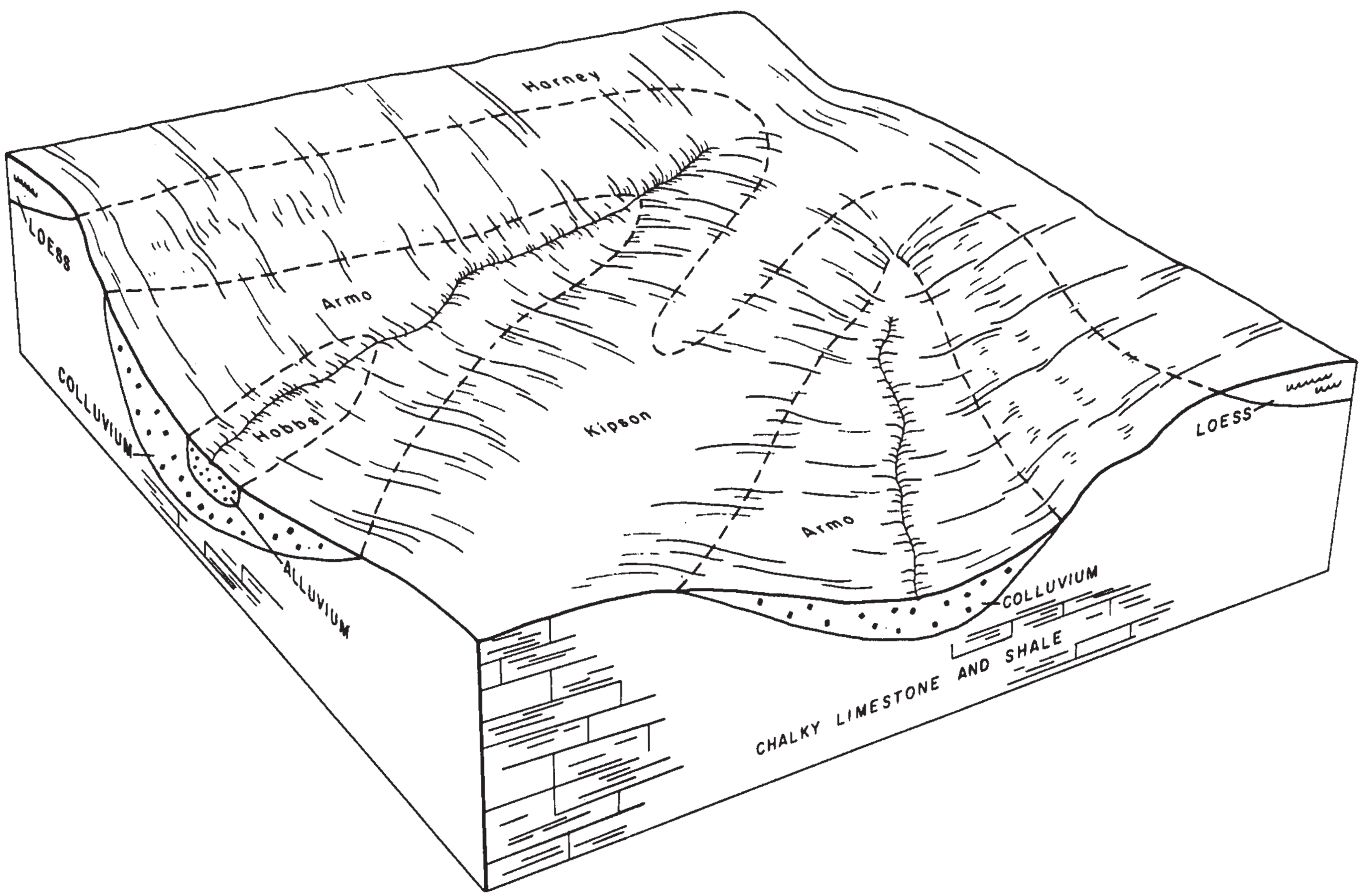


Figure 4.—Typical pattern of soils in the Kipson-Armo-Harney association.

side slopes. Typically, the surface layer is about 5 inches of grayish brown silt loam or gray silty clay loam. The subsurface layer is dark grayish brown silt loam about 5 inches thick. The subsoil is about 28 inches thick. The upper part is dark grayish brown and brown, firm silty clay loam; the next part is grayish brown, very firm silty clay; the lower part is light brownish gray, firm, mottled, calcareous silty clay loam. The substratum to a depth of about 60 inches is light gray, mottled, calcareous silty clay loam and silt loam.

Minor in this association are Edalgo, Geary, Hedville, and Hobbs soils. The moderately deep, well drained Edalgo soils and the shallow, somewhat excessively drained Hedville soils are on the tops of the lower lying ridges. The deep, well drained Geary soils are on the lower side slopes. The deep, occasionally flooded Hobbs soils are along narrow drainageways.

About half of this association is rangeland. The rest is used mainly for cultivated crops. Maintaining the growth and vigor of grasses is the main concern in managing rangeland. Wheat, sorghum, and alfalfa are the main cultivated crops. Controlling erosion and maintaining good tilth and fertility are the main concerns in managing cropland.

This association has good potential for range and fair potential for cultivated crops. It has poor to fair potential for building site development and sanitary facilities.

5. Wells-Carwile-Pratt association

Deep, nearly level to rolling, well drained and somewhat poorly drained soils on uplands

This association is on side slopes and in slight depressions. It makes up about 2 percent of the county. It is about 40 percent Wells soils, 20 percent Carwile soils, 15 percent Pratt soils, and 25 percent minor soils.

The moderately sloping, well drained Wells soils formed in residuum of noncalcareous sandstone and sandy shale on side slopes. Typically, the surface layer is grayish brown sandy loam about 5 inches thick. The subsurface layer is dark grayish brown, very friable sandy loam about 5 inches thick. The subsoil is about 32 inches thick. The upper part is brown, friable sandy clay loam; the next part is reddish yellow, firm sandy clay loam; the lower part is reddish yellow, friable sandy loam. The substratum to a depth of about 60 inches is reddish yellow sandy loam.

The nearly level, somewhat poorly drained Carwile soils formed in old alluvium or eolian sediments in slight depressions. Typically, the surface soil is grayish brown fine sandy loam about 10 inches thick. The subsoil is about 38 inches thick. The upper part is dark grayish brown, friable sandy clay loam; the next part is light brownish gray, mottled, very firm sandy clay; the lower part is light brownish gray, mottled, firm, calcareous sandy clay loam. The substratum to a depth of about 60 inches is light brownish gray, mottled, calcareous sandy clay loam.

The rolling, well drained Pratt soils formed in sandy eolian deposits on convex side slopes. Typically, the surface layer is dark grayish brown loamy sand about 10 inches thick. The subsurface layer is grayish brown, loose loamy sand about 5 inches thick. The subsoil is pale brown, loose loamy sand about 21 inches thick. It has brown clay loam or sandy clay loam horizontal lenses 1/4 inch to 1 inch thick. The substratum to a depth of about 60 inches is pale brown loamy fine sand.

Minor in this association are Crete, Els, and Geary soils. The moderately well drained Crete soils are on broad ridgetops. The somewhat poorly drained Els soils are on low stream terraces that are rarely flooded. The well drained Geary soils are on side slopes.

About half of this association is used for cultivated crops. The rest is mainly rangeland. Wheat, sorghum, and alfalfa are the main crops. Soil blowing and wetness are problems if the major soils are cultivated. Controlling soil blowing, improving surface drainage, and maintaining tilth and fertility are concerns in managing cropland. Maintaining the growth and vigor of grasses is the main concern in managing rangeland.

This association has good potential for range and fair potential for cultivated crops. It has fair potential for building site development and sanitary facilities.

6. Detroit-Hord-Roxbury association

Deep, nearly level, moderately well drained and well drained soils on low terraces

This association is on alluvial terraces in the valleys of the Solomon and Saline Rivers and Salt Creek. It makes up about 15 percent of the county. It is about 24 percent Detroit soils, 23 percent Hord soils, 18 percent Roxbury soils, and 35 percent minor soils.

The moderately well drained Detroit soils formed in calcareous silty alluvium on terraces that are rarely flooded. Typically, the surface soil is dark gray silty clay loam about 16 inches thick. The subsoil is about 28 inches thick. The upper part is grayish brown, friable silty clay loam; the next part is grayish brown, very firm silty clay; the lower part is pale brown, friable, mottled, calcareous silty clay loam. The substratum to a depth of about 60 inches is pale brown, mottled, calcareous silt loam.

The well drained Hord soils formed in calcareous silty alluvium on terraces that are rarely flooded. Typically, the surface layer is gray silt loam about 8 inches thick. The subsurface layer is dark gray, very friable silt loam about 10 inches thick. The subsoil is friable silty clay loam about 25 inches thick. The upper part is dark gray, the next part is grayish brown and calcareous, and the lower part is pale brown and calcareous. The substratum to a depth of about 60 inches is light gray, calcareous silt loam.

The well drained Roxbury soils formed in calcareous loamy alluvium on terraces that are rarely flooded. Typically, the surface layer is gray, calcareous silt loam about 7 inches thick. The subsurface layer is dark gray, friable, calcareous silt loam about 15 inches thick. The subsoil is friable, calcareous silty clay loam about 20 inches thick. The upper part is dark grayish brown, and the lower part is grayish brown. The substratum to a depth of about 60 inches is light brownish gray, calcareous silt loam.

Minor in this association are Hobbs, McCook, and New Cambria soils. The well drained, frequently flooded Hobbs soils are on flood plains. The well drained, rarely or occasionally flooded McCook soils are on terraces and flood plains. The moderately well drained, rarely flooded New Cambria soils are on terraces.

Nearly all of this association is used for cultivated crops. Sorghum, wheat, and alfalfa are the main crops. The main concerns of management are maintaining tilth and the organic-matter content. Most of the association is suitable for irrigation.

This association has good potential for cultivated crops and for range. It has fair to poor potential for building site development and sanitary facilities.

Soil maps for detailed planning

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil, a brief description of the soil profile, and a listing of the principal hazards and limitations to be considered in planning the management for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Wells loam, 3 to 7 percent slopes, is one of several phases in the Wells series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils that occur as areas so intricately mixed or so small that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Edalgo-Hedville complex, 5 to 30 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. These dissimiliar soils are described in each map unit. Also, some of the more unusual or strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes some *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits is an example. Some miscellaneous areas are large enough to be delineated on the soil maps. Some that are too small to be delineated are identified by a special symbol on the soil maps.

The names and descriptions of the soils identified on the detailed soil maps for this county do not fully agree with those of the soils identified on the maps for adjacent counties. Differences result from a better knowledge of the soils, modifications in series concepts, a higher or lower intensity of mapping, and variations in the extent of the soils in the counties.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil descriptions

Ar—Armo silt loam, 3 to 8 percent slopes. This deep, moderately sloping, well drained soil is on smooth foot slopes below Kipson soils. Individual areas are long and narrow and range from 20 to 120 acres in size.

Typically, the surface soil is dark gray, calcareous silt loam about 12 inches thick. The subsoil is friable, calcareous silty clay loam about 22 inches thick. The upper part is gray, and the lower part is grayish brown. The substratum to a depth of about 60 inches is grayish brown, calcareous clay loam. In places the subsoil is darker and more clayey. In some areas, the subsoil is browner and limy shale is within a depth of 60 inches.

Included with this soil in mapping are small areas of Geary, Hobbs, and Kipson soils, which make up about

10 to 12 percent of the map unit. The Geary soils are on the lower side slopes. They are redder than the Armo soil. The Hobbs soils are in narrow drainageways and are occasionally flooded. They are more silty than the Armo soil. The shallow, somewhat excessively drained Kipson soils generally are steeper than the Armo soil and are on the upper side slopes.

Permeability is moderate in the Armo soil, and runoff is medium. Available water capacity is high. Natural fertility is medium, and organic-matter content is moderate. The surface layer is friable and can be easily tilled. The surface layer and subsoil are mildly alkaline or moderately alkaline.

About half of the acreage is cultivated. The rest is mainly range. This soil has good potential for range, openland wildlife habitat, building site development, and sanitary facilities. It has fair potential for cultivated crops and for windbreaks.

This soil is moderately well suited to wheat, sorghum, and alfalfa. If cultivated crops are grown, erosion is a hazard. Terraces, grassed waterways, contour farming, crop residue management, and minimum tillage help to control erosion and keep the soil in good tilth.

This soil is well suited to range. Overgrazing, however, reduces the vigor and retards the growth of grasses and increases the runoff rate. Proper stocking rates, uniform grazing distribution, and deferred grazing keep the range in good condition.

This soil is suitable as a site for dwellings and septic tank absorption fields. Low strength is a severe limitation on sites for local roads and streets. Strengthening or replacing the base material helps to overcome this limitation. Seepage is a moderate limitation on sites for sewage lagoons, but it can be controlled by sealing the lagoon.

The capability subclass is IIIe.

Ca—Carwile fine sandy loam. This deep, nearly level, somewhat poorly drained soil is on uplands. It is occasionally flooded or ponded for brief periods. Individual areas are long and narrow or irregularly shaped and range from 5 to 30 acres in size.

Typically, the surface soil is grayish brown fine sandy loam about 10 inches thick. The subsoil is about 38 inches thick. The upper part is dark grayish brown, friable sandy clay loam; the next part is light brownish gray, mottled, very firm sandy clay; the lower part is light brownish gray, mottled, firm, calcareous sandy clay loam. The substratum to a depth of about 60 inches is light brownish gray, mottled, calcareous sandy clay loam.

Included with this soil in mapping are small areas of Els, Pratt, and Wells soils, which make up about 15 percent of the map unit. Els soils are less clayey than the Carwile soil. They are on low stream terraces. The well drained Pratt and Wells soils are less clayey than the Carwile soil, are steeper, and are higher on the landscape.

Runoff is slow or ponded on the Carwile soil, and permeability is slow. Available water capacity is high. The shrink-swell potential also is high. Natural fertility is medium, and organic-matter content is moderately low. The surface layer is friable and can be easily tilled. It is slightly acid or medium acid. The upper part of the subsoil is slightly acid or neutral, and the lower part is neutral to moderately alkaline. Depth to the seasonal high water table is 0 to 2 feet.

Most of the acreage is cultivated. This soil has good potential for cultivated crops, for range, and for openland and rangeland wildlife habitat. It has fair potential for windbreaks and poor potential for building site development and sanitary facilities.

This soil is suited to wheat, sorghum, and alfalfa. The clayey subsoil absorbs and releases moisture slowly. If cultivated crops are grown, wetness is a limitation and soil blowing a hazard. During wet periods water is ponded for several days. Drainage ditches reduce the wetness. Crop residue management, stripcropping, and minimum tillage increase the infiltration rate and help to control soil blowing.

This soil is well suited to range. Overgrazing or grazing when the soil is too wet, however, results in surface compaction and reduces the vigor and retards the growth of grasses. Proper stocking rates, uniform grazing distribution, deferred grazing, and restricted use during wet periods keep the range in good condition.

The shrink-swell potential, the wetness, and the flooding or ponding are severe limitations if this soil is used as a site for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the damage to buildings caused by shrinking and swelling. Constructing the buildings on suitable fill material helps to control the flooding or ponding. The low strength, the ponding, and the shrink-swell potential are severe limitations on sites for local roads and streets. Strengthening or replacing the base material helps to overcome the low strength and the shrink-swell potential. Constructing the roads and streets on suitable fill material helps to control the ponding.

This soil is generally unsuitable as a site for septic tank absorption fields because the slow permeability, the wetness, and the flooding or ponding are severe limitations. The wetness is a severe limitation on sites for sewage lagoons. It can be controlled by sealing the lagoon.

The capability subclass is IIw.

Cr—Crete silt loam, 0 to 2 percent slopes. This deep, nearly level, moderately well drained soil is on broad ridgetops in the uplands. Individual areas are irregularly shaped or long and narrow and range from 5 to 100 acres in size.

Typically, the surface soil is gray silt loam about 15 inches thick. The subsoil is about 29 inches thick. The upper part is gray, friable silty clay loam; the next part is dark grayish brown and grayish brown, very firm silty clay; the lower part is light brownish gray, calcareous, firm silty clay loam. The substratum to a depth of about 60 inches is very pale brown, mottled, calcareous silt loam.

Included with this soil in mapping are small areas of Geary and Hobbs soils, which make up about 10 percent of the map unit. These well drained soils are less clayey than the Crete soil. Geary soils are on the lower side slopes. Hobbs soils are along narrow drainageways and are occasionally flooded.

Runoff is slow on the Crete soil. Permeability also is slow. Available water capacity is high. Natural fertility also is high, and organic-matter content is moderate. The surface layer is friable and can be easily tilled. It is medium acid or slightly acid. The upper part of the subsoil is slightly acid or neutral. The shrink-swell potential is high.

Most of the acreage is cultivated. This soil has good potential for cultivated crops and for range, windbreaks, and openland and rangeland wildlife habitat. It has poor potential for building site development and sanitary facilities.

This soil is well suited to wheat, sorghum, and alfalfa. The clayey subsoil absorbs and releases moisture slowly, and water ponds on the surface in some areas during wet periods. Drainage ditches help to control the ponding. Erosion is a hazard in the more sloping areas. Terraces, grassed waterways, contour farming, minimum tillage, and crop residue management help to control erosion and increase the infiltration rate. The soil can be irrigated if an adequate supply of suitable water is available. Land leveling and water management help to control erosion and improve water distribution.

This soil is well suited to range. Overgrazing, however, retards the growth and reduces the vigor of grasses, results in surface compaction, and increases the runoff rate. Proper stocking rates, deferred grazing, uniform grazing distribution, and restricted use when the soil is wet keep the range in good condition.

The shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the damage to dwellings caused by shrinking and swelling. The shrink-swell potential and low strength are severe limitations on sites for local roads and streets. Strengthening or replacing the base material helps to overcome these limitations.

This soil is well suited to sewage lagoons. The slow permeability is a severe limitation, however, if the soil is used as a site for septic tank absorption fields. Increasing the size of the absorption field improves the functioning of the septic tank system.

The capability subclass is IIs.

Cs—Crete silt loam, 2 to 5 percent slopes. This deep, gently sloping, moderately well drained soil is on convex side slopes in the uplands. Individual areas are irregularly shaped or long and narrow and range from 10 to 110 acres in size.

Typically, the surface soil is grayish brown silt loam about 12 inches thick. The subsoil is about 27 inches thick. The upper part is gray, friable silty clay loam; the next part is dark grayish brown and grayish brown, very firm silty clay; the lower part is light brownish gray, firm, calcareous silty clay loam. The substratum to a depth of about 60 inches is very pale brown, mottled, calcareous silt loam. In eroded areas, the surface layer is grayish brown or brown silty clay loam and tilth is poor.

Included with this soil in mapping are small areas of Geary, Hobbs, and Lancaster soils, which make up about 15 percent of the map unit. These well drained soils are less clayey than the Crete soil. The Geary soils and the moderately deep Lancaster soils are on the lower side slopes. Hobbs soils are along narrow drainageways and are occasionally flooded.

Runoff is medium on the Crete soil, and permeability is slow. Available water capacity is high. Natural fertility also is high, and organic-matter content is moderate. The surface layer is friable and can be easily tilled. It is medium acid or slightly acid. The upper part of the subsoil is slightly acid or neutral. The shrink-swell potential is high.

Most of the acreage is cultivated. This soil has good potential for cultivated crops and for range, windbreaks, and rangeland wildlife habitat. It has poor potential for building site development and sanitary facilities.

This soil is suited to wheat, sorghum, and alfalfa. The clayey subsoil absorbs and releases moisture slowly. If cultivated crops are grown, erosion is a hazard. Terraces, grassed waterways, contour farming, minimum tillage, and crop residue management help to control erosion, conserve moisture, and improve tilth. The soil can be irrigated if an adequate supply of suitable water is available. Land leveling and water management help to control erosion and improve water distribution.

This soil is well suited to range. Overgrazing, however, retards the growth and reduces the vigor of grasses, results in surface compaction, and increases the runoff rate. Proper stocking rates, deferred grazing, and uniform grazing distribution keep the range in good condition.

The shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the damage to buildings caused by shrinking and swelling. The shrink-swell potential and low strength are severe limitations on sites for local roads and streets. Strengthening or replacing the base material helps to overcome these limitations.

The slope is a moderate limitation if this soil is used as a site for sewage lagoons. The slow permeability is a severe limitation if the soil is used as a site for septic tank absorption fields. Increasing the size of the absorption field improves the functioning of the septic tank system.

The capability subclass is IIIe.

Ct—Crete silty clay loam, 3 to 5 percent slopes, eroded. This deep, gently sloping, moderately well drained soil is on convex side slopes in the uplands. Individual areas are irregularly shaped or long and narrow and range from 10 to 80 acres in size.

Typically, the surface layer is gray silty clay loam about 7 inches thick. It includes material that formerly was part of the subsoil. The subsoil is about 25 inches thick. The upper part is dark grayish brown, firm silty clay; the next part is grayish brown, mottled, very firm silty clay; the lower part is grayish brown, mottled, firm, calcareous silty clay loam. The substratum to a depth of about 60 inches is very pale brown, mottled, calcareous silt loam.

Included with this soil in mapping are small areas of Geary, Hobbs, and Lancaster soils, which make up about 10 percent of the map unit. These well drained soils are less clayey than the Crete soil. The Geary soils and the moderately deep Lancaster soils are on the lower side slopes. Hobbs soils are along narrow drainageways and are occasionally flooded.

Runoff is medium on the Crete soil, and permeability is slow. Available water capacity is high. Natural fertility is medium, and organic-matter content is moderately low. Tilth is fair. The surface layer is firm. It is medium acid or slightly acid. The upper part of the subsoil is slightly acid or neutral. The shrink-swell potential is high.

Most of the acreage is cultivated. This soil has fair potential for cultivated crops and for windbreaks. It has good potential for range and rangeland wildlife habitat and poor potential for building site development and sanitary facilities.

This soil is moderately well suited to wheat, sorghum, and alfalfa. Further erosion is a severe hazard. The clayey subsoil absorbs and releases moisture slowly. Terraces, grassed waterways, contour farming, minimum tillage, and crop residue management help to control erosion and improve infiltration and tilth.

This soil is well suited to range. Overgrazing or grazing when the soil is wet, however, results in surface compaction, increases the runoff rate, and reduces the vigor and retards the growth of grasses. Proper stocking rates, deferred grazing, uniform grazing distribution, and restricted use during wet periods keep the range in good condition.

The shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the damage to buildings caused by shrinking and swelling. The shrink-swell potential and low strength are severe limitations on sites for local roads and streets. Strengthening or replacing the base material helps to overcome these limitations.

The slope is a moderate limitation if this soil is used as a site for sewage lagoons. The slow permeability is a severe limitation if the soil is used as a site for septic tank absorption fields. Increasing the size of the absorption field improves the functioning of the septic tank system.

The capability subclass is IIIe.

De—Detroit silty clay loam. This deep, nearly level, moderately well drained soil is on alluvial terraces. It is subject to rare flooding. Individual areas are long and narrow or irregularly shaped and range from 10 to 320 acres in size.

Typically, the surface soil is dark gray silty clay loam about 16 inches thick. The subsoil is about 28 inches thick. The upper part is grayish brown, friable silty clay loam; the next part is grayish brown, very firm silty clay; the lower part is pale brown, friable, mottled, calcareous silty clay loam. The substratum to a depth of about 60 inches is pale brown, mottled, calcareous silt loam.

Included with this soil in mapping are small areas of Hobbs, Hord, and Sutphen soils, which make up about 10 to 15 percent of the map unit. The well drained Hobbs and Hord soils are less clayey than the Detroit soil. Hobbs soils are along drainageways and are occasionally flooded. Hord soils and the Detroit soil are in similar positions on the landscape. The somewhat poorly drained Sutphen soils are in depressions and are sometimes ponded. They are more clayey than the Detroit soil.

Permeability is slow in the Detroit soil. Runoff also is slow. Available water capacity is high. Natural fertility also is high, and organic-matter content is moderate. The surface layer is friable and can be easily tilled. It is slightly acid or neutral. The subsoil is neutral or mildly alkaline. The shrink-swell potential is high.

Most of the acreage is cultivated. This soil has good potential for cultivated crops and for range, windbreaks, and all kinds of wildlife habitat. It has poor potential for building site development and most sanitary facilities.

This soil is well suited to wheat, sorghum, and alfalfa. The clayey subsoil absorbs and releases moisture slowly. Crop residue management and minimum tillage keep the soil in good tilth and increase the organic-matter content. The soil can be irrigated if an adequate supply of suitable water is available. Land leveling and water management help to control erosion and improve water distribution.

This soil is well suited to range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a planned grazing system, and deferred grazing keep the range in good condition.

The shrink-swell potential and the flooding are severe limitations if this soil is used as a site for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the damage to buildings caused by shrinking and swelling. Overcoming the flood hazard is difficult unless major flood control structures are built. The shrink-swell potential and low strength are severe limitations on sites for local roads and streets. Strengthening or replacing the base material helps to overcome these limitations.

This soil is suitable as a site for sewage lagoons. The slow permeability is a severe limitation, however, if the soil is used as a site for septic tank absorption fields. Increasing the size of the absorption field improves the functioning of the septic tank system.

The capability class is I.

Ed—Edalgo silt loam, 3 to 7 percent slopes. This moderately deep, moderately sloping, well drained soil is on convex side slopes and narrow ridgetops in the uplands. Individual areas are irregularly shaped and range from 5 to 20 acres in size.

Typically, the surface layer is grayish brown silt loam about 6 inches thick. The subsoil is about 24 inches thick. The upper part is grayish brown, friable silty clay loam; the next part is grayish brown, firm silty clay; the lower part is grayish brown, mottled, very firm silty clay. The substratum is light gray and grayish brown, mottled, calcareous silty clay. Clayey shale is at a depth of about 36 inches. In places the lower part of the subsoil and the substratum have concretions of lime. In eroded areas the surface layer is brown or reddish brown, firm silty clay loam.

Included with this soil in mapping are small areas of Crete, Geary, and Lancaster soils, which make up about 10 to 15 percent of the map unit. The moderately deep Lancaster soils and the deep Geary soils are less clayey than the Edalgo soil and are in similar positions on the landscape. The deep, moderately well drained Crete soils are less sloping than the Edalgo soil and are lower on the landscape.

Runoff is medium on the Edalgo soil, and permeability is very slow. Available water capacity is low. Natural fertility is medium, and organic-matter content is moderately low. The surface layer and subsoil range from medium acid to neutral. The surface layer is friable and can be easily tilled. Root penetration is restricted below a depth of about 36 inches. The shrink-swell potential is high.

Most of the acreage is cultivated. This soil has good potential for range and fair potential for cultivated crops, for windbreaks, and for woodland, rangeland, and openland wildlife habitat. It has poor potential for building site development and sanitary facilities.

This soil is moderately well suited to wheat, sorghum, and alfalfa. If cultivated crops are grown, erosion is a hazard. Terraces, grassed waterways, contour farming, crop residue management, and minimum tillage help to control erosion, conserve moisture, and keep the soil in good tilth.

This soil is suited to range. Overgrazing, however, retards the growth and decreases the vigor of grasses and increases the runoff rate. Proper stocking rates, deferred grazing, and uniform grazing distribution keep the range in good condition.

The shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the damage to buildings caused by shrinking and swelling. The shrink-swell potential and low strength are severe limitations on sites for local roads and streets. Strengthening or replacing the base material helps to overcome these limitations.

The slope and the depth to rock are moderate limitations if this soil is used as a site for sewage lagoons. The deeper, less sloping included soils are better sites. The soil is generally unsuitable as a site for septic tank absorption fields because of the very slow permeability and the depth to rock.

The capability subclass is IVe.

Ee—Edalgo-Hedville complex, 5 to 30 percent slopes. This map unit dominantly consists of moderately deep and shallow, moderately sloping to steep, well drained and somewhat excessively drained soils on side slopes and narrow ridgetops dissected by deeply entrenched drainageways. It is about 50 percent Edalgo soil and 30 percent Hedville soil. The Edalgo soil, which is less sloping, is on the lower side slopes. The Hedville soil is on the upper side slopes and narrow ridgetops. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical. Individual areas are irregular in shape and range from 20 to several hundred acres in size.

Typically, the Edalgo soil has a grayish brown loam surface layer about 10 inches thick. The subsoil is about 14 inches thick. The upper part is grayish brown, friable clay loam, and the lower part is pale brown, very firm silty clay. The substratum is gray silty clay. Clayey shale is at a depth of about 30 inches. In places the surface layer is gravelly loam or silt loam.

Typically, the Hedville soil has a grayish brown stony loam surface layer about 10 inches thick. The subsurface layer is brown, very friable loam about 6 inches thick. Sandstone bedrock is at a depth of about 16 inches. In places, the surface layer is sandy loam and the subsurface layer is sandy loam or loamy sand. In some areas the depth to sandstone is more than 20 inches.

Included with these soils in mapping are small areas of the well drained Geary, Hobbs, Lancaster, and Wells soils and small areas where sandstone crops out. These included areas make up about 20 percent of the map unit. The deep Geary and Wells soils are on the lower side slopes. The deep Hobbs soils are along narrow drainageways and are occasionally flooded. The moderately deep Lancaster soils are on the lower side slopes. Sandstone rock outcrop is in the steeper areas.

Permeability is very slow and available water capacity low in the Edalgo soil. Permeability is moderate and available water capacity very low in the Hedville soil. Surface runoff is rapid on both soils. Natural fertility is medium and organic-matter content moderately low. Root penetration is restricted at a depth of about 30 inches in the Edalgo soil and at a depth of about 16 inches in the Hedville soil. The shrink-swell potential is high in the Edalgo soil.

Most areas are used as range. The Edalgo soil has fair potential for rangeland wildlife habitat. Both soils have fair potential for range. They have poor potential for cultivated crops and for windbreaks, building site development, and sanitary facilities.

These soils are best suited to range. The major concerns of management are the hazard of erosion and the low and very low available water capacity. Overgrazing retards the growth and reduces the vigor of the grasses and increases the runoff rate. An adequate plant cover reduces the runoff rate and helps to prevent excessive soil losses. Proper stocking rates, uniform grazing distribution, and deferred grazing keep the range in good condition. Many areas are potential pond reservoir sites.

These soils are generally unsuitable as sites for dwellings, local roads and streets, and waste disposal systems. Some of the included areas are better sites.

The capability subclass is VIe.

Es—Els loamy sand. This deep, nearly level, somewhat poorly drained soil is on low stream terraces. It is subject to rare flooding. Individual areas are long and narrow and range from 10 to 50 acres in size.

Typically, the surface layer is grayish brown loamy sand about 6 inches thick. The next 8 inches is light brownish gray, mottled, loose loamy fine sand. The substratum to a depth of about 60 inches is very pale brown, mottled, fine sand stratified with coarse sand. Some areas along drainageways are frequently flooded. In these areas the soil is more stratified. In some depressions the surface layer is darker and is loam or clay loam.

Runoff is slow, and permeability is rapid. Available water capacity is low. Organic-matter content and natural fertility also are low. The surface layer is loose and can be easily tilled. Depth to the seasonal high water table ranges from about 1.5 to 3.5 feet.

Most areas are used as range. This soil has good potential for range and fair potential for cultivated crops, for windbreaks, and for all kinds of wildlife habitat. It has poor potential for building site development and sanitary facilities.

This soil is moderately well suited to wheat, sorghum, and alfalfa. If cultivated crops are grown, the major management concerns are wetness, low fertility, and low available water capacity. Artificial drainage generally is not feasible.

This soil is well suited to range. Overgrazing, however, retards the growth and reduces the vigor of grasses and encourages the growth of weeds and brush. Proper stocking rates, deferred grazing, uniform grazing distribution, and measures that control the brush keep the range in good condition.

This soil is generally unsuitable as a site for dwellings because of wetness and flooding and as a site for septic tank absorption fields and sewage lagoons because of wetness and the hazard of polluting shallow ground water. The wetness and the flooding are moderate limitations on sites for local roads and streets. Constructing the roads and streets on suitable fill material helps to overcome these limitations.

The capability subclass is IVw.

Ge—Geary silt loam, 1 to 3 percent slopes. This deep, gently sloping, well drained soil is on broad ridgetops in the uplands. Individual areas are irregular in shape and range from 5 to 30 acres in size.

Typically, the surface layer is dark grayish brown silt loam about 10 inches thick. The subsoil is silty clay loam about 38 inches thick. The upper part is dark grayish brown and friable, the next part is brown and reddish brown and firm, and the lower part is reddish yellow and friable. The substratum to a depth of about 60 inches is reddish yellow clay loam. In places, the surface layer is loam and the subsoil is clay loam.

Included with this soil in mapping are small areas of Crete and Lancaster soils, which make up about 10 percent of the map unit. The moderately well drained Crete soils are on the higher ridgetops. They are more clayey than the Geary soil. The moderately deep Lancaster soils are on ridgetops.

Permeability is moderate in the Geary soil, and runoff is medium. Available water capacity is high. Natural fertility also is high, and organic-matter content is moderate. The surface layer is friable and can be easily tilled. The surface layer and the upper part of the subsoil are medium acid or slightly acid. The shrink-swell potential is moderate.

Most of the acreage is cultivated. This soil has good potential for cultivated crops and for range, windbreaks, and openland wildlife habitat. It has fair potential for building site development and sanitary facilities.

This soil is well suited to wheat, sorghum, and alfalfa. If cultivated crops are grown, erosion is a hazard. Terraces, grassed waterways, contour farming, crop residue management, and minimum tillage help to control erosion, increase the organic-matter content, and keep the soil in good tilth. The soil can be irrigated if an adequate supply of suitable water is available. Land leveling and water management help to control erosion and improve water distribution.

This soil is well suited to range. Overgrazing, however, retards the growth and reduces the vigor of grasses and increases the runoff rate. Proper stocking rates, deferred grazing, and uniform grazing distribution keep the range in good condition.

Low strength is a severe limitation if this soil is used as a site for local roads and streets. Strengthening or replacing the base material helps to overcome this limitation. The shrink-swell potential is a moderate limitation on sites for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the damage to buildings caused by shrinking and swelling.

The moderate permeability is a moderate limitation if this soil is used as a site for septic tank absorption fields. Increasing the size of the absorption field improves the functioning of the septic tank system. Slope and seepage are moderate limitations on sites for sewage lagoons. Sealing the lagoon helps to control the seepage.

The capability subclass is IIe.

Gf—Geary silt loam, 3 to 6 percent slopes. This deep, moderately sloping, well drained soil is on ridgetops and side slopes in the uplands. Individual areas are long and narrow on the side slopes and irregularly shaped on the ridgetops. They range from 20 to 200 acres in size.

Typically, the surface layer is dark grayish brown silt loam about 8 inches thick. The subsoil is silty clay loam about 36 inches thick. The upper part is dark grayish brown and friable, the next part is brown and reddish brown and firm, and the lower part is reddish yellow and friable. The substratum to a depth of about 60 inches is reddish yellow clay loam. In places, the surface layer is loam and the subsoil is clay loam. In eroded areas the surface layer is brown or reddish brown, firm silty clay loam.

Included with this soil in mapping are small areas of Crete, Hobbs, and Lancaster soils, which make up about 15 percent of the map unit. The moderately well drained Crete soils are on the ridgetops. They are more clayey than the Geary soil. Hobbs soils are along narrow drainageways and are occasionally flooded. The moderately deep Lancaster soils are on the ridgetops and the lower side slopes.

Permeability is moderate in the Geary soil, and runoff is medium. Available water capacity is high. Natural fertility also is high, and organic-matter content is moderate. The surface layer is friable and can be easily tilled. The surface layer and the upper part of the subsoil are medium acid or slightly acid. The shrink-swell potential is moderate.

Most of the acreage is cultivated. This soil has good potential for cultivated crops and for range and windbreaks. It has fair potential for openland, woodland, and rangeland wildlife habitat and for building site development and sanitary facilities.

This soil is suited to wheat, sorghum, and alfalfa. If cultivated crops are grown, erosion is a hazard. Terraces, grassed waterways, contour farming, minimum tillage, and crop residue management help to control erosion, conserve moisture, and improve tilth.

This soil is well suited to range. Overgrazing, however, retards the growth and reduces the vigor of grasses and increases the runoff rate. Proper stocking rates, deferred grazing, and uniform grazing distribution keep the range in good condition.

The shrink-swell potential is a moderate limitation if this soil is used as a site for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the damage to buildings caused by shrinking and swelling. Low strength is a severe limitation on sites for local roads and streets. Strengthening or replacing the base material helps to overcome this limitation.

The moderate permeability is a moderate limitation if this soil is used as a site for septic tank absorption fields. Increasing the size of the absorption field improves the functioning of the septic tank system. Slope and seepage are moderate limitations on sites for sewage lagoons. Sealing the lagoon helps to control the seepage.

The capability subclass is IIIe.

Gg—Geary silty clay loam, 3 to 6 percent slopes, eroded. This deep, moderately sloping, well drained soil is on convex side slopes in the uplands. Individual areas are long and narrow or irregularly shaped and range from 20 to 80 acres in size.

Typically, the surface layer is brown silty clay loam about 6 inches thick. The subsoil is silty clay loam about 30 inches thick. The upper part is brown and firm, the next part is reddish brown and firm, and the lower part is reddish yellow and friable. The substratum to a depth of about 60 inches is reddish yellow clay loam. It has small sandstone pebbles in the lower part. In places, the surface layer is loam or clay loam and the subsoil is clay loam. In some areas the surface layer is silt loam.

Included with this soil in mapping are small areas of Crete, Hobbs, and Lancaster soils, which make up about 15 percent of the map unit. The moderately well drained Crete soils are on ridgetops and the upper side slopes. They are more clayey than the Geary soil. Hobbs soils are along narrow drainageways and are occasionally flooded. The moderately deep Lancaster soils are on ridgetops or the lower side slopes.

Permeability is moderate in the Geary soil, and runoff is medium. Available water capacity is high. Natural fertility is medium, and organic-matter content is moderately low. Tilth is fair. The surface layer is firm. It is medium acid or slightly acid. The shrink-swell potential is moderate.

Most of the acreage is cultivated. This soil has good potential for range and fair potential for cultivated crops, for openland, woodland, and rangeland wildlife habitat, for windbreaks, and for building site development and sanitary facilities.

This soil is moderately well suited to wheat, sorghum, and alfalfa. Further erosion is a hazard if cultivated crops are grown. Terraces, grassed waterways, contour farming, minimum tillage, and crop residue management help to control erosion, increase the organic-matter content, and improve tilth.

A cover of range plants is effective in controlling erosion. Overgrazing, however, retards the growth and reduces the vigor of grasses and increases the runoff rate. Proper stocking rates, deferred grazing, and uniform grazing distribution keep the range in good condition.

Low strength is a severe limitation if this soil is used as a site for local roads and streets. Strengthening or replacing the base material helps to overcome this limitation. The shrink-swell potential is a moderate limitation on sites for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the damage to buildings caused by shrinking and swelling.

The moderate permeability is a moderate limitation if this soil is used as a site for septic tank absorption fields. Increasing the size of the absorption field improves the functioning of the septic tank system. Slope and seepage are moderate limitations on sites for sewage lagoons. Sealing the lagoon helps to control the seepage.

The capability subclass is IIIe.

Ha—Harney silt loam, 2 to 7 percent slopes. This deep, moderately sloping, well drained soil is on ridgetops and side slopes in the uplands. Individual areas are long and narrow and range from 20 to 80 acres in size.

Typically, the surface layer is grayish brown silt loam about 5 inches thick. The subsurface layer is dark grayish brown silt loam about 5 inches thick. The subsoil is about 28 inches thick. The upper part is dark grayish brown, firm silty clay loam; the next part is grayish brown, very firm silty clay; the lower part is light brownish gray, firm, mottled, calcareous silty clay loam. The substratum to a depth of about 60 inches is light gray, mottled, calcareous silty clay loam and silt loam. In places the surface layer is grayish brown, firm silty clay loam.

Included with this soil in mapping are small areas of Hobbs and Kipson soils, which make up about 10 percent of the map unit. Hobbs soils are along narrow drainageways and are occasionally flooded. The shallow, somewhat excessively drained Kipson soils are less clayey than the Harney soil. They are on the lower side slopes.

Permeability is moderately slow in the Harney soil, and runoff is medium. Available water capacity is high. Natural fertility also is high, and organic-matter content is moderate. The shrink-swell potential is high. The surface layer is friable and can be easily tilled. It ranges from medium acid to neutral. The subsoil ranges from neutral to moderately alkaline.

Most of the acreage is cultivated. This soil has good potential for range and windbreaks and fair potential for cultivated crops and for woodland and openland wildlife habitat. It has poor potential for building site development and sanitary facilities.

This soil is moderately well suited to wheat, sorghum, and alfalfa. If cultivated crops are grown, erosion is a hazard. Terraces, grassed waterways, contour farming, crop residue management, and minimum tillage help to control erosion, conserve moisture, and keep the soil in good tilth.

This soil is well suited to range. Overgrazing, however, retards the growth and reduces the vigor of grasses and increases the runoff rate. Proper stocking rates, deferred grazing, and uniform grazing distribution keep the range in good condition.

The shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the damage to buildings caused by shrinking and swelling. The shrink-swell potential and low strength are severe limitations on sites for local roads and streets. Strengthening or replacing the base material helps to overcome these limitations.

The slope is a moderate limitation if this soil is used as a site for sewage lagoons. The moderately slow permeability is a severe limitation if the soil is used as a site for septic tank absorption fields. Increasing the size of the absorption field improves the functioning of the septic tank system.

The capability subclass is IIIe.

Hb—Harney silty clay loam, 2 to 7 percent slopes, eroded. This deep, moderately sloping, well drained soil is on convex side slopes in the uplands. Individual areas are long and irregularly shaped and range from 10 to 60 acres in size.

Typically, the surface layer is gray silty clay loam about 5 inches thick. It includes material that formerly was part of the subsoil. The subsoil is about 25 inches thick. The upper part is dark grayish brown, firm silty clay loam; the next part is grayish brown, very firm silty clay; the lower part is light brownish gray, firm, mottled, calcareous silty clay loam. The substratum to a depth of about 60 inches is light gray, mottled, calcareous silty clay loam and silt loam. In places the surface layer is silt loam.

Included with this soil in mapping are small areas of the less clayey Hobbs soils and the shallow Kipson soils, which make up about 15 percent of the map unit. Kipson soils are somewhat excessively drained and are on the lower side slopes. Hobbs soils are in narrow drainageways and are occasionally flooded.

Permeability is moderately slow in the Harney soil, and runoff is medium. Available water capacity is high. Natural fertility is medium, and organic-matter content is moderately low. The shrink-swell potential is high. Tilth is fair. The surface layer is firm. It ranges from medium acid to neutral. The subsoil ranges from neutral to moderately alkaline.

Most of the acreage is cultivated. This soil has good potential for range and windbreaks. It has fair potential for cultivated crops and for openland and woodland wildlife habitat and poor potential for building site development and sanitary facilities.

This soil is moderately well suited to wheat, sorghum, and alfalfa. Further erosion is a severe hazard. Contour farming, terraces, grassed waterways, crop residue management, and minimum tillage help to control erosion, improve tilth, and increase the content of organic matter.

A cover of range plants is effective in controlling erosion. Overgrazing, however, increases the runoff rate and retards the growth and reduces the vigor of grasses. Proper stocking rates, deferred grazing, and uniform grazing distribution keep the range in good condition.

The shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the damage to buildings caused by shrinking and swelling. The shrink-swell potential and low strength are severe limitations on sites for local roads and streets. Strengthening or replacing the base material helps to overcome these limitations.

The slope is a moderate limitation if this soil is used as a site for sewage lagoons. The moderately slow permeability is a severe limitation if the soil is used as a site for septic tank absorption fields. Increasing the size of the absorption field improves the functioning of the septic tank system.

The capability subclass is IVe.

He—Hedville-Rock outcrop complex, 5 to 30 percent slopes. This map unit dominantly consists of a shallow, somewhat excessively drained Hedville soil and areas of Rock outcrop on narrow ridgetops and side slopes in the uplands (fig. 5). It is moderately sloping to steep. Individual areas are irregularly shaped on the ridgetops and long and narrow on the side slopes, and they range from 20 to 120 acres in size. They are about 75 percent Hedville soil and 15 to 20 percent Rock outcrop. The Hedville soil is generally less sloping than the Rock outcrop.

Typically, the Hedville soil has a grayish brown stony loam surface layer about 10 inches thick. The subsurface layer is brown loam about 6 inches thick. Sandstone bedrock is at a depth of about 16 inches. The Rock outcrop is brown, reddish brown, or gray sandstone.

Included with the Hedville soil and the Rock outcrop in mapping are small areas of Edalgo and Lancaster soils, which make up about 5 to 15 percent of the map unit. These moderately deep, well drained soils are on the lower side slopes.

Runoff is rapid on the Hedville soil and the Rock outcrop. The Hedville soil is moderately permeable and has a very low available water capacity. It is moderately low in organic-matter content and medium in natural fertility. Root penetration is restricted below a depth of about 16 inches.

Nearly all areas are used as range. This map unit has fair potential for range and poor potential for other uses.

Figure 5.—An area of Hedville-Rock outcrop complex, 5 to 30 percent slopes. The grassed areas are Hedville stony loam. The Rock outcrop is sandstone.

This map unit is best suited to range. The major concerns of management are the hazard of erosion and the very low available water capacity. Overgrazing retards the growth and reduces the vigor of grasses and increases the runoff rate. An adequate plant cover reduces the runoff rate and helps to prevent excessive soil losses. Proper stocking rates, uniform grazing distribution, and deferred grazing keep the range in good condition.

This map unit is generally unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons because the slope and the depth to rock are severe limitations.

The capability subclass is VIIe.

Hn—Hobbs silt loam. This deep, nearly level, well drained soil is on flood plains along small creeks and drainageways. It is occasionally flooded for brief periods. Individual areas are long and narrow and range from 5 to 20 acres in size.

Typically, the surface layer is gray silt loam about 8 inches thick. The substratum to a depth of about 60 inches is multicolored silt loam. It has thin strata of fine sandy loam in the upper part. In some places the surface layer is thicker. In other places it is overlain with a thin layer of light colored sandy, silty, or gravelly material deposited during recent floods.

Included with this soil in mapping are small areas of Crete and Geary soils, which make up about 10 percent of the map unit. These soils are on upland side slopes. The moderately well drained Crete soils are more clayey than the Hobbs soil, and Geary soils are redder.

Permeability is moderate in the Hobbs soil, and available water capacity is high. Runoff is slow. Natural fertility is high, and organic-matter content is moderate. The surface layer is friable and can be easily tilled. It is slightly acid or neutral.

Most of the acreage is cultivated. This soil has good potential for cultivated crops, for range, for windbreaks, and for openland, woodland, and rangeland wildlife habitat. It has poor potential for building site development and sanitary facilities.

This soil is well suited to small grain, sorghum, and alfalfa. If cultivated crops are grown, flooding is a hazard. Installing surface drains or filling in depressions improves surface drainage. Minimum tillage and crop residue management keep the soil in good tilth and increase the infiltration rate.

This soil is well suited to range. It receives extra moisture as runoff from the uplands. Many areas are potential pond reservoir sites. Overgrazing retards the growth and reduces the vigor of grasses and encourages the growth of weeds and brush. Proper stocking rates, uniform grazing distribution, and deferred grazing keep the range in good condition.

This soil is generally unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons because the flooding is a severe hazard. Overcoming this hazard is difficult without major flood control measures.

The capability subclass is IIw.

Ho—Hobbs silt loam, frequently flooded. This deep, nearly level, well drained soil is on flood plains along the larger streams. The stream channels are deeply entrenched and have steep sides. Individual areas are long and narrow and range from 20 to 100 acres in size.

Typically, the surface layer is gray silt loam about 6 inches thick. The substratum to a depth of about 60 inches is multicolored, stratified silt loam. In some areas the surface layer is thicker. In other areas it is overlain with a thin layer of light colored sandy or silty material deposited during recent floods. This material is calcareous in places.

Included with this soil in mapping are small areas of the darker colored Detroit and McCook soils on the higher lying terraces. These soils make up about 10 percent of the map unit. The moderately well drained Detroit soils are more clayey than the Hobbs soil.

Permeability is moderate in the Hobbs soil, and available water capacity is high. Runoff is slow. Natural fertility is high, and organic-matter content is moderate. The surface layer is slightly acid or neutral.

Most areas are used as wildlife habitat or range. The vegetation is mostly trees and shrubs. This soil has good potential for windbreaks and fair potential for range and for rangeland and woodland wildlife habitat. It has poor potential for cultivated crops, building site development, and sanitary facilities.

Because of the frequent flooding, this soil is best suited to wildlife habitat or range. Overgrazing retards the growth and reduces the vigor of grasses and encourages the growth of weeds and brush. Proper stocking rates, restricted grazing when the soil is wet, and control of undesirable plants help to maintain or improve the grasses.

This soil is generally unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons because the flooding is a severe hazard.

The capability subclass is Vw.

Hp—Hobbs-Geary silt loams, 0 to 15 percent slopes. This map unit dominantly consists of deep, well drained soils along upland drainageways (fig. 6). It is about 45 percent Hobbs silt loam and 40 percent Geary silt loam. The nearly level Hobbs soil is on flood plains and is frequently flooded for brief periods. The moderately sloping and strongly sloping Geary soil is on side slopes. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical. Individual areas are long and irregularly shaped and range from 10 to 40 acres in size.

Typically, the Hobbs soil has a gray silt loam surface layer about 8 inches thick. The substratum to a depth of about 60 inches is multicolored silt loam stratified with

Figure 6.—Typical area of Hobbs-Geary silt loams, 0 to 15 percent slopes. The nearly level Hobbs soil is along the drainageway, and the moderately sloping and strongly sloping Geary soil is on the side slopes.

silty clay loam. In places the surface layer is recently deposited loam.

Typically, the Geary soil has a gray silt loam surface layer about 10 inches thick. The subsoil is silty clay loam about 28 inches thick. The upper part is dark grayish brown and friable, the next part is brown and reddish brown and firm, and the lower part is reddish yellow and friable. The substratum to a depth of about 60 inches is reddish yellow clay loam. In places partly weathered shale and sandstone are below a depth of 48 inches.

Included with these soils in mapping are small areas of Crete and Lancaster soils, which make up about 15 percent of the map unit. The moderately well drained Crete soils are on the upper side slopes. They are more clayey than the Hobbs and Geary soils. The moderately deep Lancaster soils are on the lower side slopes.

Permeability is moderate in the Hobbs and Geary soils, and available water capacity is high. Runoff is rapid on the Geary soil and slow on the Hobbs soil. Organic-matter content is moderate in both soils. Natural fertility is high in the Hobbs soil and medium in the Geary soil. The shrink-swell potential is moderate in the Geary soil.

Most areas are used as range. These soils have good potential for range and windbreaks and fair potential for rangeland and woodland wildlife habitat. They have poor potential for cultivated crops, building site development, and sanitary facilities.

These soils are best suited to range. The major concern of management is the hazard of erosion. Overgrazing retards the growth and reduces the vigor of grasses and increases the runoff rate. An adequate plant cover reduces the runoff rate and helps to prevent excessive soil losses. Proper stocking rates, uniform grazing distribution, and deferred grazing keep the range in good condition. Many areas are potential pond reservoir sites.

The Hobbs soil is generally unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons because the flooding is a severe hazard.

The shrink-swell potential and slope of the Geary soil are moderate limitations on sites for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling. The low strength of this soil is a severe limitation on sites for local roads and streets. Strengthening or replacing the base material helps to overcome this limitation.

The moderate permeability is a moderate limitation if the Geary soil is used as a site for septic tank absorption fields. Increasing the size of the absorption field improves the functioning of the septic tank system. The slope of this soil is a severe limitation on sites for sewage lagoons. Less sloping areas are better sites.

The capability subclass is VIe.

Hr—Hord silt loam. This deep, nearly level, well drained soil is on alluvial terraces. It is subject to rare flooding. Individual areas are irregular in shape and range from 20 to 320 acres in size.

Typically, the surface layer is gray silt loam about 8 inches thick. The subsurface layer is dark gray, very friable silt loam about 10 inches thick. The subsoil is friable silty clay loam about 25 inches thick. The upper part is dark gray, the next part is grayish brown and calcareous, and the lower part is pale brown and calcareous. The substratum to a depth of about 60 inches is light gray, calcareous silt loam. In some places the soil is calcareous near the surface. In other places it is noncalcareous throughout. Some areas near stream channels are occasionally flooded.

Included with this soil in mapping are small areas of Detroit, New Cambria, and Sutphen soils, which make up about 15 percent of the map unit. These soils are more clayey than the Hord soil. Detroit and New Cambria soils are moderately well drained and are in slight depressions. Sutphen soils are somewhat poorly drained and are in depressions.

Permeability is moderate in the Hord soil, and available water capacity is high. Runoff is slow. Natural fertility is high, and organic-matter content is moderate. The surface layer is very friable and can be easily tilled. It is slightly acid or neutral. The subsoil ranges from slightly acid to mildly alkaline.

Most of the acreage is cultivated. This soil has good potential for cultivated crops and for range, windbreaks, and openland, woodland, and rangeland wildlife habitat. It has poor potential for building site development and fair potential for sanitary facilities.

This soil is well suited to wheat, sorghum, and alfalfa. Minimum tillage and crop residue management help to keep the soil in good tilth and increase the organic-matter content. Diversion terraces help to control the runoff from adjacent uplands. The soil can be irrigated if an adequate supply of suitable water is available. Land leveling and water management help to control erosion and improve water distribution.

This soil is well suited to range. Overgrazing, however, retards the growth and reduces the vigor of grasses. Proper stocking rates, uniform grazing distribution, and deferred grazing keep the range in good condition.

The flooding is a severe hazard if this soil is used as a site for dwellings and a moderate hazard if the soil is used as a site for septic tank absorption fields. Overcoming the flooding is difficult without major flood control measures. Low strength is a severe limitation on sites for local roads and streets. Strengthening or replacing the base material helps to overcome this limitation. Seepage is a moderate limitation on sites for sewage lagoons. It can be controlled by sealing the lagoon.

The capability class is I.

Kp—Kipson soils, 5 to 20 percent slopes. These shallow, moderately sloping to steep, somewhat excessively drained soils are on side slopes and ridgetops in the uplands. Individual areas are irregularly shaped on the ridgetops and long and narrow on the side slopes. They range from 20 to 400 acres in size.

Typically, the surface soil is gray, calcareous stony silt loam about 12 inches thick. The substratum is light brownish gray, calcareous shaly silt loam. Silty shale is at a depth of about 16 inches. In places the surface layer is silt loam. In some areas the soil is noncalcareous and is underlain by sandstone.

Included with these soils in mapping are small areas of Armo and Harney soils and small areas where limestone crops out. These included areas make up about 10 to 15 percent of the map unit. Armo soils are on foot slopes, and Harney soils are on ridgetops. Both of these soils are deep and well drained. The limestone outcrop is in the steeper areas.

Permeability is moderate in the Kipson soils, and available water capacity is very low. Runoff is rapid. Organic-matter content is moderate, and natural fertility is low. The shrink-swell potential is moderate. Root penetration is restricted below a depth of about 16 inches.

Nearly all of the acreage is range. Some small areas at the base of side slopes are cropped. These soils have fair potential for range and for openland wildlife habitat. They have poor potential for cultivated crops and for windbreaks, building site development, and sanitary facilities.

These soils are best suited to range. The major concerns of management are the hazard of erosion and the very low available water capacity. Overgrazing retards the growth and reduces the vigor of grasses and increases the runoff rate. An adequate plant cover reduces the runoff rate and helps to prevent excessive soil losses. Proper stocking rates, uniform grazing distribution, and deferred grazing keep the range in good condition.

The slope and the depth to rock are moderate limitations if these soils are used as sites for dwellings without basements or for local roads and streets. The soils are generally unsuitable as sites for septic tank absorption fields because the depth to rock is a severe limitation. They also are generally unsuitable as sites for sewage lagoons because the slope and the depth to rock are severe limitations. The deeper, less sloping included soils are better sites for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons.

The capability subclass is VIe.

La—Lancaster loam, 3 to 7 percent slopes. This moderately deep, moderately sloping, well drained soil is on side slopes and ridgetops in the uplands. Individual areas are irregularly shaped on the ridgetops and long and narrow on the side slopes. They range from 10 to 60 acres in size.

Typically, the surface layer is dark grayish brown loam about 10 inches thick. The subsoil is about 29 inches thick. The upper part is brown, friable loam; the next part is reddish brown and yellowish red, firm clay loam; the lower part is reddish yellow, friable loam. Weathered sandy shale and sandstone are at a depth of about 39 inches. In places the depth to bedrock is more than 40 inches. In eroded areas the surface layer is redder and is clay loam.

Included with this soil in mapping are small areas of Crete, Edalgo, Geary, and Hedville soils, which make up about 15 percent of the map unit. The Edalgo soils and the deep, moderately well drained Crete soils are more clayey than the Lancaster soil. They are on the upper side slopes. The shallow, somewhat excessively drained Hedville soils also are on the upper side slopes. Geary soils are more silty than the Lancaster soil and are in similar positions on the landscape.

Permeability and available water capacity are moderate in the Lancaster soil. Runoff is medium. Organic-matter content is moderately low, and natural fertility is medium. The surface layer is friable and can be easily tilled. The surface layer and the upper part of the subsoil are medium acid or slightly acid. Root penetration is restricted below a depth of about 39 inches. The shrink-swell potential is moderate.

About half of the acreage is cultivated. The rest is mainly range. This soil has good potential for range and fair potential for cultivated crops, for windbreaks, and for openland, woodland, and rangeland wildlife habitat. It has fair to poor potential for building site development and sanitary facilities.

This soil is moderately well suited to wheat, sorghum, and alfalfa. If cultivated crops are grown, erosion is a hazard. Terraces, grassed waterways, contour farming, crop residue management, and minimum tillage help to control erosion, conserve moisture, and keep the soil in good tilth.

A cover of range plants is effective in controlling erosion. Overgrazing, however, retards the growth and reduces the vigor of grasses and increases the runoff rate. Proper stocking rates, deferred grazing, and uniform grazing distribution keep the range in good condition.

Low strength is a severe limitation if this soil is used as a site for local roads and streets. Strengthening or replacing the base material helps to overcome this limitation. The shrink-swell potential is a moderate limitation on sites for dwellings without basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the damage to buildings caused by shrinking and swelling.

The depth to rock, seepage, and slope are moderate limitations if this soil is used as a site for sewage lagoons. Sealing the lagoon helps to control the seepage. The deeper, less sloping included soils are better sites for sewage lagoons. The soil is generally unsuitable as a site for septic tank absorption fields because the depth to rock is a severe limitation.

The capability subclass is IVe.

Mc—McCook silt loam. This deep, nearly level, well drained soil is on alluvial terraces. It is subject to rare flooding. Individual areas are long and narrow or irregularly shaped and range from 10 to 100 acres in size.

Typically, the surface layer is dark grayish brown, calcareous silt loam about 8 inches thick. The subsurface layer is dark grayish brown, very friable, calcareous silt loam about 8 inches thick. The next layer is light brownish gray, very friable, calcareous very fine sandy loam about 6 inches thick. The substratum to a depth of about 60 inches is light brownish gray and pale brown, calcareous silt loam. It is stratified with silt loam, fine sandy loam, and fine sand in the lower part. In places, the soil is more clayey and the surface layer is thicker and darker. In some areas the depth to calcareous material is greater.

Included with this soil in mapping are small areas of New Cambria soils, which make up about 5 percent of the map unit. These moderately well drained soils are in depressions. They are more clayey than the McCook soil.

Permeability is moderate in the McCook soil, and available water capacity is high. Runoff is slow. Natural fertility is high, and organic-matter content is moderately low. The surface layer is mildly alkaline or moderately alkaline. It is friable and can be easily tilled.

Most of the acreage is cultivated. This soil has good potential for cultivated crops and for range, windbreaks, and openland, woodland, and rangeland wildlife habitat. It has fair to poor potential for building site development and sanitary facilities.

This soil is well suited to wheat, sorghum, and alfalfa. Crop residue management and minimum tillage help to keep the soil in good tilth and increase the organic-matter content. The soil can be irrigated if an adequate supply of suitable water is available. Land leveling and water management help to control erosion and improve water distribution.

This soil is well suited to range. Overgrazing, however, retards the growth and reduces the vigor of grasses. Proper stocking rates, uniform grazing distribution, and deferred grazing keep the range in good condition.

The flooding is a severe hazard if this soil is used as a site for dwellings and a moderate hazard if the soil is used as a site for local roads and streets. Overcoming this hazard is difficult without major flood control measures. Low strength is a limitation on sites for local roads and streets. Strengthening or replacing the base material reduces the risk of damage resulting from low strength.

The flooding is a moderate hazard if this soil is used as a site for septic tank absorption fields or sewage lagoons. Also, seepage is a moderate limitation on sites for sewage lagoons. Sealing the lagoon helps to control the seepage.

The capability class is I.

Md—McCook soils, occasionally flooded. These deep, nearly level, well drained soils are on low terraces. Individual areas are irregularly shaped or long and narrow and range from 5 to 30 acres in size.

Typically, the surface layer is dark grayish brown, calcareous silt loam about 8 inches thick. The subsurface layer also is dark grayish brown, calcareous silt loam about 8 inches thick. The next 6 inches is light brownish gray, very friable, calcareous very fine sandy loam. The substratum to a depth of about 60 inches is light brownish gray and light gray, calcareous silt loam. It has thin strata of very fine sandy loam, silt loam, and silty clay loam in the lower part. In some places the surface layer is thicker. In other places it occurs as thin strata of silty clay loam, silt loam, and silty clay.

Included with these soils in mapping are small areas of Sutphen soils, which make up about 5 percent of the map unit. These somewhat poorly drained included soils are in depressions. They are more clayey than the McCook soils.

Permeability is moderate in the McCook soils, and available water capacity is high. Runoff is slow. Natural fertility is high, and organic-matter content is moderately low. The surface layer is mildly alkaline or moderately alkaline. It is friable and can be easily tilled.

Most of the acreage is cultivated. These soils have good potential for cultivated crops and for range, windbreaks, and openland, woodland, and rangeland wildlife habitat. They have poor potential for building site development and sanitary facilities.

These soils are well suited to wheat, sorghum, and alfalfa. Floodwater, however, can damage cultivated crops. Crop residue management and minimum tillage help to keep the soil in good tilth and increase the organic-matter content.

These soils are well suited to range. Overgrazing, however, retards the growth and reduces the vigor of grasses. Proper stocking rates, uniform grazing distribution, and deferred grazing keep the range in good condition.

These soils are generally unsuitable as sites for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons because the flooding is a severe hazard. Overcoming this hazard is difficult without major flood control measures.

The capability subclass is IIw.

Nc—New Cambria silty clay loam. This deep, nearly level, moderately well drained soil is on alluvial terraces. It is subject to rare flooding. Individual areas are irregularly shaped or long and narrow and range from 20 to 140 acres in size.

Typically, the surface layer is very dark gray silty clay loam about 6 inches thick. The subsurface layer is very dark gray, friable, calcareous silty clay loam about 6 inches thick. The subsoil is calcareous silty clay about 28 inches thick. The upper part is gray and firm, and the lower part is dark grayish brown and very firm. The substratum to a depth of about 60 inches is grayish brown and brown, calcareous silty clay loam. In places the depth to calcareous material is more than 10 inches.

Included with this soil in mapping are small areas of Hord, McCook, and Roxbury soils, which make up about 10 to 15 percent of the map unit. These soils are less clayey than the New Cambria soil. They are on low, convex ridges.

Permeability is slow in the New Cambria soil. Runoff also is slow. Available water capacity is high. Natural fertility also is high, and organic-matter content is moderate. The surface layer is mildly alkaline or moderately alkaline. It is friable and can be easily tilled. If it is tilled when too wet or too dry, however, large clods form on the surface. The shrink-swell potential is high.

Most of the acreage is cultivated. This soil has good potential for cultivated crops and for range, windbreaks, and openland and woodland wildlife habitat. It has poor potential for building site development and sanitary facilities.

This soil is suited to wheat, sorghum, and alfalfa. The clayey subsoil absorbs and releases moisture slowly. Crop residue management and minimum tillage improve infiltration, keep the soil in good tilth, and increase the organic-matter content. The soil can be irrigated if an adequate supply of suitable water is available. Land leveling and water management help to control erosion and improve water distribution.

This soil is well suited to range. Overgrazing or grazing when the soil is wet, however, retards the growth and reduces the vigor of grasses. Proper stocking rates, restricted use when the soil is wet, deferred grazing, and uniform grazing distribution keep the range in good condition.

The flooding and the shrink-swell potential are severe limitations if this soil is used as a site for dwellings. Overcoming the flooding is difficult without major flood control measures. Reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the damage to buildings caused by shrinking and swelling. Low strength and the shrink-swell potential are severe limitations on sites for local roads and streets. Strengthening or replacing the base material helps to overcome these limitations.

This soil is suitable as a site for sewage lagoons. The slow permeability is a severe limitation, however, if the soil is used as a site for septic tank absorption fields. Increasing the size of the absorption field improves the functioning of the septic tank system.

The capability subclass is IIs.

Po—Pits. This map unit occurs as excavations from which sand and overburden are removed. These pits are in areas of sandy alluvial deposits along the Solomon River. They range from 5 to 25 acres in size.

The overburden from the excavations is mostly loamy soil material. It generally is stockpiled adjacent to the pits. Seepage water from the river often forms into small lakes or ponds at the bottom of the pits. Flooding is a hazard in some areas. Soil blowing is a hazard in the recent excavations unless a new plant cover is established. Cottonwoods commonly invade if the pit is abandoned.

Abandoned areas, especially those where overburden is stockpiled, can be smoothed and planted to native grasses, such as big bluestem, little bluestem, indiangrass, and switchgrass. These areas provide good wildlife habitat after the vegetation is reestablished. They have potential as recreation areas.

The capability subclass is VIIIs.

Pr—Pratt loamy sand, 5 to 12 percent slopes. This deep, rolling, well drained soil is in convex areas on uplands. Individual areas are irregular in shape and range from 15 to 100 acres in size.

Typically, the surface layer is dark grayish brown loamy sand about 10 inches thick. The subsurface layer is grayish brown, loose loamy sand about 5 inches thick. The subsoil is pale brown, loose loamy sand about 21 inches thick. It has brown clay loam or sandy clay loam horizontal lenses 1/4 inch to 1 inch thick. The substratum to a depth of about 60 inches is pale brown loamy fine sand.

Included with this soil in mapping are small areas of Carwile, Els, and Wells soils, which make up about 15 percent of the map unit. The somewhat poorly drained Carwile soils are in depressions. They are more clayey than the Pratt soil. Els soils are somewhat poorly drained and are on low stream terraces. Wells soils are on side slopes. They are more clayey than the Pratt soil.

Permeability is rapid in the Pratt soil, and available water capacity is moderate. Runoff is slow. Natural fertility and organic-matter content are low. The surface layer is loose and can be easily tilled.

Most of the acreage is range. This soil has good potential for range. It has fair potential for cultivated crops, for windbreaks, for openland, woodland, and rangeland wildlife habitat, and for building site development and sanitary facilities.

This soil is moderately well suited to wheat, sorghum, and legumes. If cultivated crops are grown, soil blowing is a hazard. Stripcropping, stubble mulching, and minimum tillage help to control soil blowing and conserve moisture. The soil is moderately well suited to sprinkler irrigation. An adequate supply of suitable water is needed.

A cover of range plants is effective in controlling soil blowing. Overgrazing, however, retards the growth and reduces the vigor of grasses and increases the risk of soil blowing. Proper stocking rates, uniform grazing distribution, and deferred grazing keep the range in good condition.

The slope is a moderate limitation if this soil is used as a site for dwellings, local roads and streets, or septic tank absorption fields, and seepage and slope are severe limitations on sites for sewage lagoons. Less sloping areas are better sites. Sealing the sewage lagoon helps to control the seepage. The effluent from sewage lagoons and septic tank absorption fields can contaminate shallow ground water because of the seepage.

The capability subclass is IVe.

Rx—Roxbury silt loam. This deep, nearly level, well drained soil is on alluvial terraces. It is subject to rare flooding. Individual areas are irregular in shape and range from 20 to 180 acres in size.

Typically, the surface layer is gray, calcareous silt loam about 7 inches thick. The subsurface layer is dark gray, friable, calcareous silt loam about 15 inches thick. The subsoil is friable, calcareous silty clay loam about 20 inches thick. The upper part is dark grayish brown, and the lower part is grayish brown. The substratum to a depth of about 60 inches is light brownish gray, calcareous silt loam. In places the depth to calcareous material is more than 15 inches.

Included with this soil in mapping are small areas of Detroit and New Cambria soils, which make up about 10 percent of the map unit. These moderately well drained soils are in slight depressions. They are more clayey than the Roxbury soil.

Permeability is moderate in the Roxbury soil, and available water capacity is high. Runoff is slow. Natural fertility is high, and organic-matter content is moderate. The surface layer is friable and can be easily tilled. It is mildly alkaline or moderately alkaline. The shrink-swell potential is moderate.

Most of the acreage is cultivated. This soil has good potential for cultivated crops and for range, openland and woodland wildlife habitat, and windbreaks. It has fair potential for sanitary facilities and poor potential for building site development.

This soil is well suited to wheat (fig. 7), sorghum, and alfalfa. Crop residue management and minimum tillage keep the soil in good tilth and increase the organic-matter content. The soil is well suited to irrigation. An adequate supply of suitable water is needed. Land leveling and water management help to control erosion and improve water distribution.

This soil is well suited to range. Overgrazing, however, retards the growth and reduces the vigor of grasses.

Figure 7.—Harvesting wheat on Roxbury silt loam.

Proper stocking rates, uniform grazing distribution, and deferred grazing keep the range in good condition.

The flooding is a severe hazard if this soil is used as a site for dwellings. Overcoming this hazard is difficult without major flood control measures. Low strength is a severe limitation on sites for local roads and streets. Strengthening or replacing the base material helps to overcome this limitation.

The flooding is a moderate hazard if this soil is used as a septic tank absorption field. Seepage is a moderate limitation on sites for sewage lagoons. It can be controlled by sealing the lagoon.

The capability class is I.

Sd—Sutphen silty clay. This deep, nearly level, somewhat poorly drained soil is on low terraces. It is occasionally flooded for very brief periods. Individual areas are irregularly shaped or long and narrow and range from 5 to 60 acres in size.

Typically, the surface layer is dark gray silty clay about 6 inches thick. The subsurface layer is dark gray, firm silty clay about 24 inches thick. The next 8 inches is grayish brown, very firm, mottled, calcareous silty clay. The substratum to a depth of about 60 inches is light brownish gray, mottled, calcareous silty clay. In places the soil is less clayey, is calcareous throughout, or is poorly drained.

Permeability is very slow, and available water capacity is moderate. Runoff is slow. Natural fertility is medium, and organic-matter content is moderate. The shrink-swell potential is high. Tilth is poor. Working the surface layer is difficult when the soil is too wet or too dry. This layer ranges from slightly acid to moderately alkaline.

Most of the acreage is cultivated. This soil has good potential for cultivated crops and for range. It has fair potential for windbreaks and for openland, woodland, and wetland wildlife habitat and poor potential for building site development and sanitary facilities.

This soil is suited to wheat, sorghum, and alfalfa. It absorbs and releases moisture slowly. If cultivated crops are grown, wetness is a limitation. Drainage ditches help to remove excess surface water. Crop residue management and minimum tillage improve infiltration, keep the soil in good tilth, and increase the organic-matter content.

This soil is suited to range. Overgrazing or grazing when the soil is wet, however, results in surface compaction and retards the growth and reduces the vigor of grasses. Proper stocking rates, uniform grazing distribution, deferred grazing, and restricted use when the soil is wet keep the range in good condition.

This soil is generally unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons because the flooding is a severe hazard. Overcoming this hazard is difficult without major flood control measures.

The capability subclass is IIIw.

Wa—Wells sandy loam, 2 to 5 percent slopes. This deep, gently sloping, well drained soil is on side slopes in the uplands. Individual areas are irregularly shaped or long and narrow and range from 20 to 80 acres in size.

Typically, the surface layer is grayish brown sandy loam about 5 inches thick. The subsurface layer is dark grayish brown, very friable sandy loam about 5 inches thick. The subsoil is about 32 inches thick. The upper part is brown, friable sandy clay loam; the next part is reddish yellow, firm sandy clay loam; the lower part is reddish yellow, friable sandy loam. The substratum to a depth of about 60 inches is reddish yellow sandy loam. In places sandstone is within a depth of 40 inches.

Included with this soil in mapping are small areas of Carwile, Edalgo, Hobbs, and Pratt soils, which make up about 10 to 15 percent of the map unit. The somewhat poorly drained Carwile soils and the moderately deep Edalgo soils are more clayey than the Wells soil. Carwile soils are in slight depressions, and Edalgo soils are on ridgetops or the lower side slopes. Hobbs soils are along drainageways and are occasionally flooded. They are more silty than the Wells soil. Pratt soils are less clayey than the Wells soil. They are on narrow ridgetops.

Permeability is moderate in the Wells soil, and available water capacity is high. Runoff is medium. Natural fertility is medium, and organic-matter content is moderately low. The surface layer and the upper part of the subsoil are medium acid or slightly acid. The surface layer is very friable and can be easily tilled. The shrink-swell potential is moderate.

About half of the acreage is range. The rest generally is cultivated. This soil has good potential for range, for openland wildlife habitat, and for windbreaks. It has fair potential for cultivated crops, building site development, and sanitary facilities.

This soil is moderately well suited to wheat, sorghum, and alfalfa. If cultivated crops are grown, erosion and soil blowing are hazards. Terraces, grassed waterways, contour farming, stubble mulching, and minimum tillage help to control erosion and soil blowing and conserve moisture. The soil is suitable for irrigation. An adequate supply of suitable water is needed. Land leveling and water management help to control erosion and improve water distribution.

A cover of range plants is effective in controlling erosion and soil blowing. Overgrazing, however, retards the growth and reduces the vigor of grasses. Proper stocking rates, deferred grazing, and uniform grazing distribution keep the range in good condition.

The shrink-swell potential is a moderate limitation if this soil is used as a site for dwellings. Reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the damage to buildings caused by shrinking and swelling. Low strength is a severe limitation on sites for local roads and streets. Strengthening or replacing the base material helps to overcome this limitation.

This soil is a suitable site for septic tank absorption fields. Seepage and slope are moderate limitations, however, on sites for sewage lagoons. Sealing the lagoon helps to control the seepage.

The capability subclass is IIIe.

We—Wells loam, 3 to 7 percent slopes. This deep, moderately sloping, well drained soil is on side slopes and foot slopes in the uplands. Individual areas are long and narrow or irregularly shaped and range from 20 to 120 acres in size.

Typically, the surface layer is dark grayish brown loam about 10 inches thick. The subsoil is clay loam about 40 inches thick. The upper part is brown and friable, the next part is yellowish red and reddish yellow and friable and firm, and the lower part is reddish yellow and friable. The substratum to a depth of about 60 inches is reddish yellow loam. In some areas the surface layer is clay loam. In other areas, weathered sandstone fragments are at the surface and bedrock is within a depth of 40 inches. In places the soil is less sandy.

Included with this soil in mapping are small areas of Crete, Edalgo, and Hobbs soils, which make up about 15 percent of the map unit. The moderately well drained Crete soils and the moderately deep Edalgo soils are on ridgetops and the lower side slopes. They are more clayey than the Wells soil. Hobbs soils are along drainageways and are occasionally flooded. They are more silty than the Wells soil.

Permeability is moderate in the Wells soil, and available water capacity is high. Runoff is medium. Natural fertility also is medium, and organic-matter content is moderately low. The surface layer and the upper part of the subsoil are medium acid or slightly acid. The surface layer is very friable and can be easily tilled. The shrink-swell potential is moderate.

About half of the acreage is cultivated. The rest is mainly range. This soil has good potential for range, for openland wildlife habitat, and for windbreaks. It has fair potential for cultivated crops, building site development, and sanitary facilities.

This soil is moderately well suited to wheat, sorghum, and alfalfa. If cultivated crops are grown, erosion is a hazard. Terraces, grassed waterways, contour farming, crop residue management, and minimum tillage help to control erosion, increase the organic-matter content, and keep the soil in good tilth.

This soil is well suited to range. Overgrazing, however, retards the growth and reduces the vigor of grasses and increases the runoff rate. Proper stocking rates, deferred grazing, and uniform grazing distribution keep the range in good condition.

The shrink-swell potential is a moderate limitation if this soil is used as a site for dwellings. Reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the damage to buildings caused by shrinking and swelling. Low strength is a severe limitation on sites for local roads and streets. Strengthening or replacing the base material helps to overcome this limitation.

This soil is a suitable site for septic tank absorption fields. Seepage and slope are moderate limitations, however, on sites for sewage lagoons. Sealing the lagoon helps to control the seepage.

The capability subclass is IIIe.

Wf—Wells loam, 3 to 7 percent slopes, eroded. This deep, moderately sloping, well drained soil is on side slopes and foot slopes in the uplands. Individual areas are long and narrow or irregularly shaped and range from 20 to 90 acres in size.

Typically, the surface layer is brown loam about 5 inches thick. The subsoil is clay loam about 30 inches thick. The upper part is yellowish red and firm, and the lower part is reddish yellow and friable. The substratum to a depth of about 60 inches is reddish yellow loam. In places the surface layer is clay loam. In some areas, partly weathered sandstone fragments are at the surface and sandstone bedrock is within a depth of 40 inches. In other areas the soil is less sandy.

Included with this soil in mapping are small areas of Crete, Edalgo, and Hobbs soils, which make up about 10 percent of the map unit. The moderately well drained Crete soils and the moderately deep Edalgo soils are on ridgetops and the lower side slopes. They are more clayey than the Wells soil. Hobbs soils are along drainageways and are occasionally flooded. They are more silty than the Wells soil.

Permeability is moderate in the Wells soil, and available water capacity is high. Runoff is medium. Natural fertility also is medium, and organic-matter content is moderately low. The surface layer and the upper part of the subsoil are medium acid or slightly acid. The surface layer is firm, and tilth is fair. The shrink-swell potential is moderate.

Most of the acreage is cultivated. This soil has good potential for range and for openland wildlife habitat. It has fair potential for cultivated crops and for windbreaks, building site development, and sanitary facilities.

This soil is moderately well suited to wheat, sorghum, and alfalfa. Further erosion is a hazard if cultivated crops are grown. Terraces, grassed waterways, contour farming, minimum tillage, and crop residue management help to control erosion, increase the organic-matter content, and keep the soil in good tilth.

A cover of range plants is effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, increases the runoff rate and retards the growth and reduces the vigor of grasses. Proper stocking rates, deferred grazing, uniform grazing distribution, and restricted use when the soil is wet keep the range in good condition.

The shrink-swell potential is a moderate limitation if this soil is used as a site for dwellings. Reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the damage to buildings caused by shrinking and swelling. Low strength is a severe limitation on sites for local roads and streets. Strengthening or replacing the base material helps to overcome this limitation.

This soil is suitable as a site for septic tank absorption fields. Seepage and slope are moderate limitations, however, on sites for sewage lagoons. Sealing the lagoon helps to control the seepage.

The capability subclass is IVe.

Use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, and trees and shrubs.

Crops and pasture

Earl J. Bondy, conservation agronomist, Soil Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Soil maps for detailed planning." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

Approximately 50 percent of the acreage in Ottawa County was cropped in 1967. From 1967 to 1976, wheat was grown on about 66 percent of the cropland, sorghum on 13 percent, alfalfa on 7 percent, and oats, barley, rye, corn, and soybeans on 5 percent. The remaining 9 percent was summer fallowed.

The acreage planted to wheat increased 20 percent from 1967 to 1976. The acreage of all other crops and of summer fallow decreased during this period.

Soil erosion is the major problem on about 60 percent of the cropland in Ottawa County. If the slope is more than 1 percent, erosion is a hazard. Loss of the surface layer through erosion is damaging for two reasons. Firstly, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into a plow layer. Loss of the surface layer is especially damaging on soils that have a clayey subsoil, such as Crete soils. Secondly, erosion results in sediment entering streams. Control of erosion minimizes the pollution of streams by sediment and improves the quality of water.

Erosion control practices provide protective surface cover, reduce the runoff rate, and increase the infiltration rate. A cropping system that keeps a plant cover on the surface for extended periods reduces the risk of erosion and preserves the productive capacity of the soils.

Terraces and diversions reduce the length of slopes, the runoff rate, and the risk of erosion. They are most practical on deep, well drained soils that have uniform, regular slopes. Almost all of the soils in the county are suitable for terraces and diversions.

Contour tillage should generally be used in combination with terraces (fig. 8). It is best suited to those soils that have smooth, uniform slopes and are suitable for terracing.

Leaving crop residue on the surface, either through minimum tillage or stubble mulching, increases the infiltration rate and reduces the runoff rate and the hazard of water erosion. The extra cover helps to control soil blowing (fig. 9). Minimum tillage and stubble mulching are becoming more common in Ottawa County.

Information about the design of erosion control practices is available at county offices of the Soil Conservation Service. The latest information about growing crops can be obtained from the Cooperative Extension Service or the Soil Conservation Service.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

For yields of irrigated crops, it is assumed that the irrigation system is adapted to the soils and to the crops grown, that good quality irrigation water is uniformly applied as needed, and that tillage is kept to a minimum.

Figure 8.—Disking wheat residue on the contour in preparation for planting sorghum on Crete soils.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils.

Land capability classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

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

Class I soils have slight limitations that restrict their use.

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

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

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

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Figure 9.—Crop residue of sorghum on Crete soils. Leaving the residue on the surface helps to control soil blowing and erosion.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

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

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Soil maps for detailed planning."

Rangeland

Kenneth L. Hladek, range conservationist, Soil Conservation Service, helped prepare this section.

About 190,774 acres, or 41 percent of the acreage in Ottawa County, is rangeland. About 35 percent of the agricultural income in the county is derived from the sale of livestock and livestock products, principally cattle.

Most of the ranches in Ottawa County are cow-calf units. These units are most common on the larger ranches, where the rangeland occurs as large continuous tracts. Small stock farms are throughout the central part of the county, where small acreages of rangeland are interspersed with larger areas of cropland.

Some livestock producers extend the grazing season by providing pastures of cool season tame grasses, principally bromegrass. Many also supplement the grassland forage with grain sorghum crop residue and, occasionally, small grain on winter pastures. During the winter, hay and protein concentrates generally are used as supplements.

Soils strongly influence the potential natural plant community in any area. As a result of the nature of the soils and the amount of precipitation received, most areas in Ottawa County can support a unique natural plant community. The county is in a transition zone between the Mixed Prairie to the west and the Tall Grass Prairie to the east. The dominant grasses, however, are most like those on the Bluestem Prairie. The plant communities are dominated by bluestems (*Andropogon*), switchgrass (*Panicum virgatum*), and indiangrass (*Sorghastrum nutans*).

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 6 shows, for many soils in the survey area, the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the average percentage of each species. Only those soils that are used as or are suited to rangeland are listed. Explanation of the column headings in table 6 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight is the total annual yield per acre reduced to a common percent of air-dry moisture.

Characteristic vegetation—the grasses, forbs, and shrubs that make up most of the potential natural plant community on each soil—is listed by common name. Under *composition*, the expected percentage of the total annual production is given for each species making up the characteristic vegetation. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only. It does not have a specific meaning that pertains to the present plant community in a given use.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Forage production has been reduced in some areas in the county because overgrazing has depleted the natural plant community. Sound range management that is based on soil survey information and other inventory data can maintain or improve forage production. Proper grazing use and an even distribution of grazing help to keep the range in good condition. Deferred grazing, a planned grazing system, measures that control brush, and reseeding of marginal cropland improve the range condition.

Windbreaks and environmental plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens.

Careful planning and special management are needed when windbreaks are established. The trees and shrubs should be selected according to their suitability for the different kinds of soil. They should not be planted, for example, on the shallow Hedville and Kipson soils, which are generally unsuitable for windbreaks. Site preparation is needed before the trees or shrubs are planted. Controlling grasses and weeds increases the amount of available moisture. In areas supporting young trees, protection from fire, livestock, insects, rabbits, and rodents is needed.

Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a nursery.

Recreation

Robert J. Higgins, biologist, Soil Conservation Service, helped prepare this section.

Several areas in Ottawa County are valuable as scenic or recreation areas. Several watershed lakes, farm ponds, and the Saline and Solomon Rivers provide opportunities for recreation on privately owned land. The potential for additional recreational development is fair to good.

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife habitat

Robert J. Higgins, biologist, Soil Conservation Service, helped prepare this section.

The primary game species in Ottawa County are pheasant, bobwhite quail, mourning dove, cottontail rabbit, fox squirrel, white-tailed deer, and several species of waterfowl. The nongame species are various because the habitat types are diverse. Cropland, woodland, and grassland are interspersed throughout the county. Each provides a habitat for different kinds of animals.

Furbearers are common along the Solomon and Saline Rivers and their tributaries. They are trapped to a limited extent. Fish inhabit stockwater ponds, streams, and watershed lakes. Common species are bass, channel cat and flathead catfish, carp, and bluegill.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, barley, and grain sorghum.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, wheatgrass, grama, indiangrass, switchgrass, perennial sunflowers, ragweed, and native legumes.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are oak, elm, chokecherry, black walnut, hackberry, cottonwood, willow, green ash, boxelder, and mulberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, crabapple, plum, fragrant sumac, and winterberry.

Coniferous plants furnish browse, seeds, and cones. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, and redcedar.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are sumac, plum, gooseberry, buckbrush, prairie rose, and dogwood.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, cattail, saltgrass, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite, pheasant, meadowlark, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, crows, thrushes, owls, woodpeckers, squirrels, raccoon, opossum, and white-tailed deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, beaver, and redwing blackbirds.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include prairie dogs, white-tailed deer, meadowlark, coyotes, badgers, jack rabbits, mule deer, hawks, and killdeer.

Onsite technical assistance in planning wildlife areas and in determining suitable species of vegetation for planting can be obtained from the Soil Conservation Service, the Kansas Fish and Game Commission, and the Cooperative Extension Service.

Engineering

Glen Creager, Jr., civil engineer, Soil Conservation Service, helped prepare this section.

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables. Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building site development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Sanitary facilities

Table 11 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to effectively filter the effluent. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair, poor* or *unsuited* as a source of roadfill, sand, gravel, and topsoil. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering properties.

A soil that is a good source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water management

Table 13 gives information on the soil properties and site features that affect water management. The kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances, such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering properties

Table 14 gives estimates of the engineering classification and of the range of properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains particles coarser than sand, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

Physical and chemical properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility of soil to soil blowing and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and water features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt or water in swamps and marshes is not considered flooding.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered is local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table—that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16.

An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. An artesian water table is under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole. A perched water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either rippable or hard. If the rock is rippable or fractured, excavations generally can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavations.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate,* or *high,* is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Soil series and morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (*3*). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (*4*). Unless otherwise stated, matrix colors in the descriptions are for dry soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Soil maps for detailed planning."

Armo series

The Armo series consists of deep, well drained, moderately permeable soils on foot slopes. These soils formed in strongly calcareous loamy colluvium derived from interbedded limestone and shale modified by silty loess. Slopes range from 3 to 8 percent.

Armo soils are commonly adjacent to Crete, Geary, Hobbs, and Kipson soils. Crete and Geary soils have an argillic horizon. They are on the lower slopes. Hobbs soils lack a mollic epipedon. They are on flood plains. Kipson soils have limestone and shale bedrock within 20 inches of the surface. They are in the steeper areas above the Armo soils.

Typical pedon of Armo silt loam, 3 to 8 percent slopes, 1,320 feet south and 1,320 feet west of the northeast corner of sec. 8, T. 9 S., R. 5 W.

Ap—0 to 6 inches; dark gray (10YR 4/1) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; hard, friable; violent effervescence; 10 percent channery limestone fragments; moderately alkaline; abrupt smooth boundary.

A12—6 to 12 inches; dark gray (10YR 4/1) silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, very friable; violent effervescence; 10 percent fine channery limestone fragments; moderately alkaline; gradual smooth boundary.

B1—12 to 17 inches; gray (10YR 5/1) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; slightly hard, friable; violent effervescence; 5 percent fine channery limestone fragments; few white soft carbonate coatings; moderately alkaline; gradual smooth boundary.

B2ca—17 to 34 inches; grayish brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate fine subangular blocky structure; hard, friable; violent effervescence; common white soft carbonate threads and coatings; 5 percent fine channery limestone fragments; moderately alkaline; gradual smooth boundary.

C1ca—34 to 44 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; weak medium subangular blocky structure; hard, friable; violent effervescence; common white soft carbonate threads and coatings; 5 percent fine channery limestone fragments; moderately alkaline; gradual smooth boundary.

C2—44 to 60 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; weak medium blocky structure; hard, friable; violent effervescence; few white soft carbonate threads and coatings; moderately alkaline.

The solum ranges from 24 to 40 inches in thickness. It is mildly alkaline or moderately alkaline. The mollic epipedon ranges from 12 to 18 inches in thickness. The content of channery fragments on or in the soil ranges, by volume, from less than 5 percent to 20 percent. The soils are calcareous throughout.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silt loam, but the range includes silty clay loam. The B2 and C horizons have hue of 10YR, value of 5 or 6 (4 or 5 moist), and chroma of 2 or 3. The B2 horizon is silty clay loam, loam, or clay loam. It ranges from 25 to 35 percent clay. The C horizon is silt loam or clay loam.

Carwile series

The Carwile series consists of deep, somewhat poorly drained, slowly permeable soils on uplands. These soils formed in old alluvium or in eolian sediments. Slopes are 0 to 1 percent.

The annual temperature of the Carwile soils in this county is a few degrees lower than is defined as the range for the Carwile series. This difference, however, does not alter the use or behavior of the soils.

Carwile soils are commonly adjacent to Els, Pratt, and Wells soils. Els and Pratt soils are sandy. Els soils are on low stream terraces, and Pratt and Wells soils are in the steeper areas above the Carwile soils. Wells soils have a less clayey argillic horizon than Carwile soils.

Typical pedon of Carwile fine sandy loam, 2,120 feet east and 150 feet north of the southwest corner of sec. 36, T. 11 S., R. 2 W.

Ap—0 to 6 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; slightly acid; abrupt smooth boundary.

A12—6 to 10 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable; few thin strata of lighter colored sandy loam; slightly acid; gradual smooth boundary.

B1—10 to 15 inches; dark grayish brown (10YR 4/2) sandy clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; hard, friable; slightly acid; gradual smooth boundary.

B2t—15 to 38 inches; light brownish gray (2.5Y 6/2) sandy clay, grayish brown (2.5Y 5/2) moist; many fine and medium prominent yellowish brown (10YR 5/6), reddish brown (5YR 4/4), and light gray (10YR 7/1) mottles; moderate medium and fine blocky structure; very hard, very firm; nearly continuous clay films on vertical faces of peds; common fine and medium dark concretions; neutral; gradual smooth boundary.

B3—38 to 48 inches; light brownish gray (2.5Y 6/2) sandy clay loam, grayish brown (2.5Y 5/2) moist; many fine prominent yellowish brown (10YR 5/6), reddish brown (5YR 4/4), and light gray (10YR 7/1) mottles; moderate fine subangular blocky structure; very hard, firm; thin clay films on vertical faces of some peds in the upper part; common medium dark concretions; slight effervescence; mildly alkaline; gradual smooth boundary.

C—48 to 60 inches; light brownish gray (2.5Y 6/2) sandy clay loam, grayish brown (2.5Y 5/2) moist; many fine prominent yellowish brown (10YR 5/6), reddish brown (5YR 4/4), and light gray (10YR 7/1) mottles; massive; hard, friable; common medium and fine dark concretions; common lime concretions; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 40 to 54 inches. The depth to free carbonates ranges from 38 to 60 inches. The thickness of the mollic epipedon ranges from 10 to 16 inches.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 2. It is dominantly fine sandy loam but is loam in some pedons. It is slightly acid or medium acid. The B2 horizon has hue of 10YR or 2.5Y, value of 5 or 6 (4 or 5 moist), and chroma of 1 or 2. It is sandy clay or clay loam, and it ranges from 35 to 50 percent clay. It is slightly acid or neutral. The C horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 to 6 moist), and chroma of 1 to 3. It is fine sandy loam or sandy clay loam. The brown, red, and gray mottles in the B2t, B3, and C horizons range from few to many and are fine or medium and distinct or prominent.

Crete series

The Crete series consists of deep, moderately well drained, slowly permeable, soils on loess-covered uplands. These soils formed in calcareous silty loess. Slopes range from 0 to 5 percent.

Crete soils are similar to Detroit and Harney soils and are commonly adjacent to Geary and Hobbs soils. Detroit and Geary soils have a less clayey argillic horizon than Crete soils. Detroit soils are on alluvial terraces, and Geary soils are on the lower slopes. Harney soils have a mollic epipedon that is less than 20 inches thick. They are on the higher ridgetops and side slopes. Hobbs soils are fine-silty. They are on flood plains.

Typical pedon of Crete silt loam, 0 to 2 percent slopes (fig. 10), 2,100 feet south and 100 feet west of the northeast corner of sec. 11, T. 10 S., R. 4 W.

Ap—0 to 8 inches; gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; weak fine granular structure; slightly hard, very friable; slightly acid; abrupt smooth boundary.

A12—8 to 15 inches; gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; moderate fine granular structure; slightly hard, friable; slightly acid; gradual smooth boundary.

B1—15 to 19 inches; gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) moist; moderate fine and medium subangular blocky structure; hard, friable; patchy clay films on faces of some peds near the lower boundary; slightly acid; gradual smooth boundary.

B21t—19 to 27 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; strong coarse blocky structure parting to strong fine blocky; very hard, very firm; continuous clay films on faces of peds; slightly acid; gradual smooth boundary.

B22t—27 to 38 inches; grayish brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) moist; moderate coarse blocky structure parting to strong fine blocky; very hard, very firm; continuous clay films on faces of peds; neutral; gradual smooth boundary.

B3—38 to 44 inches; light brownish gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) moist; few fine faint dark brown (10YR 3/3) mottles; moderate medium and fine subangular blocky structure; hard, firm; patchy clay films on vertical faces of some peds in the upper part; few fine dark concretions; few fine lime concretions; slight effervescence; mildly alkaline; gradual smooth boundary.

Figure 10.—Profile of Crete silt loam. The subsoil has blocky structure.

C—44 to 60 inches; very pale brown (10YR 7/3) silt loam, pale brown (10YR 6/3) moist; common fine faint dark brown (10YR 3/3) and yellowish brown (10YR 5/6) mottles; massive; slightly hard, friable; common fine dark concretions; common fine lime concretions; strong effervescence; mildly alkaline.

The thickness of the solum ranges from 36 to 48 inches. The depth to free carbonates ranges from 32 to 48 inches. The thickness of the mollic epipedon ranges from 20 to 30 inches.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silt loam but is silty clay loam in some pedons. It is medium acid or slightly acid. The B2 horizon has hue of 10YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 or 3. The darker colors are in the upper part. This horizon averages as low as 45 percent clay in some pedons and as high as 50 percent clay in others. It is slightly acid or neutral. The C horizon has hue of 10YR, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4.

Detroit series

The Detroit series consists of deep, moderately well drained, slowly permeable soils on alluvial terraces. These soils formed in calcareous silty alluvium. Slopes are 0 to 1 percent.

Detroit soils are similar to Crete, Harney, and New Cambria soils and are commonly adjacent to Hord and Sutphen soils. Crete and Harney soils are on loess-covered uplands. Crete soils have a more clayey argillic horizon than Detroit soils, and Harney soils have a mollic epipedon that is less than 20 inches thick. The position of Hord and New Cambria soils on the landscape is similar to that of Detroit soils. Hord soils are fine-silty, and New Cambria soils lack an argillic horizon. Sutphen soils have a more clayey control section than Detroit soils and lack an argillic horizon. They are in slight depressions.

Typical pedon of Detroit silty clay loam, 2,630 feet west and 50 feet north of the southeast corner of sec. 11, T. 11 S., R. 4 W.

Ap—0 to 6 inches; dark gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) moist; weak fine granular structure; hard, friable; slightly acid; abrupt smooth boundary.

A12—6 to 16 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; moderate fine granular structure; hard, friable; slightly acid; gradual smooth boundary.

B21t—16 to 27 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine blocky structure; hard, friable; patchy clay films on faces of peds; neutral; gradual smooth boundary.

B22t—27 to 37 inches; grayish brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) moist; thin vertical streaks, dark gray (10YR 4/1) moist; moderate medium and fine blocky structure; very hard, very firm; few fine lime concretions below 30 inches; mildly alkaline; gradual smooth boundary.

B3ca—37 to 44 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 4/3) moist; few fine faint yellowish brown (10YR 5/6) mottles; moderate medium and fine subangular blocky structure; hard, friable; many fine dark concretions; many fine lime concretions; strong effervescence; mildly alkaline; gradual smooth boundary.

C—44 to 60 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; few fine faint yellowish brown (10YR 5/6) mottles; weak medium and fine subangular blocky structure; hard, friable; few fine dark concretions; common fine lime concretions; strong effervescence; mildly alkaline.

The thickness of the solum ranges from 30 to 48 inches. The mollic epipedon ranges from 20 to 40 inches in thickness. The depth to free carbonates ranges from 24 to 40 inches.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silty clay loam but in some pedons is silt loam. It is slightly acid or neutral. The B2 horizon has hue of 10YR, value of 4 or 5 (3 or 4 moist), and chroma of 2 or 3. It is silty clay or silty clay loam, and it averages as low as 35 percent clay in some pedons and as high as 45 percent clay in others. It is neutral or mildly alkaline. Some pedons do not have a B3 horizon. The C horizon has hue of 10YR, value of 4 to 6 (3 to 5 moist), and chroma of 3 or 4.

Edalgo series

The Edalgo series consists of moderately deep, well drained, very slowly permeable soils on uplands. These soils formed in clayey residuum of noncalcareous silty and clayey shale. Slopes range from 3 to 15 percent.

Edalgo soils are commonly adjacent to Crete, Geary, Hedville, and Lancaster soils. Crete soils have a mollic epipedon that is more than 20 inches thick and do not have bedrock within a depth of 40 inches. They are on ridgetops or the upper slopes. Geary and Lancaster soils are on ridgetops or side slopes. Geary soils are fine-silty and do not have bedrock within a depth of 40 inches. Lancaster soils are fine-loamy. Hedville soils are shallow to sandstone. They are on the steeper upper side slopes and narrow ridgetops.

Typical pedon of Edalgo silt loam, 3 to 7 percent slopes, 2,400 feet south and 150 feet east of the northwest corner of sec. 8, T. 12 S., R. 1 W.

A1—0 to 6 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable; medium acid; gradual smooth boundary.

B1—6 to 12 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; hard, friable; medium acid; clear smooth boundary.

B21t—12 to 18 inches; grayish brown (10YR 5/2) silty clay, dark grayish brown and grayish brown (10YR 4/2, 5/2) moist; strong fine blocky structure; very hard, firm; slightly acid; gradual smooth boundary.

B22t—18 to 30 inches; grayish brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) moist; few fine faint reddish brown (5YR 5/4) mottles; strong fine blocky structure; very hard, very firm; slightly acid; gradual smooth boundary.

C—30 to 36 inches; light gray and grayish brown (10YR 7/1, 5/2) silty clay, gray and dark grayish brown (10YR 6/1, 4/2) moist; common medium distinct reddish brown (5YR 4/4) mottles; moderate fine and medium blocky structure; very hard, very firm; few fine lime concretions; neutral; clear wavy boundary.

Cr—36 inches; weathered clayey shale.

The thickness of the solum ranges from 20 to 36 inches. The depth to weathered clayey shale ranges from 20 to 40 inches. The mollic epipedon ranges from 8 to 18 inches in thickness.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silt loam but in some pedons is loam or silty clay loam. The A and B horizons range from medium acid to neutral. The B2t horizon has hue of 10YR or 7.5YR, value of 5 to 7 (4 or 5 moist), and chroma of 2 to 4. It is silty clay or silty clay loam. The mottles in the lower part of the B2t horizon and in the C horizon are few to many, fine to coarse, and faint to prominent. The C horizon has hue of 10YR or 7.5YR, value of 5 to 7 (4 to 6 moist), and chroma of 1 to 4. In some pedons it does not occur. In others it does not have carbonate concretions.

Els series

The Els series consists of deep, somewhat poorly drained, rapidly permeable soils on low stream terraces. These soils formed in eolian sand. Slopes range from 0 to 3 percent.

Els soils are commonly adjacent to Carwile, Pratt, and Wells soils. All of these adjacent soils have an argillic horizon. They are on uplands above the Els soils. The Pratt and Wells soils are well drained.

Typical pedon of Els loamy sand, 2,100 feet north and 650 feet east of the southwest corner of sec. 3, T. 12 S., R. 2 W.

A1—0 to 6 inches; grayish brown (10YR 5/2) loamy sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure parting to single grained; loose; neutral; gradual smooth boundary.

AC—6 to 14 inches; light brownish gray (10YR 6/2) loamy fine sand, grayish brown (10YR 5/2) moist; few fine faint yellowish brown (10YR 5/6) mottles; single grained; loose; neutral; gradual smooth boundary.

C1—14 to 20 inches; very pale brown (10YR 7/4) fine sand, light yellowish brown (10YR 6/4) moist; few strata of coarse sand; common medium distinct yellowish brown (10YR 5/6) and reddish brown (5YR 4/4) mottles; single grained; loose; neutral; gradual smooth boundary.

C2—20 to 60 inches; very pale brown (10YR 8/3) fine sand, pale brown (10YR 6/3) moist; few strata of coarse sand; many coarse distinct yellowish brown (10YR 5/6), reddish brown (5YR 4/4), and gray (10YR 5/1) mottles; single grained; loose; neutral.

The thickness of the solum ranges from 10 to 15 inches. The A horizon has hue of 10YR, value of 4 or 5 (3 or 4 moist), and chroma of 1 or 2. It is dominantly loamy sand, but the range includes fine sand. The AC horizon has hue of 10YR, value of 5 or 6 (4 or 5 moist), and chroma of 2. It is fine sand or loamy fine sand. The C horizon has hue of 10YR, value of 6 to 8 (5 or 6 moist), and chroma of 2 to 4. Some pedons have coarse sand and gravel below a depth of 40 inches.

Geary series

The Geary series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in reddish loess. Slopes range from 1 to 15 percent.

Geary soils are similar to Wells soils and are commonly adjacent to Crete, Hobbs, Hord, Lancaster, and Wells soils. Crete soils have a thicker mollic epipedon and a more clayey argillic horizon than Geary soils. They are on the upper side slopes and ridgetops. Hobbs soils lack a mollic epipedon. They are on flood plains. Hord soils have a thicker mollic epipedon than Geary soils. They are on terraces. Lancaster and Wells soils are fine-loamy. Their position on the landscape is similar to that of Geary soils. Lancaster soils have bedrock within a depth of 40 inches.

Typical pedon of Geary silt loam, 3 to 6 percent slopes (fig. 11), 1,320 feet north and 75 feet west of the southeast corner of sec. 12, T. 10 S., R. 3 W.

A1—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; strong fine granular structure; slightly hard, very friable; slightly acid; gradual smooth boundary.

B1—8 to 12 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; strong fine subangular blocky structure; slightly hard, friable; slightly acid; gradual smooth boundary.

B21t—12 to 18 inches; brown (7.5YR 5/4) silty clay loam, brown (7.5YR 4/4) moist; strong fine subangu-

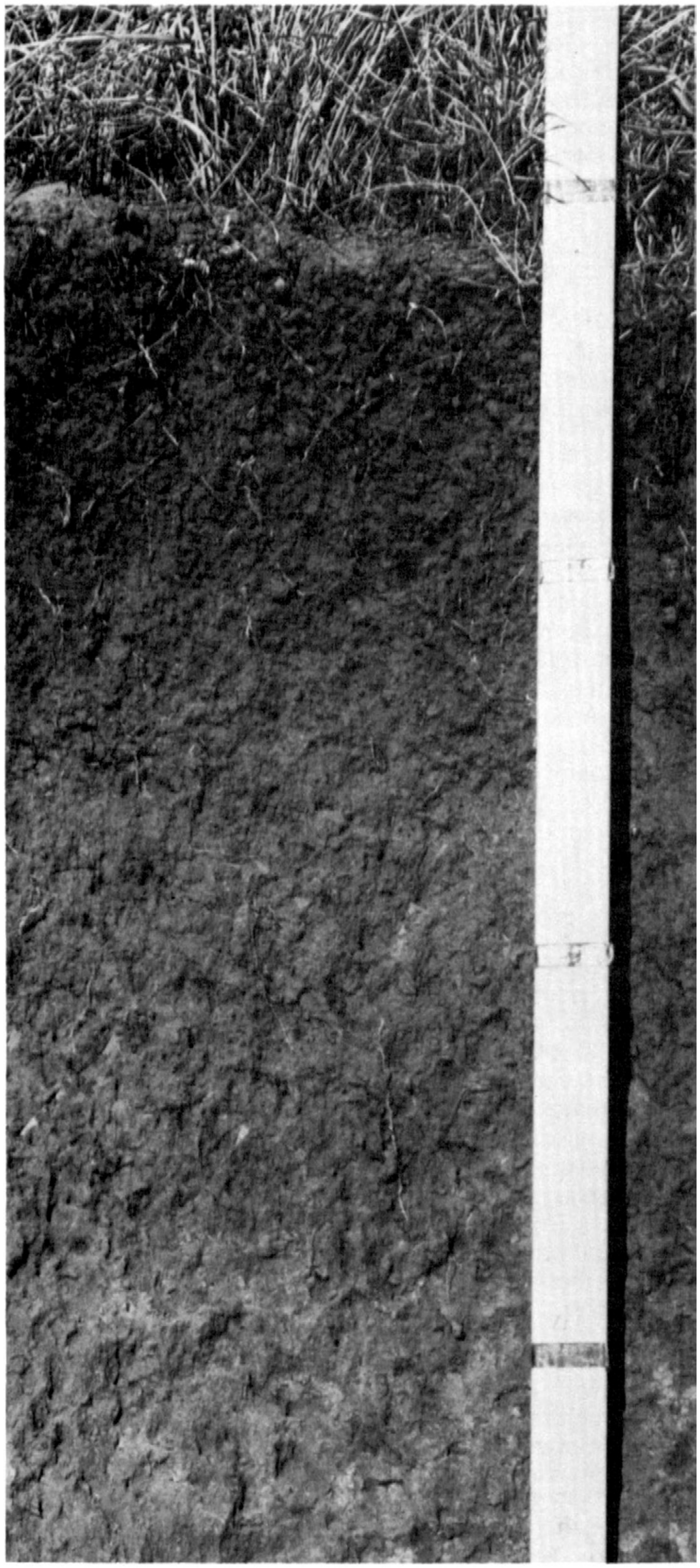


Figure 11.—Profile of Geary silt loam. The surface layer is dark. Depth is marked in feet.

lar blocky structure; hard, firm; thin patchy clay films on faces of some peds; slightly acid; gradual smooth boundary.

B22t—18 to 36 inches; reddish brown (5YR 5/3) silty clay loam, reddish brown (5YR 4/3) moist; strong medium and fine blocky structure; very hard, firm; thin patchy clay films in the upper part; slightly acid; gradual smooth boundary.

B3—36 to 44 inches; reddish yellow (5YR 6/6) silty clay loam, yellowish red (5YR 5/6) moist; moderate fine subangular blocky structure; hard, friable; thin patchy clay films on faces of some peds; slightly acid; gradual smooth boundary.

IIC—44 to 60 inches; reddish yellow (5YR 6/6) clay loam, yellowish red (5YR 5/6) moist; massive; hard, friable; common fine dark concretions and fine sandstone gravel; neutral.

The thickness of the solum ranges from 36 to 50 inches. The depth to free carbonates is more than 44 inches. The thickness of the mollic epipedon ranges from 10 to 15 inches.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 2 or 3. It is dominantly silt loam but in some pedons is silty clay loam. It is medium acid or slightly acid. The B2t horizon has hue of 7.5YR or 5YR, value of 4 to 6 (3 to 5 moist), and chroma of 3 to 6. The darker colors are in the upper part. This horizon averages as low as 30 percent clay in some pedons and as high as 35 percent clay in others. The C horizon has hue of 7.5YR or 5YR, value of 5 to 7 (4 or 5 moist), and chroma of 4 to 6. It is neutral or mildly alkaline.

Harney series

The Harney series consists of deep, well drained, moderately slowly permeable soils on uplands. These soils formed in calcareous silty loess. Slopes range from 2 to 7 percent.

Harney soils are similar to Crete and Detroit soils and are commonly adjacent to Kipson soils. Crete and Detroit soils have a mollic epipedon that is more than 20 inches thick. Crete soils are on the lower slopes, and Detroit soils are on alluvial terraces. Kipson soils lack an argillic horizon and are shallow over interbedded limestone and shale. They are on the lower slopes or the higher ridgetops.

Typical pedon of Harney silt loam, 2 to 7 percent slopes, 1,580 feet south and 450 feet east of the northwest corner of sec. 21, T. 9 S., R. 5 W.

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

A12—5 to 10 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; hard, friable; slightly acid; gradual smooth boundary.

B21t—10 to 16 inches; dark grayish brown (10YR4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; strong medium and fine subangular blocky structure; hard, firm; thin patchy clay films; neutral; gradual smooth boundary.

B22t—16 to 29 inches; grayish brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) moist; few fine faint brown (10YR 5/3) mottles; strong medium and fine blocky structure; very hard, very firm; thin patchy clay films; mildly alkaline; gradual smooth boundary.

B3ca—29 to 38 inches; light brownish gray (10YR 6/2) silty clay loam, grayish brown (10YR 5/2) moist; few fine faint brown (10YR 5/3) mottles; moderate fine subangular blocky structure; hard, firm; many soft carbonate accumulations and lime concretions; strong effervescence; moderately alkaline; gradual smooth boundary.

C1ca—38 to 48 inches; light gray (10YR 7/2) silty clay loam, light brownish gray (10YR 6/2) moist; few fine faint brown (10YR 5/3) mottles; massive; hard, friable; common soft carbonate accumulations and lime concretions; strong effervescence; moderately alkaline; gradual smooth boundary.

C2—48 to 60 inches; light gray (10YR 7/2) silt loam, light brownish gray (10YR 6/2) moist; few fine distinct yellowish brown (10YR 5/4) and dark brown (10YR 3/3) mottles; massive; hard, friable; few lime concretions; strong effervescence; mildly alkaline.

The thickness of the solum ranges from 30 to 48 inches. The mollic epipedon ranges from 10 to 16 inches in thickness. The depth to free carbonates ranges from 20 to 30 inches.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 2 or 3. It is dominantly silt loam but in some pedons is silty clay loam. It ranges from medium acid to neutral. In some pedons the upper part of the B2t horizon is part of the mollic epipedon and has colors like those of the A horizon. The lower part has hue of 10YR, value of 5 or 6 (4 or 5 moist), and chroma of 2 or 3. It is silty clay loam or silty clay, and it ranges from 35 to 42 percent clay. It ranges from neutral to moderately alkaline. The C horizon has hue of 10YR, value of 6 or 7 (5 or 6 moist), and chroma of 2 or 3. It is mildly alkaline or moderately alkaline.

Hedville series

The Hedville series consists of shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in residuum of noncalcareous sandstone. Slopes range from 5 to 30 percent.

Hedville soils are similar to Kipson soils and are commonly adjacent to Edalgo, Geary, Lancaster, and Wells soils. Edalgo and Lancaster soils have an argillic horizon and are more than 20 inches deep to bedrock. Edalgo soils are on side slopes, some of which are below the Hedville soils, and Lancaster soils are on the lower side slopes. Geary and Wells soils have an argillic horizon and are more than 40 inches deep to bedrock. They are on the lower side slopes. Kipson soils are calcareous throughout. They are on the higher ridgetops and the upper side slopes.

Typical pedon of Hedville stony loam, in an area of Hedville-Rock outcrop complex, 5 to 30 percent slopes, 1,400 feet east and 350 feet north of the southwest corner of sec. 9, T. 11 S., R. 4 W.

A11—0 to 10 inches; grayish brown (10YR 5/2) stony loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, very friable; slightly acid; gradual wavy boundary.

A12—10 to 16 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; weak fine granular structure; slightly hard, very friable; 15 percent gravel; slightly acid; clear wavy boundary.

R—16 inches; sandstone.

The thickness of the solum, or the depth to bedrock, ranges from 4 to 20 inches. The thickness of the mollic epipedon ranges from 4 to 18 inches. Reaction is medium acid or slightly acid.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 to 3. It is dominantly stony loam, but the range includes loam and stony sandy loam. The content of coarse fragments ranges from 15 to 25 percent. In some pedons the A horizon extends into pits and cracks in the sandstone.

Hobbs series

The Hobbs series consists of deep, well drained, moderately permeable soils on flood plains. These soils formed in noncalcareous silty alluvium. Slopes range from 0 to 2 percent.

Hobbs soils are similar to Hord and Roxbury soils and are commonly adjacent to Crete, Geary, Hord, and Wells soils. Unlike Hobbs soils, all of these similar or adjacent soils have a mollic epipedon. Also, Crete, Geary, and Wells soils have an argillic horizon. They are on uplands. Hord and Roxbury soils are on stream terraces.

Typical pedon of Hobbs silt loam, 1,250 feet west and 75 feet north of the southeast corner of sec. 24, T. 12 S., R. 4 W.

Ap—0 to 8 inches; gray (10YR 5/1) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, very friable; slightly acid; abrupt smooth boundary.

C1—8 to 14 inches; dark gray and pale brown (10YR 4/1, 6/3) silt loam, very dark gray and brown (10YR 3/1, 5/3) moist; thin strata of grayish brown (10YR 5/2) silt loam and fine sandy loam; weak fine granular structure; slightly hard, very friable; slightly acid; clear smooth boundary.

C2—14 to 32 inches; dark gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) moist; some grayish brown (10YR 5/2) strata; moderate fine granular structure; slightly hard, friable; slightly acid; gradual smooth boundary.

C3—32 to 44 inches; dark gray and light brownish gray (10YR 4/1, 6/2) silt loam, very dark grayish brown and pale brown (10YR 3/2, 6/3) moist; moderate fine subangular blocky structure; hard, friable; neutral; gradual smooth boundary.

C4—44 to 60 inches; light gray and dark grayish brown (10YR 7/2, 4/2) silt loam, pale brown and very dark grayish brown (10YR 6/3, 3/2) moist; massive; hard, friable; common soft carbonate accumulations and lime concretions; strong effervescence; moderately alkaline.

Free carbonates generally are at a depth of more than 40 inches. In some pedons, however, they are in a recently deposited surface layer that is less than 20 inches thick.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silt loam but in some pedons is silty clay loam. It is slightly acid or neutral. Stratification is apparent in undisturbed areas. The C horizon has hue of 10YR, value of 4 to 7 (3 to 6 moist), and chroma of 1 to 3. It is silt loam or silty clay loam. In some pedons it has thin strata of coarser or finer textured material. It ranges from slightly acid to moderately alkaline.

Hord series

The Hord series consists of deep, well drained, moderately permeable soils on terraces. These soils formed in calcareous silty alluvium. Slopes range from 0 to 2 percent.

Hord soils are similar to Hobbs, McCook, and Roxbury soils and are commonly adjacent to those soils and to Detroit and New Cambria soils. Detroit and New Cambria soils are fine textured. They are in slight depressions at the same level on the landscape as Hord soils or at a slightly lower level. Hobbs soils lack a mollic epipedon. They are on flood plains. McCook soils are coarse-silty and have a mollic epipedon that is less than 20 inches thick. They are slightly lower on the landscape than Hord soils or are at the same level. Roxbury soils have free carbonates within 15 inches of the surface. Their position on the landscape is similar to that of Hord soils.

Typical pedon of Hord silt loam, 1,300 feet north and 990 feet east of the southwest corner of sec. 18, T. 11 S., R. 3 W.

Ap—0 to 8 inches; gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; weak fine granular structure; slightly hard, very friable; neutral; abrupt smooth boundary.

A12—8 to 18 inches; dark gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) moist; moderate fine granular structure; slightly hard, very friable; neutral; gradual smooth boundary.

B21—18 to 24 inches; dark gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) moist; moderate fine subangular blocky structure; slightly hard, friable; neutral; gradual smooth boundary.

B22—24 to 34 inches; grayish brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate fine subangular blocky structure; hard, friable; slight effervescence near the lower boundary; neutral; gradual smooth boundary.

B3—34 to 43 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 4/3) moist; weak fine subangular blocky structure; slightly hard, friable; few soft carbonate accumulations and lime concretions; slight effervescence; mildly alkaline; gradual smooth boundary.

C—43 to 60 inches; light gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) moist; massive; hard, very friable; common soft carbonate accumulations and lime concretions; strong effervescence; moderately alkaline.

The solum is 37 to 48 inches thick. The mollic epipedon is 20 to 36 inches thick. The depth to free carbonates is dominantly 30 to 36 inches but ranges from 24 to 48 inches.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silt loam but in some pedons is loam. It is slightly acid or neutral. The upper part of the B2 horizon is part of the mollic epipedon and has colors like those of the A horizon. The lower part has hue of 10YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 or 3. The B2 horizon is silty clay loam or silt loam. It averages as low as 24 percent clay in some pedons and as high as 35 percent clay in others. It is neutral or mildly alkaline. The C horizon has hue of 10YR, value of 5 to 7 (4 or 5 moist), and chroma of 2 or 3. It is silt loam or stratified silt loam, loam, and fine sandy loam. It is mildly alkaline or moderately alkaline.

Kipson series

The Kipson series consists of shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in residuum of calcareous silty shale. Slopes range from 5 to 20 percent.

Kipson soils are similar to Hedville soils and are commonly adjacent to Armo and Harney soils. Armo soils are more than 40 inches deep to bedrock. They are on foot slopes below the Kipson soils. Harney soils have an argillic horizon and are more than 40 inches deep to bedrock. They are on the higher ridgetops and side slopes. Hedville soils are noncalcareous. They are at the lower elevations.

Typical pedon of Kipson stony silt loam (fig. 12), in an area of Kipson soils, 5 to 20 percent slopes, 1,150 feet

Figure 12.—Profile of Kipson stony silt loam. Silty shale is at a depth of about 16 inches.

west and 25 feet north of the southeast corner of sec. 20, T. 9 S., R. 5 W.

A1—0 to 12 inches; gray (10YR 5/1) stony silt loam, very dark gray (10YR 3/1) moist; moderate fine granular structure; slightly hard, friable; strong effervescence; moderately alkaline; clear smooth boundary.

C1—12 to 16 inches; light brownish gray (10YR 6/2) shaly silt loam, grayish brown (10YR 5/2) moist; weak fine granular structure in the upper 2 inches, thin platy structure in the lower 2 inches; 15 percent hard limy shale fragments; white carbonate coatings on shale fragments; violent effervescence, moderately alkaline; abrupt smooth boundary.

Cr—16 inches; calcareous silty shale.

The solum and the mollic epipedon are 6 to 12 inches thick. The depth to bedrock ranges from 7 to 20 inches.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly stony silt loam, but the range includes flaggy silt loam and silt loam. The C horizon has hue of 10YR, value of 5 or 6 (4 or 5 moist), and chroma of 2 or 3.

Lancaster series

The Lancaster series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in residuum of noncalcareous sandstone and sandy shale. Slopes range from 3 to 7 percent.

Lancaster soils are similar to Wells soils and are commonly adjacent to Edalgo, Geary, Hedville, and Wells soils. Unlike Lancaster soils, Edalgo soils are fine textured. They are on similar side slopes. Geary soils are fine-silty. Geary and Wells soils are more than 40 inches deep to bedrock. They are on the lower side slopes. Hedville soils are less than 20 inches deep to bedrock. They are on the upper side slopes and narrow ridgetops.

Typical pedon of Lancaster loam, 3 to 7 percent slopes, 150 feet south and 200 feet west of the northeast corner of sec. 17, T. 11 S., R. 1 W.

A1—0 to 10 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, very friable; medium acid; gradual smooth boundary.

B1—10 to 14 inches; brown (7.5YR 4/3) loam, dark brown (7.5YR 3/3) moist; moderate fine subangular blocky structure; slightly hard, friable; medium acid; gradual smooth boundary.

B21t—14 to 20 inches; reddish brown (5YR 5/4) clay loam, reddish brown (5YR 4/4) moist; moderate fine subangular blocky structure; hard, firm; darker colored clay films on faces of some peds; slightly acid; gradual smooth boundary.

B22t—20 to 30 inches; yellowish red (5YR 5/6) clay loam, yellowish red (5YR 4/6) moist; moderate fine blocky structure; hard, firm; thin clay films on faces of most peds; slightly acid; gradual smooth boundary.
B3—30 to 39 inches; reddish yellow (5YR 6/6) loam, yellowish red (5YR 5/6) moist; moderate fine subangular blocky structure; slightly hard, friable; slightly acid; gradual smooth boundary.
Cr—39 inches; partly weathered sandy shale and sandstone.

The thickness of the solum, or the depth to bedrock, ranges from 20 to 40 inches. The mollic epipedon is 10 to 16 inches thick.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 to 3. It is dominantly loam but in some pedons is sandy loam. It is medium acid or slightly acid. The B2t horizon has hue of 7.5YR or 5YR, value of 4 to 6 (3 to 5 moist), and chroma of 3 to 6. The darker colors are in the upper part. This horizon is clay loam or sandy clay loam. It is neutral or slightly acid. The B3 horizon has hue of 7.5YR or 5YR, value of 5 or 6 (4 or 5 moist), and chroma of 4 to 6. It is loam or sandy clay loam and is slightly acid or neutral. Some pedons have a C1 horizon, which is similar in color, texture, and reaction to the B3 horizon. In some pedons mottles that are more gray, yellow, or red than the soil matrix are below a depth of 20 inches.

McCook series

The McCook series consists of deep, well drained, moderately permeable soils on terraces. These soils formed in calcareous alluvium. Slopes range from 0 to 2 percent.

McCook soils are similar to Hord and Roxbury soils and are commonly adjacent to Detroit, Hord, New Cambria, Roxbury, and Sutphen soils. Hord and Roxbury soils are fine-silty and have a mollic epipedon that is more than 20 inches thick. They are on the same terraces as McCook soils or on higher ones. Detroit, New Cambria, and Sutphen soils are in slight depressions in the same terraces or in higher ones. They are fine textured.

Typical pedon of McCook silt loam, 1,850 feet east and 100 feet north of the southwest corner of sec. 27, T. 10 S., R. 4 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable; slight effervescence; mildly alkaline; abrupt smooth boundary.
A12—8 to 16 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable; strong effervescence; moderately alkaline; gradual smooth boundary.
AC—16 to 22 inches; light brownish gray (10YR 6/2) very fine sandy loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; soft, very friable; violent effervescence; moderately alkaline; gradual smooth boundary.
C1—22 to 32 inches; light brownish gray (10YR 6/2) silt loam, grayish brown (10YR 5/2) moist; massive; soft, very friable; violent effervescence; moderately alkaline; gradual smooth boundary.
C2—32 to 60 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; strata of silt loam, fine sandy loam, and fine sand; massive; loose; violent effervescence; moderately alkaline.

The thickness of the solum is dominantly 17 to 22 inches but ranges from 17 to 30 inches. The mollic epipedon is 10 to 16 inches thick. Reaction is mildly alkaline or moderately alkaline throughout the profile, and free carbonates are within 10 inches of the surface.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 2. It is dominantly silt loam, but the range includes loam. The C horizon has hue of 10YR, value of 5 to 7 (4 or 5 moist), and chroma of 2 or 3. It is silt loam or very fine sandy loam. Some pedons have a buried A horizon below a depth of 48 inches.

New Cambria series

The New Cambria series consists of deep, moderately well drained, slowly permeable soils on terraces. These soils formed in calcareous silty and clayey alluvium. Slopes range from 0 to 2 percent.

New Cambria soils are similar to Detroit and Sutphen soils and are commonly adjacent to Detroit, Hord, McCook, Roxbury, and Sutphen soils. The position of Detroit, Hord, and Sutphen soils on the landscape is similar to that of New Cambria soils. Detroit soils have an argillic horizon and do not have free carbonates within 24 inches of the surface. Hord soils are fine-silty. Sutphen soils do not have free carbonates within 20 inches of the surface. McCook soils are coarse-silty and have a mollic epipedon that is less than 20 inches thick. They are on the same terraces as New Cambria soils or on lower ones. Roxbury soils are fine-silty. Their position on the landscape is similar to that of New Cambria soils.

Typical pedon of New Cambria silty clay loam, 600 feet east and 400 feet south of the northwest corner of sec. 16, T. 10 S., R. 4 W.

Ap—0 to 6 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; moderate fine granular structure; hard, friable; mildly alkaline; abrupt smooth boundary.
A12—6 to 12 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; strong fine granular structure; hard, friable; slight effervescence; moderately alkaline; gradual smooth boundary.
B21—12 to 26 inches; gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) moist; strong fine and medium blocky structure; very hard, firm; strong efferves-

cence; moderately alkaline; gradual smooth boundary.

B22—26 to 40 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; strong fine and medium blocky structure; extremely hard, very firm; soft white carbonate accumulations; strong effervescence; moderately alkaline; gradual smooth boundary.

C1—40 to 50 inches; grayish brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate fine and medium blocky structure; very hard, firm; soft white carbonate accumulations and few lime concretions; strong effervescence; moderately alkaline; gradual smooth boundary.

C2—50 to 60 inches; brown (10YR 5/3) silty clay loam, brown (10YR 4/3) moist; massive; hard, friable; soft white carbonate accumulations and lime concretions; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 36 to 45 inches. The mollic epipedon ranges from 30 to 40 inches in thickness. The depth to free carbonates is less than 10 inches. Reaction dominantly is moderately alkaline throughout, but in many pedons the upper 10 inches is mildly alkaline.

The A horizon has hue of 10YR, value of 3 or 4 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silty clay loam, but the range includes silty clay. The B2 horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It averages as low as 40 percent clay in some pedons and as high as 50 percent clay in others. The C horizon has hue of 10YR, value of 5 or 6 (4 or 5 moist), and chroma of 1 to 3.

Pratt series

The Pratt series consists of deep, well drained, rapidly permeable soils on uplands. These soils formed in sandy eolian deposits. Slopes range from 5 to 12 percent.

The annual temperature of the Pratt soils in this county is a few degrees lower than is defined as the range for the Pratt series. This difference, however, does not alter the use or behavior of the soils.

Pratt soils are commonly adjacent to Carwile, Els, and Wells soils. Carwile soils are fine textured and have a mottled argillic horizon. They are in slight depressions. The somewhat poorly drained Els soils are on low stream terraces. They lack an argillic horizon. Wells soils are fine-loamy and have a mollic epipedon. Their position on the landscape is similar to that of Pratt soils.

Typical pedon of Pratt loamy sand, 5 to 12 percent slopes, 2,500 feet north and 100 feet west of the southeast corner of sec. 3, T. 12 S., R. 2 W.

A11—0 to 10 inches; dark grayish brown (10YR 4/2) loamy sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, loose; slightly acid; gradual smooth boundary.

A12—10 to 15 inches; grayish brown (10YR 5/2) loamy sand, dark grayish brown (10YR 4/2) moist; weak fine granular structure; slightly hard, loose; slightly acid; gradual smooth boundary.

B2t—15 to 36 inches; pale brown (10YR 6/3) loamy sand, brown (10YR 4/3) moist; weak fine prismatic structure parting to weak fine granular; slightly hard, loose; 1/4- to 1-inch lamellae of brown (7.5YR 5/4) clay loam or sandy clay loam throughout the horizon; slightly acid; gradual smooth boundary.

C—36 to 60 inches; pale brown (10YR 6/3) loamy fine sand, brown (10YR 5/3) moist; single grained; loose; neutral.

The thickness of the solum ranges from 30 to 48 inches. The depth to free carbonates is more than 48 inches.

The A horizon has hue of 10YR, value of 4 or 5 (3 or 4 moist), and chroma of 1 or 2. It is dominantly loamy sand, but the range includes loamy fine sand. The B2t horizon has hue of 10YR or 7.5YR, value of 5 or 6 (4 or 5 moist), and chroma of 2 to 4. It is loamy sand or loamy fine sand. It has few to common lamellae. The B and C horizons are slightly acid or neutral. The C horizon has hue of 10YR or 7.5YR, value of 6 (5 moist), and chroma of 3 or 4. It is loamy fine sand or fine sand. In some pedons finer textured material is below a depth of about 48 inches.

Roxbury series

The Roxbury series consists of deep, well drained, moderately permeable soils on terraces. These soils formed in calcareous loamy alluvium. Slopes range from 0 to 2 percent.

Roxbury soils are similar to Hobbs, Hord, and McCook soils and are commonly adjacent to Detroit, Hord, McCook, New Cambria, and Sutphen soils. Detroit soils have an argillic horizon. They are at the same level on the landscape as Roxbury soils or are at a slightly higher level. Hobbs soils lack a mollic epipedon. They are on flood plains. Hord soils do not have free carbonates within a depth of 24 inches. They are at the same level on the landscape as Roxbury soils. McCook soils are coarse-silty and have a mollic epipedon that is less than 20 inches thick. They are at the same level on the landscape as Roxbury soils or are at a lower level. New Cambria and Sutphen soils are more clayey throughout than the Roxbury soils. New Cambria soils are at the same level on the landscape as Roxbury soils, and Sutphen soils are at the same level or at a slightly lower level.

Typical pedon of Roxbury silt loam, 1,000 feet east and 200 feet south of the northwest corner of sec. 20, T. 9 S., R. 4 W.

Ap—0 to 7 inches; gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; weak fine granular structure;

slightly hard, very friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

A12—7 to 22 inches; dark gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) moist; moderate fine granular structure; slightly hard, friable; strong effervescence; moderately alkaline; gradual smooth boundary.

B21—22 to 32 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; hard, friable; strong effervescence; moderately alkaline; gradual smooth boundary.

B22—32 to 42 inches; grayish brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate fine subangular blocky structure; hard, friable; common soft white carbonate accumulations and few lime concretions; strong effervescence; moderately alkaline; gradual smooth boundary.

Cca—42 to 60 inches; light brownish gray (10YR 6/2) silt loam, grayish brown (10YR 5/2) moist; weak medium and fine subangular blocky structure; hard, firm; many soft white carbonate accumulations and lime concretions; violent effervescence; moderately alkaline.

The solum is 36 to 48 inches thick. The mollic epipedon is 24 to 36 inches thick. The depth to free carbonates is less than 12 inches. Reaction is mildly alkaline or moderately alkaline throughout the profile.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silt loam, but the range includes loam. The B2 horizon has hue of 10YR, value of 4 to 6 (2 to 4 moist), and chroma of 1 or 2. The darker colors are in the upper part. This horizon is silty clay loam or silt loam. It averages as low as 25 percent clay in some pedons and as high as 35 percent clay in others. The C horizon has hue of 10YR, value of 5 to 7 (4 or 5 moist), and chroma of 2 or 3. In some pedons it is stratified with silty clay loam or fine sandy loam.

Sutphen series

The Sutphen series consists of deep, somewhat poorly drained, very slowly permeable soils on terraces. These soils formed in clayey alluvium. Slopes are 0 to 1 percent.

Sutphen soils are similar to New Cambria soils and are commonly adjacent to Detroit, Hord, McCook, New Cambria, and Roxbury soils. Detroit soils have an argillic horizon. They are slightly higher on the landscape than Sutphen soils. Hord and Roxbury soils are fine-silty. Hord soils are in the same position on the landscape as Sutphen soils, and Roxbury soils are slightly lower. McCook and New Cambria soils also are slightly lower. McCook soils are coarse-silty and have a mollic epipedon that is less than 20 inches thick. New Cambria soils have free carbonates within a depth of 10 inches and lack vertic characteristics.

Typical pedon of Sutphen silty clay, 1,980 feet north and 100 feet west of the southeast corner of sec. 10, T. 11 S., R. 4 W.

Ap—0 to 6 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; moderate medium and fine granular structure; hard, firm; neutral; abrupt smooth boundary.

A12—6 to 30 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) moist; moderate medium and fine blocky structure; very hard, firm; neutral; gradual smooth boundary.

AC—30 to 38 inches; grayish brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) moist; few fine faint brown (7.5YR 5/4) mottles; weak medium blocky structure; very hard, very firm; few soft white carbonate accumulations and lime concretions; slight effervescence; mildly alkaline; gradual smooth boundary.

C—38 to 60 inches; light brownish gray (10YR 6/2) silty clay, grayish brown (10YR 5/2) moist; common fine faint brown (7.5YR 5/4) mottles; massive; very hard, very firm; common soft white carbonate accumulations and lime concretions; strong effervescence; moderately alkaline.

The solum and the mollic epipedon range from 24 to 40 inches in thickness. The depth to free carbonates ranges from 20 to 36 inches.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It ranges from slightly acid to moderately alkaline. It is dominantly silty clay, but in some pedons the upper 8 inches is silty clay loam. The C horizon has hue of 10YR, value of 5 to 7 (4 to 6 moist), and chroma of 2 or 3. It is mildly alkaline or moderately alkaline. Faint mottles are below a depth of 24 inches.

Wells series

The Wells series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in residuum of noncalcareous sandstone and sandy shale. Slopes range from 2 to 7 percent.

Wells soils are similar to Geary and Lancaster soils and are commonly adjacent to Crete, Edalgo, Geary, Hedville, and Lancaster soils. Crete soils are fine textured and have a mollic epipedon that is more than 20 inches thick. They are on ridgetops and the upper side slopes. Edalgo soils are fine textured and are less than 40 inches deep over bedrock. They are on the upper side slopes. Geary soils are fine-silty. They are on ridgetops or side slopes. Hedville soils are less than 20 inches deep over sandstone bedrock. They are on narrow ridgetops and the steeper upper side slopes. Lancaster soils are less than 40 inches deep over sandstone bedrock. They are on ridgetops and on the upper side slopes above the Wells soils.

Typical pedon of Wells loam, 3 to 7 percent slopes, 50 feet south and 300 feet west of the northeast corner of sec. 13, T. 11 S., R. 5 W.

A1—0 to 10 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, very friable; medium acid; gradual smooth boundary.

B1—10 to 16 inches; brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) moist; moderate fine subangular blocky structure; slightly hard, friable; medium acid; gradual smooth boundary.

B21t—16 to 22 inches; yellowish red (5YR 5/6) clay loam, yellowish red (5YR 4/6) moist; moderate fine subangular blocky structure; hard, friable; thin continuous clay films on faces of peds; slightly acid; gradual smooth boundary.

B22t—22 to 40 inches; reddish yellow (5YR 6/6) clay loam, yellowish red (5YR 4/6) moist; strong fine and medium blocky structure; hard, firm; thin continuous clay films on faces of peds; slightly acid; gradual smooth boundary.

B3—40 to 50 inches; reddish yellow (7.5YR 6/8) clay loam, strong brown (7.5YR 5/8) moist; moderate fine blocky structure; hard, friable; slightly acid; gradual smooth boundary.

C—50 to 60 inches; reddish yellow (7.5YR 6/6) loam, strong brown (7.5YR 5/6) moist; massive; slightly hard, very friable; few fine dark concretions; slightly acid.

The thickness of the solum ranges from 35 to 55 inches. The mollic epipedon ranges from 12 to 20 inches in thickness. The depth to bedrock is more than 40 inches.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 to 3. It is dominantly loam but is sandy loam in some pedons. It is medium acid or slightly acid. The B2t horizon has hue of 7.5YR or 5YR, value of 4 to 6 (3 to 5 moist), and chroma of 3 to 6. It is clay loam or sandy clay loam. The C horizon has hue of 7.5YR or 5YR, value of 5 to 7 (5 or 6 moist), and chroma of 4 to 8. It is loam, sandy loam, or clay loam. It is slightly acid or neutral. In some pedons it has a few calcium carbonate concretions.

Classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*4*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 17, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Ustolls (*Ust*, meaning dryness, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplustolls (*Hapl*, meaning minimal horizonation, plus *ustolls*, the suborder of the Mollisols that have an ustic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Cumulic* identifies the subgroup that has a thick, dark surface layer. An example is Cumulic Haplustolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-silty, mixed, mesic Cumulic Haplustolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Formation of the soils

This section relates five factors of soil formation to the soils in the survey area. These factors are (1) the physical and mineralogical composition of the parent material,

(2) the climate under which the soil material accumulated and has existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief, and (5) the length of time that the forces of soil formation have acted on the soil material.

Climate and plant and animal life are active factors of soil formation. They act on the parent material that has accumulated and slowly change it into a natural body that has genetically related horizons. The parent material affects the kind of soil profile that forms and in a few places determines it almost entirely. The effects of climate and plant and animal life are modified by the relief. Finally, time is needed to change the parent material into a soil. Some time is always required for the development of horizons. 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.

Parent material

The weathering of accumulated geologic material results in the parent material in which soils form. In Ottawa County the parent material has accumulated through the weathering of bedrock or the loose material deposited by water or wind.

Interbedded shale and sandstone of the Dakota Formation provided the parent material for Hedville, Edalgo, Lancaster, and Wells soils. The shallow Hedville soils formed in residuum of sandstone. Edalgo soils formed in residuum of silty and clayey shale. Wells and Lancaster soils formed in loamy residuum of sandy shale and sandstone. These four soils are in all parts of the county except for the northwest corner.

In the northwest corner interbedded limestone and shale of the Greenhorn Formation provided the parent material for calcareous soils. The shallow Kipson soils formed in residuum of calcareous shale. Armo soils formed in colluvium derived from limestone and shale modified by loess.

Crete and Harney soils, which are on uplands, formed in Peorian loess. Pratt soils, also on uplands, formed in eolian sand.

The soils on terraces formed in silty, clayey, or loamy alluvium. Detroit, Hord, McCook, and Roxbury soils formed in silty or loamy alluvium, and Sutphen soils formed in clayey alluvium. New Cambria soils formed in silty and clayey alluvium. Hobbs soils, which are on flood plains, formed in silty alluvium.

Soils generally inherit some characteristics from the parent material in which they form. These characteristics are physical, mineralogical, or chemical. For example, the reddish color of Geary soils and the lack of sand in Crete soils are inherited characteristics.

Climate

Climate directly influences soil formation by weathering the parent material. It indirectly influences soil formation through its effect on the plants and animals in and on the soil.

The climate of Ottawa County is continental. It is characterized by intermittent dry and moist periods, which can occur within a year or in cycles of several years. The soil material dries to varying depths during dry periods. It slowly regains moisture during wet periods and can become so saturated that excess moisture penetrates the substratum. The accumulation of soft lime in the substratum of Harney soils is an indication of this excess moisture. The wetting and drying has resulted in the leaching of some of the basic nutrients and even clay particles from the upper horizons of some soils.

Plant and animal life

Plants and animals are important to soil formation. Plants generally affect the amount of nutrients and organic matter in the soil and the color of the surface layer. Earthworms, cicadas, burrowing animals, and other animals help to keep the soil open and porous. Earthworms in McCook soils have left many worm casts. Bacteria and fungi help to decompose the plants, thus releasing more nutrients for plant food.

Mid and tall prairie grasses have had the greatest influence on soil formation in Ottawa County. As a result of the grasses, the upper part of a typical soil in the county is dark and has a high content of organic matter. The transitional part in many places is slightly finer textured and somewhat lighter colored than the layer above. The underlying parent material generally is light in color and has a high content of carbonates.

Relief

Relief influences the formation of soils through its effect on drainage, runoff, plant cover, and soil temperature. The soil temperature, for example, is slightly lower on the east- and north-facing slopes than on the west- and south-facing slopes. Most important is the effect that relief has had on the movement of water on the surface and into the soil.

On sloping or steep soils in the uplands, runoff is more rapid and the hazard of erosion more severe than on less sloping soils. Hedville and Kipson soils formed in the oldest parent material in the county, but they are not the most mature soils because relief has restricted soil formation. Runoff is rapid in the steep areas of these soils, and much of the soil is removed as soon as it forms.

In Ottawa County the soils having distinct horizons generally are nearly level or gently sloping. Nearly level soils on stream terraces, for example, Detroit soils, formed in the younger parent material in the county, but they have distinct horizons. Most of the precipitation received penetrates these soils.

Time

The differences in the length of time that the parent materials have been in place are commonly reflected in the degree of profile development. Some soils form rapidly; others form slowly.

The soils in Ottawa County range from immature to mature. Those that are mature, for example, Harney soils, have distinct horizons. Soils on low bottoms are subject to stream overflow. They receive new sediment with each flood. As a result, they are immature. They have a thick, dark colored surface layer, but the soil structure is weak. An example is Roxbury soils.

References

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(3) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus. [Supplements replacing pp. 173-188 issued May 1962]

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Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (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 moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	More than 12

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

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

Blowout. A shallow depression from which all or most of the soil material has been removed by wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

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

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils is synonymous with base-exchange capacity, but is more precise in meaning.

Channery soil. A soil that is, by volume, more than 15 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches along the longest axis. A single piece is called a fragment.

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

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. Mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter.

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

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

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

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

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

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

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

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

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

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

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or arresting grazing for a prescribed period.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the removal of water from the soil. Drainage classes are determined on the basis of an overall evaluation of water removal as influenced by climate, slope, and position on the landscape. Precipitation, runoff, amount of moisture infiltrating the soil, and rate of water movement through the soil affect the degree and duration of wetness. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. The soils in this class generally are free of mottles throughout. They commonly are shallow, very porous, or steep, or a combination of these.

Somewhat excessively drained.—Water is removed from the soil rapidly. The soils in this class generally are free of mottles throughout. They commonly are shallow or moderately deep, very porous, or steep, or a combination of these.

Well drained.—Water is removed from the soil so readily that the upper 40 inches generally does not have the mottles or dull colors related to wetness.

Moderately well drained.—Water is removed from the soil so slowly that the upper 20 to 40 inches has the mottles and dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Somewhat poorly drained.—Water is removed from the soil so slowly that the upper 10 to 20 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Poorly drained.—Water is removed so slowly that either the soil is periodically saturated or the upper 10 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water is at or on the surface most of the time. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Large stones (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

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

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, differences in slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Ponding. Standing water on soils in closed depressions. The water can be removed only by percolation or evapotranspiration.

Productivity (soil). The capability of a soil for producing a specified plant or sequence of plants under specific management.

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

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor, on the basis of how much the present plant community has departed from the potential.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH

7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

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

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

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called groundwater runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay, and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles 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 that is 80 percent or more silt and less than 12 percent clay.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Small stones (in tables). Rock fragments less than 3 inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and 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.

Soil separates. Mineral particles less than 2 mm in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	Less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of 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 plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

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

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A1, A2, or A3) below the surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A horizon. Includes all subdivisions of this horizon (A1, A2, and A3).

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

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

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

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

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the low lands along streams.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

TABLES

TABLE 1.--TEMPERATURE AND PRECIPITATION

Month	Temperature					Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	In	In	In		In
January----	40.2	18.4	29.3	66	-9	0.65	0.11	0.96	2	3.8
February---	46.3	23.1	34.7	75	-1	0.81	0.35	1.32	2	4.8
March------	54.8	29.9	42.4	86	2	1.48	0.67	2.41	3	3.8
April------	68.7	42.9	55.8	91	22	2.43	1.01	3.80	5	0.2
May--------	78.0	53.0	65.5	97	32	4.07	2.03	6.56	7	0.0
June-------	87.7	62.9	75.3	105	44	4.82	2.01	7.07	7	0.0
July-------	93.5	67.6	80.6	108	53	3.68	1.37	5.70	6	0.0
August-----	93.0	66.9	80.0	108	51	3.06	1.48	4.74	4	0.0
September--	83.2	56.9	70.1	105	36	3.94	1.43	5.28	6	0.0
October----	72.2	45.9	59.1	94	25	2.10	0.63	3.43	3	0.2
November---	55.4	31.8	43.6	79	7	0.95	0.10	1.85	2	1.4
December---	43.2	22.3	32.8	67	-4	0.76	0.11	1.39	2	4.3
Year-----	68.0	43.5	55.8	108	- 9	28.75	21.70	32.56	49	18.5

TABLE 2.--FREEZE DATES IN SPRING AND FALL

Probability	Minimum temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 13	April 22	May 7
2 years in 10 later than--	April 8	April 17	May 2
5 years in 10 later than--	March 30	April 7	April 22
First freezing temperature in fall:			
1 year in 10 earlier than--	October 25	October 15	October 6
2 years in 10 earlier than--	October 29	October 20	October 10
5 years in 10 earlier than--	November 8	October 29	October 20

TABLE 3.--GROWING SEASON

Probability	Daily minimum temperature		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	205	186	160
8 years in 10	211	193	167
5 years in 10	223	205	181
2 years in 10	235	217	194
1 year in 10	242	224	202

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Ar	Armo silt loam, 3 to 8 percent slopes	3,800	0.8
Ca	Carwile fine sandy loam	1,600	0.3
Cr	Crete silt loam, 0 to 2 percent slopes	43,300	9.4
Cs	Crete silt loam, 2 to 5 percent slopes	58,700	12.7
Ct	Crete silty clay loam, 3 to 5 percent slopes, eroded	5,800	1.3
De	Detroit silty clay loam	16,900	3.7
Ed	Edalgo silt loam, 3 to 7 percent slopes	1,600	0.3
Ee	Edalgo-Hedville complex, 5 to 30 percent slopes	85,400	18.5
Es	Els loamy sand	700	0.2
Ge	Geary silt loam, 1 to 3 percent slopes	6,200	1.3
Gf	Geary silt loam, 3 to 6 percent slopes	79,300	17.1
Gg	Geary silty clay loam, 3 to 6 percent slopes, eroded	18,900	4.1
Ha	Harney silt loam, 2 to 7 percent slopes	2,600	0.6
Hb	Harney silty clay loam, 2 to 7 percent slopes, eroded	900	0.2
He	Hedville-Rock outcrop complex, 5 to 30 percent slopes	4,800	1.0
Hn	Hobbs silt loam	16,400	3.5
Ho	Hobbs silt loam, frequently flooded	7,000	1.5
Hp	Hobbs-Geary silt loams, 0 to 15 percent slopes	7,400	1.6
Hr	Hord silt loam	31,000	6.7
Kp	Kipson soils, 5 to 20 percent slopes	6,300	1.4
La	Lancaster loam, 3 to 7 percent slopes	11,800	2.5
Mc	McCook silt loam	5,700	1.2
Md	McCook soils, occasionally flooded	1,800	0.4
Nc	New Cambria silty clay loam	9,200	2.0
Po	Pits	84	*
Pr	Pratt loamy sand, 5 to 12 percent slopes	1,000	0.2
Rx	Roxbury silt loam	12,600	2.7
Sd	Sutphen silty clay	4,200	0.9
Wa	Wells sandy loam, 2 to 5 percent slopes	3,480	0.8
We	Wells loam, 3 to 7 percent slopes	12,600	2.7
Wf	Wells loam, 3 to 7 percent slopes, eroded	1,400	0.3
	Water	256	0.1
	Total	462,720	100.0

* Less than 0.1 percent.

TABLE 5.--YIELDS PER ACRE OF CROPS

[Yields in the N columns are for nonirrigated soils; those in the I columns are for irrigated soils. Yields are those that can be expected under a high level of management. Only arable soils are listed. Absence of a yield figure indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Grain sorghum		Corn		Winter wheat		Alfalfa hay	
	N	I	N	I	N	I	N	I
	Bu	Bu	Bu	Bu	Bu	Bu	Ton	Ton
Ar----------------------- Armo	45	---	---	---	32	---	2.0	---
Ca----------------------- Carwile	45	---	---	---	26	---	2.5	---
Cr----------------------- Crete	65	115	---	125	38	---	3.0	6.0
Cs----------------------- Crete	60	---	---	---	36	---	2.5	---
Ct----------------------- Crete	50	---	---	---	28	---	2.0	---
De----------------------- Detroit	65	115	---	125	38	---	3.0	6.5
Ed----------------------- Edalgo	45	---	---	---	30	---	1.5	---
Es----------------------- Els	40	---	---	---	26	---	1.5	---
Ge----------------------- Geary	65	---	---	---	36	---	3.0	---
Gf----------------------- Geary	60	---	---	---	34	---	3.0	---
Gg----------------------- Geary	55	---	---	---	32	---	2.5	---
Ha----------------------- Harney	60	---	---	---	36	---	2.5	---
Hb----------------------- Harney	50	---	---	---	32	---	2.0	---
Hn----------------------- Hobbs	65	110	---	120	34	---	3.5	6.0
Hr----------------------- Hord	70	120	---	130	40	---	3.5	7.0
La----------------------- Lancaster	55	---	---	---	32	---	2.5	---
Mc----------------------- McCook	70	120	---	130	40	---	3.5	7.0
Md----------------------- McCook	65	110	---	120	34	---	3.0	6.0
Nc----------------------- New Cambria	65	110	---	120	36	---	3.0	6.5

TABLE 5.--YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Grain sorghum		Corn		Winter wheat		Alfalfa hay	
	N	I	N	I	N	I	N	I
	Bu	Bu	Bu	Bu	Bu	Bu	Ton	Ton
Pr------------------------- Pratt	50	---	---	---	28	---	2.0	5.5
Rx------------------------- Roxbury	70	120	---	130	40	---	3.5	7.0
Sd------------------------- Sutphen	60	---	---	120	32	---	2.5	6.0
Wa, We-------------------- Wells	55	---	---	---	32	---	3.0	---
Wf------------------------- Wells	50	---	---	---	30	---	2.5	---

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES

[Only the soils that support rangeland vegetation suitable for grazing are listed]

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Ar: Armo	Limy Upland	Favorable	4,000	Big bluestem	40
		Normal	3,000	Little bluestem	20
		Unfavorable	1,000	Sideoats grama	10
				Indiangrass	5
				Switchgrass	5
Ca: Carwile	Sandy	Favorable	5,000	Switchgrass	20
		Normal	3,800	Little bluestem	15
		Unfavorable	3,000	Indiangrass	10
				Sand bluestem	10
				Scribner panicum	5
				Canada wildrye	5
				Sideoats grama	5
Cr, Cs: Crete	Clay Upland	Favorable	3,500	Big bluestem	20
		Normal	3,000	Western wheatgrass	15
		Unfavorable	2,000	Blue grama	15
				Little bluestem	10
				Sideoats grama	10
				Switchgrass	5
				Indiangrass	5
				Tall dropseed	5
De: Detroit	Loamy Terrace	Favorable	5,000	Big bluestem	30
		Normal	4,000	Western wheatgrass	15
		Unfavorable	3,000	Little bluestem	10
				Switchgrass	10
				Sideoats grama	10
				Indiangrass	5
Ed: Edalgo	Clay Upland	Favorable	4,500	Big bluestem	25
		Normal	3,500	Little bluestem	15
		Unfavorable	2,000	Switchgrass	10
				Sideoats grama	10
				Indiangrass	5
				Tall dropseed	5
Ee*:					
Edalgo	Clay Upland	Favorable	4,500	Big bluestem	25
		Normal	3,500	Little bluestem	15
		Unfavorable	2,000	Switchgrass	10
				Sideoats grama	10
				Indiangrass	5
				Tall dropseed	5
Hedville	Shallow Sandstone	Favorable	3,500	Little bluestem	35
		Normal	3,000	Big bluestem	20
		Unfavorable	2,000	Switchgrass	5
				Indiangrass	5
				Sideoats grama	5
				Tall dropseed	5
Es: Els	Subirrigated	Favorable	6,000	Big bluestem	30
		Normal	5,000	Indiangrass	15
		Unfavorable	4,000	Prairie cordgrass	15
				Switchgrass	10
				Little bluestem	10

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Ge, Gf, Gg: Geary	Loamy Upland	Favorable	5,000	Big bluestem	25
		Normal	4,000	Little bluestem	20
		Unfavorable	3,000	Switchgrass	10
				Indiangrass	10
				Tall dropseed	5
				Sideoats grama	5
Ha, Hb: Harney	Loamy Upland	Favorable	5,000	Big bluestem	25
		Normal	3,500	Little bluestem	20
		Unfavorable	2,000	Sideoats grama	10
				Western wheatgrass	10
				Blue grama	5
He*:					
Hedville	Shallow Sandstone	Favorable	3,500	Little bluestem	35
		Normal	3,000	Big bluestem	20
		Unfavorable	2,000	Switchgrass	5
				Indiangrass	5
				Sideoats grama	5
				Tall dropseed	5
Rock outcrop.					
Hn, Ho: Hobbs	Loamy Lowland	Favorable	6,000	Big bluestem	35
		Normal	5,000	Switchgrass	10
		Unfavorable	4,000	Little bluestem	10
				Indiangrass	10
				Sideoats grama	5
Hp*:					
Hobbs	Loamy Lowland	Favorable	6,000	Big bluestem	35
		Normal	5,000	Switchgrass	10
		Unfavorable	4,000	Little bluestem	10
				Indiangrass	10
				Sideoats grama	5
Geary	Loamy Upland	Favorable	5,000	Big bluestem	25
		Normal	4,000	Little bluestem	20
		Unfavorable	3,000	Switchgrass	10
				Indiangrass	10
				Tall dropseed	5
				Sideoats grama	5
Hr: Hord	Loamy Terrace	Favorable	5,000	Big bluestem	30
		Normal	3,800	Little bluestem	10
		Unfavorable	2,500	Indiangrass	10
				Switchgrass	10
				Porcupinegrass	5
				Sideoats grama	5
				Tall dropseed	5
				Western wheatgrass	5
				Sedge	5
Kp: Kipson	Limy Upland	Favorable	4,500	Big bluestem	30
		Normal	3,500	Little bluestem	25
		Unfavorable	2,000	Switchgrass	5
				Indiangrass	5
				Sideoats grama	5
				Tall dropseed	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production		Characteristic vegetation	Composition
		Kind of year	Dry weight		
			Lb/acre		Pct
La-----Lancaster	Loamy Upland	Favorable	5,000	Big bluestem	25
		Normal	3,500	Little bluestem	20
		Unfavorable	2,000	Indiangrass	10
				Switchgrass	10
				Sideoats grama	5
				Tall dropseed	5
Mc, Md-----McCook	Loamy Terrace	Favorable	5,000	Big bluestem	30
		Normal	4,000	Little bluestem	15
		Unfavorable	3,000	Switchgrass	10
				Indiangrass	10
				Western wheatgrass	10
Nc-----New Cambria	Clay Terrace	Favorable	4,500	Big bluestem	30
		Normal	3,500	Little bluestem	15
		Unfavorable	2,000	Indiangrass	10
				Switchgrass	10
				Western wheatgrass	10
				Sideoats grama	5
				Tall dropseed	5
				Blue grama	5
Pr-----Pratt	Sands	Favorable	5,000	Sand bluestem	25
		Normal	4,000	Little bluestem	20
		Unfavorable	3,000	Indiangrass	15
				Sand lovegrass	10
				Switchgrass	5
				Sand dropseed	5
Rx-----Roxbury	Loamy Terrace	Favorable	5,000	Big bluestem	30
		Normal	4,000	Western wheatgrass	15
		Unfavorable	3,000	Switchgrass	10
				Little bluestem	10
				Sideoats grama	10
				Indiangrass	5
Sd-----Sutphen	Clay Lowland	Favorable	5,500	Big bluestem	35
		Normal	4,500	Indiangrass	15
		Unfavorable	3,500	Switchgrass	10
				Little bluestem	5
				Prairie cordgrass	5
				Western wheatgrass	5
				Sideoats grama	5
				Eastern gamagrass	5
Wa, We, Wf-----Wells	Loamy Upland	Favorable	5,000	Big bluestem	25
		Normal	4,000	Little bluestem	20
		Unfavorable	3,000	Indiangrass	10
				Switchgrass	10
				Sideoats grama	5
				Tall dropseed	5

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Ar: Armo	Fragrant sumac.	Russian-olive.	Eastern redcedar, ponderosa pine, honeylocust, osageorange.	---	---
Ca: Carwile	Fragrant sumac, gray dogwood, Peking cotoneaster.	---	Eastern redcedar, Russian mulberry, common hackberry.	Ponderosa pine, Austrian pine.	Eastern cottonwood.
Cr, Cs, Ct: Crete	Fragrant sumac, Siberian peashrub, Peking cotoneaster.	Russian-olive, eastern redcedar.	Common hackberry, honeylocust, Siberian elm.	---	---
De: Detroit	Peking cotoneaster, lilac, fragrant sumac.	Redbud, Russian-olive.	Russian mulberry, osageorange.	Eastern redcedar, ponderosa pine, common hackberry, black walnut.	Eastern cottonwood, Siberian elm.
Ed: Edalgo	Fragrant sumac, Siberian peashrub.	Eastern redcedar, Rocky mountain juniper.	Ponderosa pine, Siberian elm, osageorange, common hackberry.	---	---
Ee*:					
Edalgo	Fragrant sumac, Siberian peashrub.	Eastern redcedar, redbud, Russian-olive.	Ponderosa pine, Siberian elm, osageorange.	---	---
Hedville.					
Es: Els	Gray dogwood, redosier dogwood.	Redbud.	Eastern redcedar, Russian mulberry, Austrian pine.	Honeylocust, green ash.	Eastern cottonwood.
Ge, Gf, Gg: Geary	Fragrant sumac, Peking cotoneaster.	Russian-olive.	Eastern redcedar, common hackberry, osageorange.	Honeylocust, Austrian pine.	Siberian elm.
Ha, Hb: Harney	Fragrant sumac, Peking cotoneaster.	Russian-olive, American plum.	Eastern redcedar, osageorange, ponderosa pine.	Siberian elm, honeylocust.	---
He*:					
Hedville.					
Rock outcrop.					
Hn, Ho: Hobbs	American plum, Peking cotoneaster, lilac.	Redbud, Russian-olive.	Eastern redcedar, Russian mulberry.	Ponderosa pine, Austrian pine, honeylocust, green ash, silver maple.	Eastern cottonwood, Siberian elm.
Hp*:					
Hobbs	American plum, Peking cotoneaster, lilac.	Redbud, Russian-olive.	Eastern redcedar, Russian mulberry.	Ponderosa pine, Austrian pine, honeylocust, green ash.	Eastern cottonwood, Siberian elm.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Hp*:					
Geary	Fragrant sumac, Peking cotoneaster.	Russian-olive	Eastern redcedar, common hackberry, osageorange.	Honeylocust, Austrian pine.	Siberian elm.
Hr Hord	Peking cotoneaster, fragrant sumac, lilac.	Redbud, Russian-olive.	Russian mulberry, osageorange.	Ponderosa pine, Austrian pine, honeylocust, common hackberry, black walnut.	Eastern cottonwood, Siberian elm.
Kp. Kipson					
La Lancaster	Fragrant sumac, Peking cotoneaster.	Russian-olive	Eastern redcedar, osageorange, common hackberry.	Honeylocust, Austrian pine.	Siberian elm.
Mc, Md McCook	Peking cotoneaster, fragrant sumac, lilac.	Redbud, Russian-olive.	Russian mulberry, osageorange.	Ponderosa pine, Austrian pine, common hackberry, honeylocust.	Eastern cottonwood, Siberian elm.
Nc New Cambria	American plum, gray dogwood, redosier dogwood.	Russian-olive, redbud.	Eastern redcedar, Russian mulberry, Austrian pine.	Common hackberry, honeylocust, green ash.	Siberian elm, eastern cottonwood.
Po*: Pits					
Pr Pratt	Siberian peashrub, fragrant sumac.	---	Eastern redcedar, ponderosa pine, white mulberry, common hackberry.	Siberian elm	---
Rx Roxbury	Peking cotoneaster, fragrant sumac, lilac.	Redbud, Russian-olive.	Eastern redcedar, Russian mulberry.	Common hackberry, honeylocust, ponderosa pine, black walnut.	Siberian elm, eastern cottonwood.
Sd Sutphen	Gray dogwood, redosier dogwood.	Russian-olive, redbud.	Eastern redcedar, Austrian pine, Russian mulberry.	Common hackberry, honeylocust, green ash.	Siberian elm, eastern cottonwood.
Wa, We, Wf Wells	Fragrant sumac, Peking cotoneaster.	Russian-olive	Eastern redcedar, osageorange, common hackberry.	Honeylocust, Austrian pine.	Siberian elm.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Ar-------------------- Armo	Slight---------------	Slight---------------	Moderate: slope.	Slight.
Ca-------------------- Carwile	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Cr-------------------- Crete	Slight---------------	Slight---------------	Slight---------------	Slight.
Cs-------------------- Crete	Slight---------------	Slight---------------	Moderate: slope.	Slight.
Ct-------------------- Crete	Slight---------------	Slight---------------	Moderate: slope, too clayey.	Slight.
De-------------------- Detroit	Severe: floods.	Slight---------------	Moderate: too clayey.	Slight.
Ed-------------------- Edalgo	Moderate: percs slowly.	Slight---------------	Moderate: slope, percs slowly, depth to rock.	Slight.
Ee*:				
Edalgo---------------	Moderate: slope, percs slowly.	Moderate: slope.	Severe: slope.	Slight.
Hedville-------------	Severe: slope, depth to rock.	Severe: slope.	Severe: large stones, slope, depth to rock.	Severe: large stones.
Es-------------------- Els	Severe: floods.	Moderate: wetness, too sandy.	Moderate: too sandy, wetness.	Moderate: too sandy.
Ge, Gf---------------- Geary	Slight---------------	Slight---------------	Moderate: slope.	Slight.
Gg-------------------- Geary	Slight---------------	Slight---------------	Moderate: slope, too clayey.	Slight.
Ha-------------------- Harney	Slight---------------	Slight---------------	Moderate: slope.	Slight.
Hb-------------------- Harney	Slight---------------	Slight---------------	Moderate: slope, too clayey.	Slight.
He*:				
Hedville-------------	Severe: slope, depth to rock.	Severe: slope.	Severe: large stones, slope, depth to rock.	Severe: large stones.
Rock outcrop.				
Hn-------------------- Hobbs	Severe: floods.	Moderate: floods.	Moderate: floods.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Ho-------------------- Hobbs	Severe: floods.	Moderate: floods.	Severe: floods.	Moderate: floods.
Hp*:				
Hobbs----------------	Severe: floods.	Moderate: floods.	Severe: floods.	Moderate: floods.
Geary----------------	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Hr-------------------- Hord	Severe: floods.	Slight---------------	Slight---------------	Slight.
Kp-------------------- Kipson	Severe: depth to rock.	Moderate: slope, small stones.	Severe: depth to rock, slope, small stones.	Moderate: small stones.
La-------------------- Lancaster	Slight---------------	Slight---------------	Moderate: slope, depth to rock.	Slight.
Mc-------------------- McCook	Severe: floods.	Slight---------------	Slight---------------	Slight.
Md-------------------- McCook	Severe: floods.	Slight---------------	Moderate: floods.	Slight.
Nc-------------------- New Cambria	Severe: floods.	Slight---------------	Moderate: too clayey.	Slight.
Po*. Pits				
Pr-------------------- Pratt	Moderate: too sandy, slope.	Moderate: too sandy, slope.	Severe: slope.	Moderate: too sandy.
Rx-------------------- Roxbury	Severe: floods.	Slight---------------	Slight---------------	Slight.
Sd-------------------- Sutphen	Severe: floods.	Moderate: too clayey.	Severe: too clayey.	Moderate: too clayey.
Wa, We, Wf------------ Wells	Slight---------------	Slight---------------	Moderate: slope.	Slight.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements								Potential as habitat for--			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Ar-----------------Armo	Fair	Good	Good	Fair	Poor	Fair	Poor	Very poor.	Good	Fair	Very poor.	Fair.
Ca-----------------Carwile	Fair	Good	Good	Fair	Poor	Good	Good	Fair	Good	Fair	Fair	Good.
Cr-----------------Crete	Good	Good	Good	Fair	Fair	Fair	Very poor.	Very poor.	Good	Fair	Very poor.	Good.
Cs, Ct-------------Crete	Fair	Good	Good	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.	Good.
De-----------------Detroit	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Good	Good	Good.
Ed-----------------Edalgo	Fair	Good	Fair	Poor	Poor	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.	Fair.
Ee*:												
Edalgo------------	Poor	Fair	Fair	Poor	Poor	Fair	Very poor.	Very poor.	Fair	Poor	Very poor.	Fair.
Hedville----------	Very poor.	Poor	Poor	Very poor.	Very poor.	Poor	Very poor.	Very poor.	Poor	Very poor.	Very poor.	Poor.
Es-----------------Els	Poor	Fair	Fair	Fair	Fair	Fair	Good	Fair	Fair	Fair	Fair	Fair.
Ge-----------------Geary	Good	Good	Fair	Fair	Poor	Fair	Poor	Fair	Good	Fair	Poor	Fair.
Gf, Gg-------------Geary	Fair	Good	Fair	Fair	Poor	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.	Fair.
Ha, Hb-------------Harney	Fair	Good	Fair	Fair	Poor	Poor	Poor	Poor	Fair	Fair	Poor	Poor.
He*:												
Hedville----------	Very poor.	Poor	Poor	Very poor.	Very poor.	Poor	Very poor.	Very poor.	Poor	Very poor.	Very poor.	Poor.
Rock outcrop.												
Hn-----------------Hobbs	Good	Good	Good	Good	Fair	Good	Poor	Poor	Good	Good	Poor	Good.
Ho-----------------Hobbs	Very poor.	Fair	Fair	Good	Fair	Fair	Poor	Poor	Poor	Fair	Poor	Fair.
Hp*:												
Hobbs-------------	Very poor.	Fair	Fair	Good	Fair	Fair	Poor	Poor	Poor	Fair	Poor	Fair.
Geary-------------	Fair	Good	Fair	Fair	Poor	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.	Fair.
Hr-----------------Hord	Good	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.
Kp-----------------Kipson	Poor	Fair	Fair	Very poor.	Very poor.	Poor	Very poor.	Very poor.	Fair	Very poor.	Very poor.	Poor.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements								Potential as habitat for--			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
La----------------- Lancaster	Fair	Good	Fair	Fair	Poor	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.	Fair.
Mc, Md------------- McCook	Good	Good	Good	Good	Fair	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.
Nc----------------- New Cambria	Good	Good	Fair	Good	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair.
Po*. Pits												
Pr----------------- Pratt	Fair	Good	Fair	Poor	Poor	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.	Fair.
Rx----------------- Roxbury	Good	Good	Good	Good	Fair	Fair	Poor	Fair	Good	Good	Poor	Fair.
Sd----------------- Sutphen	Fair	Fair	Fair	Fair	Fair	Fair	Poor	Good	Fair	Fair	Fair	---
Wa, We, Wf--------- Wells	Good	Good	Good	Fair	Poor	Fair	Very poor.	Very poor.	Good	Fair	Very poor.	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Ar----------------- Armo	Slight-----------	Slight-----------	Slight-----------	Moderate: slope.	Severe: low strength.
Ca----------------- Carwile	Severe: wetness, floods.	Severe: wetness, floods, ponding, shrink-swell.	Severe: wetness, floods, ponding, shrink-swell.	Severe: wetness, floods, ponding, shrink-swell.	Severe: low strength, shrink-swell, ponding.
Cr, Cs, Ct--------- Crete	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
De----------------- Detroit	Moderate: floods.	Severe: shrink-swell, floods.	Severe: shrink-swell, floods.	Severe: shrink-swell, floods.	Severe: shrink-swell, low strength.
Ed----------------- Edalgo	Moderate: depth to rock, too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
Ee*:					
Edalgo------------	Moderate: depth to rock, too clayey, slope.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, slope.	Severe: shrink-swell, low strength.
Hedville----------	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.
Es----------------- Els	Severe: wetness, cutbanks cave.	Severe: floods.	Severe: wetness, floods.	Severe: floods.	Moderate: wetness, floods.
Ge----------------- Geary	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Gf, Gg------------- Geary	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: slope, shrink-swell.	Severe: low strength.
Ha, Hb------------- Harney	Slight-----------	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
He*:					
Hedville----------	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.
Rock outcrop.					
Hn, Ho------------- Hobbs	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods, low strength.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Hp*:					
Hobbs	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods, low strength.
Geary	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, slope.	Severe: slope.	Severe: low strength.
Hr: Hord	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength.
Kp: Kipson	Moderate: slope, depth to rock.	Moderate: slope, depth to rock.	Severe: depth to rock.	Severe: slope.	Moderate: slope, depth to rock.
La: Lancaster	Moderate: depth to rock.	Moderate: shrink-swell.	Moderate: shrink-swell, depth to rock.	Moderate: shrink-swell, slope.	Severe: low strength.
Mc: McCook	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Moderate: floods, low strength.
Md: McCook	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.
Nc: New Cambria	Moderate: too clayey, floods.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: low strength, shrink-swell.
Po*. Pits					
Pr: Pratt	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
Rx: Roxbury	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength.
Sd: Sutphen	Severe: floods.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: low strength, shrink-swell, floods.
Wa: Wells	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
We, Wf: Wells	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Ar: Armo	Slight	Moderate: seepage.	Slight	Slight	Fair: too clayey.
Ca: Carwile	Severe: percs slowly, wetness, floods.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Cr: Crete	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Fair: too clayey.
Cs, Ct: Crete	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
De: Detroit	Severe: percs slowly.	Slight	Moderate: floods, too clayey.	Moderate: floods.	Fair: too clayey.
Ed: Edalgo	Severe: percs slowly, depth to rock.	Moderate: slope, depth to rock.	Severe: too clayey, depth to rock.	Moderate: depth to rock.	Poor: too clayey, area reclaim.
Ee*:					
Edalgo	Severe: percs slowly, depth to rock.	Severe: slope.	Severe: too clayey, depth to rock.	Moderate: slope, depth to rock.	Poor: too clayey, area reclaim.
Hedville	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: slope, depth to rock.	Poor: area reclaim.
Es: Els	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, seepage.
Ge, Gf, Gg: Geary	Moderate: percs slowly.	Moderate: slope, seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
Ha, Hb: Harney	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
He*:					
Hedville	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: slope, depth to rock.	Poor: area reclaim.
Rock outcrop.					
Hn, Ho: Hobbs	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Good.
Hp*:					
Hobbs	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Good.
Geary	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Moderate: slope.	Fair: too clayey, slope.
Hr: Hord	Moderate: floods.	Moderate: seepage.	Moderate: floods.	Moderate: floods.	Good.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Kp------------------ Kipson	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
La------------------ Lancaster	Severe: depth to rock.	Moderate: depth to rock, seepage, slope.	Severe: depth to rock.	Moderate: depth to rock.	Poor: area reclaim.
Mc------------------ McCook	Moderate: floods.	Moderate: floods, seepage.	Moderate: floods.	Moderate: floods.	Good.
Md------------------ McCook	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Good.
Nc------------------ New Cambria	Severe: percs slowly.	Slight-----------	Severe: too clayey.	Moderate: floods.	Poor: too clayey.
Po*. Pits					
Pr------------------ Pratt	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: too sandy, slope.
Rx------------------ Roxbury	Moderate: floods.	Moderate: seepage.	Moderate: floods.	Moderate: floods.	Good.
Sd------------------ Sutphen	Severe: percs slowly, floods.	Severe: floods.	Severe: floods, too clayey.	Severe: floods.	Poor: too clayey.
Wa, We, Wf---------- Wells	Slight-----------	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and "poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Ar-------------------- Armo	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Ca-------------------- Carwile	Poor: low strength, shrink-swell, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, wetness.
Cr, Cs---------------- Crete	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Ct-------------------- Crete	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, thin layer.
De-------------------- Detroit	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
Ed-------------------- Edalgo	Poor: shrink-swell, low strength, thin layer.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: area reclaim, thin layer.
Ee*:				
Edalgo----------------	Poor: shrink-swell, low strength, thin layer.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, area reclaim, slope.
Hedville-------------	Poor: thin layer, area reclaim.	Unsuited: thin layer.	Unsuited: thin layer.	Poor: area reclaim, slope, large stones.
Es-------------------- Els	Fair: wetness.	Fair: excess fines.	Unsuited: excess fines.	Fair: too sandy, thin layer.
Ge, Gf---------------- Geary	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Gg-------------------- Geary	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, thin layer.
Ha-------------------- Harney	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Hb-------------------- Harney	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, thin layer.
He*:				
Hedville-------------	Poor: thin layer, area reclaim.	Unsuited: thin layer.	Unsuited: thin layer.	Poor: area reclaim, slope, large stones.
Rock outcrop.				
Hn, Ho---------------- Hobbs	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Hp*:				
Hobbs	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Geary	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: slope, thin layer.
Hr: Hord	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Kp: Kipson	Poor: thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: thin layer, area reclaim, large stones.
La: Lancaster	Poor: area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, area reclaim.
Mc, Md: McCook	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Nc: New Cambria	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
Po*. Pits				
Pr: Pratt	Good	Poor: excess fines.	Unsuited: excess fines.	Fair: too sandy, slope.
Rx: Roxbury	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Sd: Sutphen	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
Wa, We, Wf: Wells	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Ar: Armo	Seepage	Favorable	Not needed	Favorable	Favorable	Favorable.
Ca: Carwile	Favorable	Wetness	Percs slowly	Percs slowly, wetness, soil blowing.	Not needed	Percs slowly, wetness.
Cr: Crete	Favorable	Hard to pack	Not needed	Percs slowly, erodes easily.	Not needed	Percs slowly, erodes easily.
Cs, Ct: Crete	Favorable	Hard to pack	Not needed	Percs slowly, erodes easily.	Percs slowly	Percs slowly, erodes easily.
De: Detroit	Favorable	Favorable	Not needed	Percs slowly, erodes easily.	Not needed	Percs slowly, erodes easily.
Ed: Edalgo	Depth to rock	Thin layer, hard to pack.	Not needed	Rooting depth, percs slowly, erodes easily.	Percs slowly, depth to rock.	Depth to rock, erodes easily, percs slowly.
Ee*:						
Edalgo	Slope, depth to rock.	Thin layer, hard to pack.	Not needed	Rooting depth, percs slowly, erodes easily.	Percs slowly, depth to rock.	Slope, depth to rock, erodes easily.
Hedville	Slope, depth to rock.	Thin layer, large stones.	Not needed	Large stones, droughty, rooting depth.	Slope, depth to rock, large stones.	Slope, droughty, large stones.
Es: Els	Seepage	Seepage	Favorable	Fast intake, wetness, droughty.	Not needed	Droughty.
Ge, Gf, Gg: Geary	Seepage	Favorable	Not needed	Favorable	Erodes easily	Erodes easily.
Ha, Hb: Harney	Favorable	Favorable	Not needed	Favorable	Erodes easily	Erodes easily.
He*:						
Hedville	Slope, depth to rock.	Thin layer, large stones.	Not needed	Large stones, droughty, rooting depth.	Slope, depth to rock, large stones.	Slope, droughty, large stones.
Rock outcrop.						
Hn, Ho: Hobbs	Seepage	Favorable	Not needed	Floods	Not needed	Favorable.
Hp*:						
Hobbs	Seepage	Favorable	Not needed	Floods	Not needed	Favorable.
Geary	Seepage, slope.	Favorable	Not needed	Slope	Erodes easily,	Slope, erodes easily.
Hr: Hord	Seepage	Favorable	Not needed	Favorable	Not needed	Favorable.
Kp: Kipson	Slope, depth to rock.	Thin layer, large stones.	Not needed	Large stones, droughty, rooting depth.	Large stones, depth to rock.	Slope, droughty, large stones.
La: Lancaster	Depth to rock, seepage.	Thin layer	Not needed	Rooting depth	Depth to rock	Depth to rock.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Mc McCook	Seepage	Piping	Not needed	Favorable	Not needed	Erodes easily.
Md McCook	Seepage	Piping	Not needed	Floods	Not needed	Erodes easily.
Nc New Cambria	Favorable	Hard to pack	Not needed	Percs slowly	Not needed	Percs slowly.
Po*. Pits						
Pr Pratt	Seepage, slope.	Seepage	Not needed	Fast intake, soil blowing, slope.	Too sandy, soil blowing.	Slope.
Rx Roxbury	Seepage	Favorable	Not needed	Favorable	Not needed	Erodes easily.
Sd Sutphen	Favorable	Hard to pack	Not needed	Floods, slow intake, percs slowly.	Not needed	Percs slowly.
Wa Wells	Seepage	Favorable	Not needed	Soil blowing	Soil blowing	Favorable.
We, Wf Wells	Seepage	Favorable	Not needed	Favorable	Favorable	Favorable.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Ar----------------- Armo	0-12	Silt loam-------	CL	A-6, A-4	0	95-100	90-100	90-100	70-90	30-40	8-18
	12-34	Loam, silty clay loam, clay loam.	CL	A-6, A-4	0	95-100	90-100	90-100	70-90	25-35	8-18
	34-44	Silt loam, clay loam.	CL	A-6, A-4	0	95-100	90-100	90-100	70-80	25-35	8-18
	44-60	Silt loam, clay loam.	CL, SC, GC	A-6, A-4	0	60-80	50-60	50-60	40-55	25-35	8-18
Ca----------------- Carwile	0-10	Fine sandy loam	ML, CL, CL-ML, SM	A-4	0	100	98-100	94-100	36-85	<30	NP-10
	10-15	Clay loam, sandy clay loam.	CL, SC	A-6, A-7	0	100	100	90-100	36-90	35-50	14-26
	15-38	Clay loam, clay, sandy clay.	CL, CH, SC	A-6, A-7	0	100	100	90-100	40-95	35-70	14-38
	38-48	Clay loam, sandy clay loam, clay.	CL, CH, SC	A-4, A-6, A-7	0	100	100	90-100	36-95	25-70	7-38
	48-60	Fine sandy loam, sandy clay loam, clay.	CL, CH, SC, CL-ML	A-4, A-6, A-7	0	100	98-100	90-100	36-95	22-70	4-38
Cr, Cs------------- Crete	0-15	Silt loam-------	CL	A-4, A-6	0	100	100	100	95-100	30-40	8-15
	15-38	Silty clay, silty clay loam	CH	A-7	0	100	100	100	95-100	50-65	25-38
	38-60	Silty clay loam, silt loam.	CL, CH	A-6, A-7	0	100	100	100	95-100	35-55	18-35
Ct----------------- Crete	0-7	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	35-50	15-30
	7-32	Silty clay, silty clay loam	CH	A-7	0	100	100	100	95-100	50-65	25-38
	32-60	Silty clay loam, silt loam.	CL, CH	A-6, A-7	0	100	100	100	95-100	35-55	18-35
De----------------- Detroit	0-16	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	35-45	18-24
	16-37	Silty clay, silty clay loam.	CH, CL	A-7	0	100	100	95-100	90-100	45-55	20-30
	37-60	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	100	95-100	90-100	35-45	18-24
Ed----------------- Edalgo	0-6	Silt loam-------	CL, CL-ML	A-4, A-6	0	100	100	90-100	70-95	20-40	5-15
	6-12	Silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	25-45	10-25
	12-36	Silty clay, clay, silty clay loam.	CH, CL	A-7-6	0	100	100	90-100	85-95	45-70	20-40
	36	Weathered bedrock.	---	---	---	---	---	---	---	---	---
Ee*: Edalgo------------	0-10	Loam-----------	CL, CL-ML	A-4, A-6	0	100	100	90-100	70-95	20-40	5-15
	10-14	Silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	25-45	10-25
	14-30	Silty clay, clay, silty clay loam.	CH, CL	A-7-6	0	100	100	90-100	85-95	45-70	20-40
	30	Weathered bedrock.	---	---	---	---	---	---	---	---	---
Hedville----------	0-16	Stony loam, loam.	SM, ML, SC, CL	A-4	30-50	70-100	70-100	50-85	35-70	<26	NP-8
	16	Unweathered bedrock.	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
Es----------------- Els	0-6	Loamy sand------	SP-SM, SM	A-2, A-3	0	100	100	70-95	5-35	---	NP
	6-60	Fine sand, loamy sand, loamy fine sand.	SP-SM, SM	A-2, A-3	0	90-100	90-100	70-95	5-30	---	NP
Ge, Gf------------- Geary	0-8	Silt loam--------	ML, CL	A-4, A-6	0	100	100	96-100	80-98	25-40	2-15
	8-44	Silty clay loam, clay loam.	CL	A-7, A-6	0	100	100	96-100	85-98	35-50	15-25
	44-60	Silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	96-100	85-98	30-45	11-20
Gg----------------- Geary	0-6	Silty clay loam	ML, CL	A-4, A-6	0	100	100	96-100	80-98	25-40	2-15
	6-36	Silty clay loam, clay loam.	CL	A-7, A-6	0	100	100	96-100	85-98	35-50	15-25
	36-60	Silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	96-100	85-98	30-45	11-20
Ha----------------- Harney	0-10	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-20
	10-38	Silty clay, silty clay loam.	CL, CH	A-7, A-6	0	100	100	95-100	85-100	35-60	15-35
	38-60	Silty clay loam, silt loam.	CL	A-6	0	100	100	95-100	85-100	30-40	10-20
Hb----------------- Harney	0-5	Silty clay loam	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-20
	5-32	Silty clay, silty clay loam.	CL, CH	A-7, A-6	0	100	100	95-100	85-100	35-60	15-35
	32-60	Silty clay loam, silt loam.	CL	A-6	0	100	100	95-100	85-100	30-40	10-20
He*:											
Hedville----------	0-16	Stony loam, loam.	SM, ML, SC, CL	A-4	30-50	70-100	70-100	50-85	35-70	<26	NP-8
	16	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Rock outcrop.											
Hn----------------- Hobbs	0-8	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-20
	8-60	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-20
Ho----------------- Hobbs	0-6	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-20
	6-60	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-20
Hp*:											
Hobbs-------------	0-8	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-20
	8-60	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-20
Geary-------------	0-10	Silt loam--------	ML, CL	A-4, A-6	0	100	100	96-100	80-98	25-40	4-17
	10-38	Silty clay loam, clay loam.	CL	A-7, A-6	0	100	100	96-100	85-98	35-50	15-25
	38-60	Silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	96-100	85-98	30-45	11-20
Hr----------------- Hord	0-18	Silt loam--------	CL, ML, CL-ML	A-4, A-6	0	100	100	100	90-100	20-35	3-18
	18-34	Silt loam, silty clay loam, loam.	CL	A-6, A-4	0	100	100	100	90-100	25-40	8-23
	34-60	Silt loam, very fine sandy loam, silty clay loam.	CL, CL-ML	A-6, A-4	0	100	100	100	90-100	25-40	6-21

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Kp------------------ Kipson	0-12	Stony silt loam	CL-ML, CL	A-4, A-6	25-45	70-100	70-95	65-95	60-95	25-40	5-20
	12-16	Shaly silt loam, shaly silty clay loam, shaly loam.	CL-ML, CL	A-6, A-4	0-25	70-100	70-95	65-95	60-95	25-40	5-20
	16	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
La------------------ Lancaster	0-10	Loam------------	CL-ML, CL	A-4, A-6	0	100	100	85-100	50-85	20-35	5-15
	10-30	Sandy clay loam, clay loam, loam.	CL, SC	A-4, A-6	0	100	100	80-90	40-60	20-40	8-25
	30-39	Clay loam, loam, sandy clay loam.	CL-ML, SC, SM-SC, CL	A-4, A-6	0	100	100	80-100	40-80	20-40	5-15
	39	Weathered bedrock.	---	---	---	---	---	---	---	---	---
Mc, Md-------------- McCook	0-16	Silt loam--------	ML, CL, CL-ML	A-4	0	100	100	95-100	60-98	20-35	2-10
	16-60	Very fine sandy loam, silt loam, loam.	ML, CL, CL-ML	A-4	0	100	100	95-100	55-98	<20	NP-10
Nc------------------ New Cambria	0-12	Silty clay loam	CH, CL	A-7	0	100	100	95-100	90-100	41-60	28-45
	12-40	Silty clay, silty clay loam, clay.	CH, CL	A-7	0	100	100	95-100	85-100	41-60	28-45
	40-60	Silty clay, silty clay loam, clay.	CH, CL	A-7	0	100	100	95-100	85-100	41-60	28-45
Po*. Pits											
Pr------------------ Pratt	0-15	Loamy sand-------	SM	A-2	0	100	95-100	70-100	15-35	---	NP
	15-36	Loamy fine sand, loamy sand, fine sandy loam.	SM, SM-SC	A-2, A-4	0	100	95-100	90-100	15-40	<20	NP-6
	36-60	Loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	100	95-100	80-100	5-35	---	NP
Rx------------------ Roxbury	0-22	Silt loam--------	CL	A-4, A-6, A-7-6	0	100	100	96-100	65-98	30-45	8-20
	22-42	Silt loam, silty clay loam.	CL	A-4, A-6, A-7-6	0	100	100	96-100	80-98	30-50	8-25
	42-60	Silt loam, silty clay loam, loam.	ML, CL	A-4, A-6, A-7-6	0	100	100	96-100	65-98	30-50	7-25
Sd------------------ Sutphen	0-6	Silty clay-------	CH	A-7	0	100	100	95-100	90-100	50-70	25-40
	6-38	Clay, silty clay	CH	A-7	0	100	100	95-100	90-100	50-70	25-40
	38-60	Clay, silty clay, silty clay loam.	CH, CL	A-7	0	100	100	95-100	90-100	41-70	20-40
Wa------------------ Wells	0-10	Sandy loam-------	SM, ML, SM-SC, CL-ML	A-4	0	100	100	85-100	35-60	<25	NP-5
	10-42	Clay loam, sandy clay loam.	SC, CL	A-4, A-6, A-7	0	100	100	80-100	40-85	30-50	8-25
	42-60	Clay loam, loam, sandy loam.	SC, CL, ML, SM	A-4, A-6	0	100	100	80-100	35-85	20-40	NP-15

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
We, Wf-------------- Wells	0-10	Loam------------	CL-ML, CL	A-4, A-6	0	100	100	95-100	65-85	20-30	5-15
	10-40	Clay loam, sandy clay loam.	SC, CL	A-4, A-6, A-7	0	100	100	80-100	40-85	30-50	8-25
	40-60	Clay loam, loam, sandy loam.	SC, CL, ML, SM	A-4, A-6	0	100	100	80-100	35-85	20-40	NP-15

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	Mmhos/cm				
Ar----------------	0-12	0.6-2.0	0.21-0.24	7.4-8.4	<2	Low--------	0.28	5	4L
Armo	12-34	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low--------	0.28		
	34-44	0.6-2.0	0.15-0.21	7.9-8.4	<2	Low--------	0.28		
	44-60	0.6-2.0	0.15-0.21	7.9-8.4	<2	Low--------	0.28		
Ca----------------	0-10	0.6-2.0	0.11-0.20	5.1-7.3	<2	Low--------	0.24	5	3
Carwile	10-15	0.2-2.0	0.12-0.20	5.1-7.3	<2	Moderate	0.37		
	15-38	0.06-0.2	0.12-0.20	6.1-8.4	<2	High-------	0.37		
	38-48	0.2-2.0	0.12-0.20	6.6-8.4	<2	High-------	0.32		
	48-60	0.2-2.0	0.11-0.18	7.9-8.4	<2	High-------	0.24		
Cr, Cs------------	0-15	0.6-2.0	0.22-0.24	5.6-6.5	<2	Moderate	0.37	4	6
Crete	15-38	0.06-0.2	0.12-0.14	6.1-7.3	<2	High-------	0.37		
	38-60	0.2-0.6	0.18-0.20	7.4-7.8	<2	High-------	0.37		
Ct----------------	0-7	0.2-0.6	0.21-0.23	5.6-6.5	<2	High-------	0.37	4	7
Crete	7-32	0.06-0.2	0.12-0.14	6.1-7.3	<2	High-------	0.37		
	32-60	0.2-0.6	0.18-0.20	7.4-7.8	<2	High-------	0.37		
De----------------	0-16	0.2-0.6	0.21-0.23	6.1-7.3	<2	Moderate	0.37	5	7
Detroit	16-37	0.06-0.2	0.12-0.15	6.6-7.8	<2	High-------	0.37		
	37-60	0.2-0.6	0.18-0.20	6.6-7.8	<2	Moderate	0.37		
Ed----------------	0-6	0.6-2.0	0.18-0.24	5.6-7.3	<2	Low--------	0.37	3	6
Edalgo	6-12	0.06-0.6	0.10-0.22	5.6-7.3	<2	Moderate	0.37		
	12-36	<0.06	0.10-0.18	5.6-7.3	<2	High-------	0.37		
	36	---	---	---	---	-----------	---		
Ee*:									
Edalgo-----------	0-10	0.6-2.0	0.18-0.24	5.6-7.3	<2	Low--------	0.37	3	6
	10-14	0.06-0.6	0.10-0.22	5.6-7.3	<2	Moderate	0.37		
	14-30	<0.06	0.10-0.18	5.6-7.3	<2	High-------	0.37		
	30	---	---	---	---	-----------	---		
Hedville---------	0-16	0.6-2.0	0.09-0.14	5.6-7.3	<2	Low--------	0.24	2	8
	16	---	---	---	---	-----------	---		
Es----------------	0-6	6.0-20	0.07-0.09	6.6-7.8	<2	Low--------	0.17	5	2
Els	6-60	6.0-20	0.06-0.08	6.6-7.8	<2	Low--------	0.17		
Ge, Gf------------	0-8	0.6-2.0	0.18-0.24	5.6-6.5	<2	Low--------	0.32	5	6
Geary	8-44	0.2-2.0	0.17-0.20	6.1-7.8	<2	Moderate	0.43		
	44-60	0.6-2.0	0.15-0.19	6.6-7.8	<2	Moderate	0.43		
Gg----------------	0-6	0.6-2.0	0.18-0.24	5.6-6.5	<2	Low--------	0.32	5	6
Geary	6-36	0.2-2.0	0.17-0.20	6.1-7.8	<2	Moderate	0.43		
	36-60	0.6-2.0	0.15-0.19	6.6-7.8	<2	Moderate	0.43		
Ha----------------	0-10	0.6-2.0	0.21-0.24	5.6-7.3	<2	Low--------	0.32	5	6
Harney	10-38	0.2-0.6	0.12-0.19	6.6-8.4	<2	High-------	0.43		
	38-60	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low--------	0.43		
Hb----------------	0-5	0.6-2.0	0.21-0.24	5.6-7.3	<2	Low--------	0.32	5	6
Harney	5-32	0.2-0.6	0.12-0.19	6.6-8.4	<2	High-------	0.43		
	32-60	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low--------	0.43		
He*:									
Hedville---------	0-16	0.6-2.0	0.09-0.14	5.6-7.3	<2	Low--------	0.24	2	8
	16	---	---	---	---	-----------	---		
Rock outcrop.									

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	Mmhos/cm				
Hn----------------- Hobbs	0-8	0.6-2.0	0.21-0.24	6.1-7.8	<2	Low--------	0.32	5	6
	8-60	0.6-2.0	0.18-0.22	6.1-8.4	<2	Low--------	0.32		
Ho----------------- Hobbs	0-6	0.6-2.0	0.21-0.24	6.1-7.8	<2	Low--------	0.32	5	6
	6-60	0.6-2.0	0.18-0.22	6.1-8.4	<2	Low--------	0.32		
Hp*:									
Hobbs------------	0-8	0.6-2.0	0.21-0.24	6.1-7.8	<2	Low--------	0.32	5	6
	8-60	0.6-2.0	0.18-0.22	6.1-8.4	<2	Low--------	0.32		
Geary------------	0-10	0.6-2.0	0.18-0.24	5.6-6.5	<2	Low--------	0.32	5	6
	10-38	0.2-2.0	0.17-0.20	6.1-7.8	<2	Moderate	0.43		
	38-60	0.6-2.0	0.15-0.19	6.6-7.8	<2	Moderate	0.43		
Hr----------------- Hord	0-18	0.6-2.0	0.22-0.24	6.1-7.3	<2	Low--------	0.32	5	6
	18-34	0.6-2.0	0.20-0.22	6.1-7.3	<2	Low--------	0.32		
	34-60	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low--------	0.43		
Kp----------------- Kipson	0-12	0.6-2.0	0.12-0.18	7.9-8.4	<2	Low--------	0.32	2	8
	12-16	0.6-2.0	0.15-0.20	7.9-8.4	<2	Moderate	0.37		
	16	---	---	---	---	-----------	---		
La----------------- Lancaster	0-10	0.6-2.0	0.17-0.22	5.6-6.5	<2	Low--------	0.28	4	6
	10-30	0.6-2.0	0.15-0.19	5.6-7.3	<2	Moderate	0.28		
	30-39	0.6-2.0	0.15-0.19	6.1-7.3	<2	Low--------	0.28		
	39	---	---	---	---	-----------	---		
Mc, Md------------ McCook	0-16	0.6-2.0	0.19-0.22	7.4-8.4	<2	Low--------	0.32	5	4L
	16-60	0.6-2.0	0.17-0.20	7.4-8.4	<2	Low--------	0.43		
Nc----------------- New Cambria	0-12	0.06-0.2	0.13-0.18	6.6-8.4	<2	High-------	0.28	5	4
	12-40	0.06-0.2	0.13-0.18	7.9-8.4	<2	High-------	0.28		
	40-60	0.06-0.6	0.12-0.16	7.9-8.4	<2	High-------	0.28		
Po*. Pits									
Pr----------------- Pratt	0-15	6.0-20	0.10-0.13	5.6-7.3	<2	Low--------	0.17	5	2
	15-36	6.0-20	0.09-0.16	5.6-7.3	<2	Low--------	0.17		
	36-60	6.0-20	0.08-0.12	6.1-7.3	<2	Low--------	0.17		
Rx----------------- Roxbury	0-22	0.6-2.0	0.22-0.24	7.4-8.4	<2	Moderate	0.32	5	4L
	22-42	0.6-2.0	0.17-0.22	7.4-8.4	<2	Moderate	0.43		
	42-60	0.6-2.0	0.17-0.22	7.4-8.4	<2	Moderate	0.43		
Sd----------------- Sutphen	0-6	<0.06	0.11-0.14	6.1-8.4	<2	High-------	0.28	5	4
	6-38	<0.06	0.10-0.14	6.6-8.4	<2	High-------	0.28		
	38-60	<0.2	0.10-0.18	7.4-8.4	<2	High-------	0.28		
Wa----------------- Wells	0-10	0.6-2.0	0.13-0.15	5.6-6.5	<2	Low--------	0.28	5	3
	10-42	0.6-2.0	0.15-0.19	5.6-7.3	<2	Moderate	0.28		
	42-60	0.6-2.0	0.12-0.18	6.1-7.3	<2	Low--------	0.28		
We, Wf------------ Wells	0-10	0.6-2.0	0.20-0.22	5.6-6.5	<2	Low--------	0.28	5	6
	10-40	0.6-2.0	0.15-0.19	5.6-7.3	<2	Moderate	0.28		
	40-60	0.6-2.0	0.12-0.18	6.1-7.3	<2	Low--------	0.28		

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

[The definitions of "flooding" and "water table" in the text explain terms such as "rare," "brief," "apparent," and "perched." The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness	Uncoated steel	Concrete
					Ft			In			
Ar: Armo	B	None	---	---	>6.0	---	---	>60	---	Low	Low.
Ca: Carwile	D	Occasional	Brief	Apr-Oct	0-2.0	Apparent	Oct-Apr	>60	---	High	Moderate.
Cr, Cs, Ct: Crete	D	None	---	---	>6.0	---	---	>60	---	Moderate	Low.
De: Detroit	C	Rare	---	---	>6.0	---	---	>60	---	High	Low.
Ed: Edalgo	C	None	---	---	>6.0	---	---	20-40	Rippable	Moderate	Low.
Ee*:											
Edalgo	C	None	---	---	>6.0	---	---	20-40	Rippable	Moderate	Low.
Hedville	D	None	---	---	>6.0	---	---	4-20	Hard	Low	Moderate.
Es: Els	A	Rare	---	---	1.5-3.5	Apparent	Nov-May	>60	---	Moderate	Low.
Ge, Gf, Gg: Geary	B	None	---	---	>6.0	---	---	>60	---	Low	Low.
Ha, Hb: Harney	C	None	---	---	>6.0	---	---	>60	---	High	Low.
He*:											
Hedville	D	None	---	---	>6.0	---	---	4-20	Hard	Low	Moderate.
Rock outcrop.											
Hn: Hobbs	B	Occasional	Brief	Apr-Sep	>6.0	---	---	>60	---	Low	Low.
Ho: Hobbs	B	Frequent	Brief	Apr-Sep	>6.0	---	---	>60	---	Low	Low.
Hp*:											
Hobbs	B	Frequent	Brief	Apr-Sep	>6.0	---	---	>60	---	Low	Low.
Geary	B	None	---	---	>6.0	---	---	>60	---	Low	Low.
Hr: Hord	B	Rare	---	---	>6.0	---	---	>60	---	High	Low.
Kp: Kipson	D	None	---	---	>6.0	---	---	7-20	Rippable	Low	Low.
La: Lancaster	B	None	---	---	>6.0	---	---	20-40	Rippable	Low	Moderate.
Mc: McCook	B	Rare	---	---	>6.0	---	---	>60	---	High	Low.
Md: McCook	B	Occasional	Very brief	Apr-Jul	>6.0	---	---	>60	---	High	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hard-ness	Uncoated steel	Concrete
					Ft			In			
Nc------------------ New Cambria	C	None to rare	---	---	>6.0	---	---	>60	---	High-----	Low.
Po*. Pits											
Pr------------------ Pratt	A	None---------	---	---	>6.0	---	---	>60	---	Low------	Moderate.
Rx------------------ Roxbury	B	Rare---------	---	---	>6.0	---	---	>60	---	Low------	Low.
Sd------------------ Sutphen	D	Occasional	Very brief	Mar-Sep	>6.0	---	---	>60	---	High-----	Low.
Wa, We, Wf--------- Wells	B	None---------	---	---	>6.0	---	---	>60	---	Low------	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series]

Soil name	Family or higher taxonomic class
Armo-----------------------	Fine-loamy, mixed, mesic Entic Haplustolls
*Carwile--------------------	Fine, mixed, thermic Typic Argiaquolls
Crete-----------------------	Fine, montmorillonitic, mesic Pachic Argiustolls
Detroit---------------------	Fine, montmorillonitic, mesic Pachic Argiustolls
Edalgo----------------------	Fine, mixed, mesic Udic Argiustolls
Els-------------------------	Mixed, mesic Aquic Ustipsamments
Geary-----------------------	Fine-silty, mixed, mesic Udic Argiustolls
Harney----------------------	Fine, montmorillonitic, mesic Typic Argiustolls
Hedville--------------------	Loamy, mixed, mesic Lithic Haplustolls
Hobbs-----------------------	Fine-silty, mixed, nonacid, mesic Mollic Ustifluvents
Hord------------------------	Fine-silty, mixed, mesic Cumulic Haplustolls
Kipson----------------------	Loamy, mixed, mesic, shallow Udorthentic Haplustolls
Lancaster-------------------	Fine-loamy, mixed, mesic Udic Argiustolls
McCook----------------------	Coarse-silty, mixed, mesic Fluventic Haplustolls
New Cambria-----------------	Fine, montmorillonitic, mesic Cumulic Haplustolls
*Pratt----------------------	Sandy, mixed, thermic Psammentic Haplustalfs
Roxbury---------------------	Fine-silty, mixed, mesic Cumulic Haplustolls
Sutphen---------------------	Fine, montmorillonitic, mesic Udertic Haplustolls
Wells-----------------------	Fine-loamy, mixed, mesic Udic Argiustolls

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