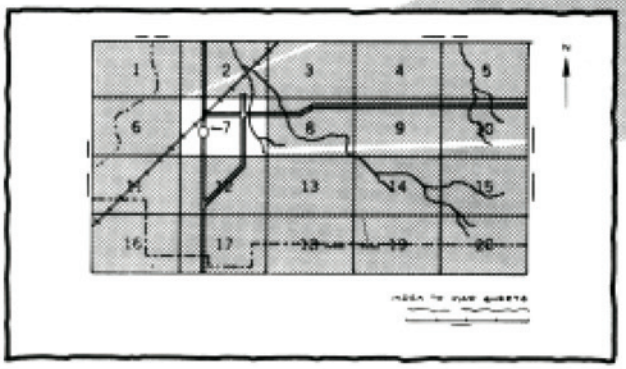
Soil survey of

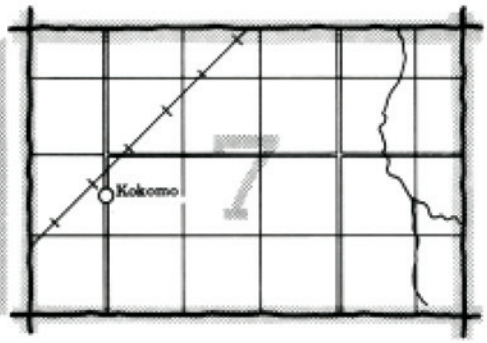
Rawlins County, Kansas

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

HOW TO USE

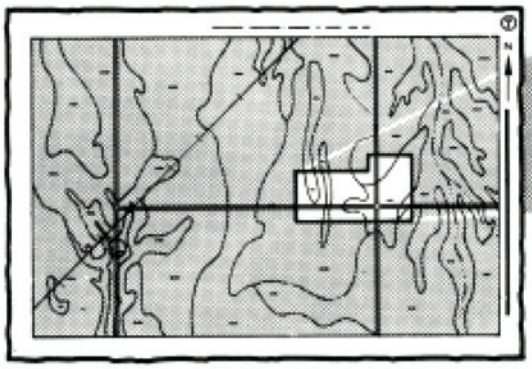
1. Locate your area of interest on the "Index to Map Sheets"

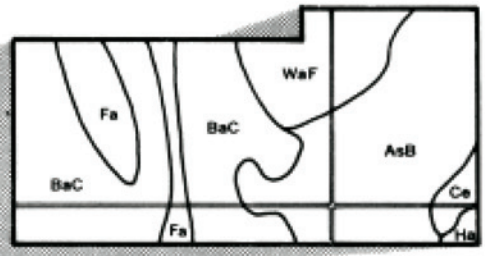




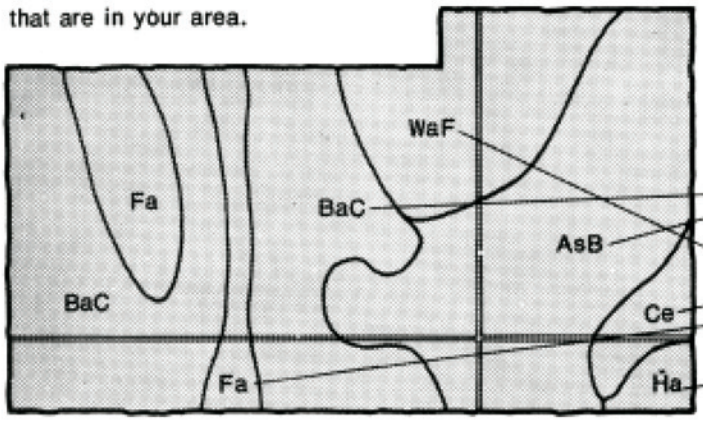
2. Note the number of the map sheet and turn to that sheet.

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





4. List the map unit symbols that are in your area.

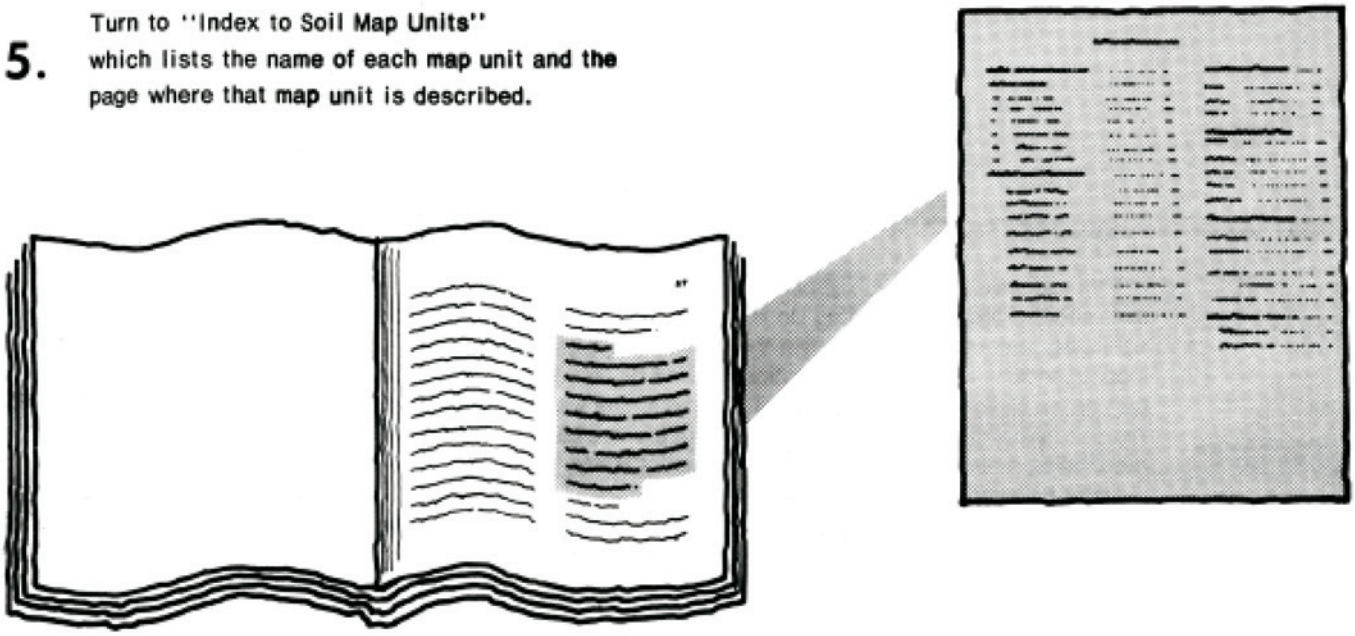


Symbols

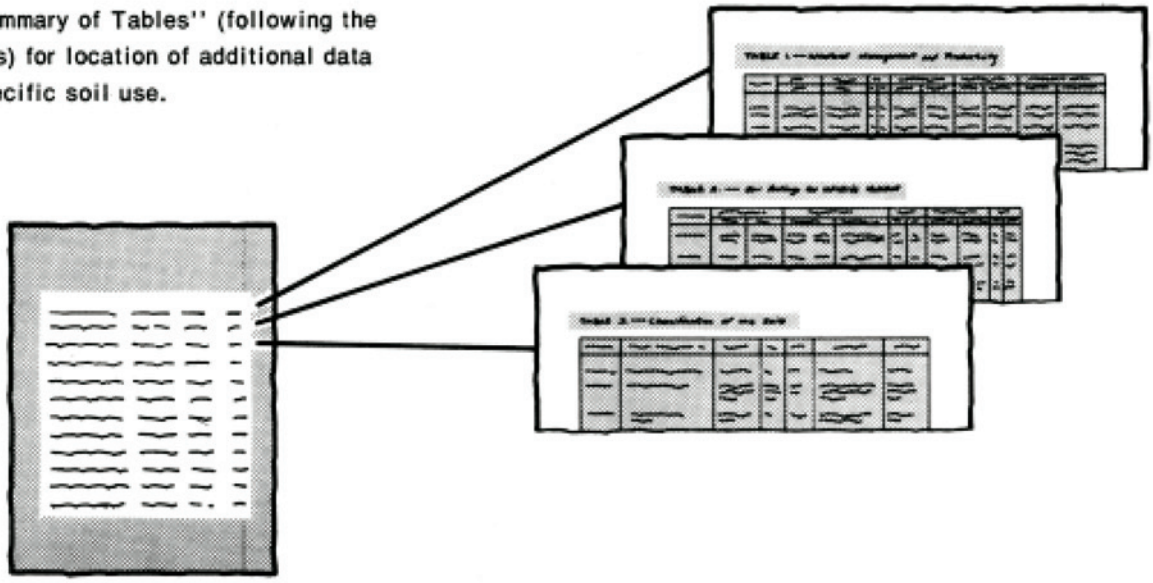
- AsB
- BaC
- Ce
- Fa
- Ha
- WaF

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 Rawlins County Conservation District. Major fieldwork was performed in the period 1973-78. Soil names and descriptions were approved in 1979. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1979.

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.

Cover: An area of the valley of Beaver Creek where a diversion and terraces help to control erosion. The soils support native grass, sorghum, and alfalfa. Colby and Ulysses soils support native grass on the steeper slopes in the background.

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Issued July 1981

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Foreword

This soil survey contains information that can be used in land-planning programs in Rawlins County, Kansas. 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

soil survey of
Rawlins County, Kansas

By Raymond C. Angell, Wesley L. Barker, and Bobby D. Tricks,
Soil Conservation Service

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

RAWLINS COUNTY is in the northwest part of Kansas. It is bordered on the north by Nebraska and is one county away from Colorado on the west (fig. 1). It has a total area of 689,920 acres, or 1,078 square miles. In 1978, the population of the county was 4,166, and that of Atwood, the county seat, was 1,708.

Rawlins County was organized in 1881. Most of the county is in the Central High Tableland land resource area, but the northeastern part is in the Rolling Plains and Breaks land resource area. The west-central and southwestern parts are characterized by broad areas of nearly level tableland, where the soils are deep and formed in a thick deposit of silty loess. In these areas, the surface drainage pattern is not well defined and surface runoff accumulates in small depressions after rains. In the rest of the county, the soils are deep, friable, and dominantly nearly level to moderately sloping. In areas along the major drainageways, they are steeper.

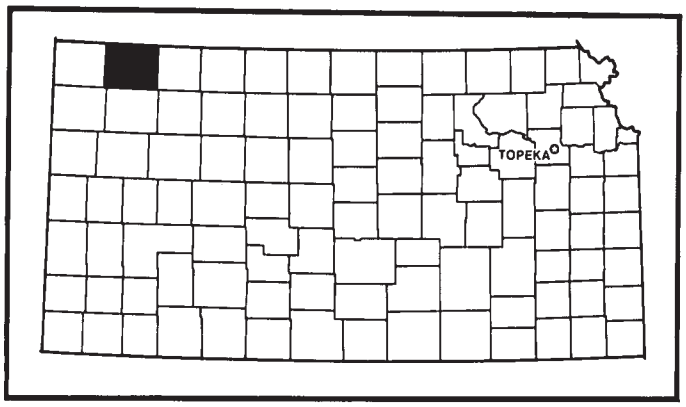

Figure 1.—Location of Rawlins County in Kansas.

Beaver Creek, which is the largest stream in Rawlins County, and its tributaries drain about half of the county, mainly the central part. Three forks of Sappa Creek and their tributaries drain most of the southern part. Burntwood, Timber, and Driftwood Creeks and their tributaries drain the northern part. In Rawlins County these streams generally flow only intermittently. The general direction of flow is northeasterly.

The main sources of income in the county are farming and ranching. Wheat, sorghum, corn, and alfalfa are the main crops.

general nature of the county

This section gives general information concerning the county. It describes climate and natural resources.

climate

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

The climate of Rawlins County is typical continental, as would be expected of a location in the interior of a

large land mass in the middle latitudes. It is characterized by large daily and annual variations in temperature. Winters are cold because of the frequent outbreaks of polar air. They last only from December through February. Warm summer temperatures last for about 6 months every year. Spring and fall generally are short. The elevation of the county is generally higher than that of the counties to the east and southeast. As a result, the growing season is usually shorter.

Rawlins County lies within the rain shadow of the Rocky Mountains and west of the moisture-laden currents of air from the Gulf of Mexico. The air from the Pacific Ocean precipitates its moisture as it passes over the mountains. Precipitation is usually inadequate for crop production because of the high rate of evaporation produced by warm temperatures and high wind velocities. Successful farming depends on irrigation, summer fallow, and extensive conservation measures. Dry conditions in the fall and winter sometimes limit the growth of wheat. As a result, wheat fields do not have a good plant cover in spring, when the windspeed is highest, and soil blowing causes heavy damage.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Atwood in the period 1951 to 1976. 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 31.3 degrees F, and the average daily minimum temperature is 17.1 degrees. The lowest temperature on record, which occurred at Atwood on January 12, 1912, is -33 degrees. In summer the average temperature is 74.8 degrees, and the average daily maximum temperature is 89.8 degrees. The highest recorded temperature, which occurred at Atwood on July 24, 1976, is 118 degrees.

The total annual precipitation is 20.49 inches. Of this, 15.65 inches, or 76 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 11.33 inches. The heaviest 1-day rainfall was 4.42 inches at Atwood on May 21, 1977.

Hail that falls during severe thunderstorms considerably damages crops. It frequently falls just prior to harvest, when the wheat crop is most vulnerable. Although these storms are local in extent, they occur frequently enough to be considered a major risk in Rawlins County.

Average seasonal snowfall is 34 inches. The greatest snowfall, which occurred during the winter of 1948-49, was 84.4 inches. On an average of 37 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 77 percent of the time possible in summer and 67 percent in winter. The prevailing wind is from the south. Average windspeed is highest, 14.5 miles per hour, in April.

natural resources

Soil is the most widely used natural resource in Rawlins County. If managed and used properly, it is a renewable resource. The purpose of this survey is to aid in maintaining and improving the soil.

Other natural resources are sand, gravel, quartzite, volcanic ash, and oil. An adequate supply of sand and gravel is available for roads and other structures. Quartzite is used as building stone and as road-surfacing material.

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 units" and "Detailed soil map units."

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 units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each 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 descriptions and names of the soils identified on the general soil map of this county do not fully agree with those of the soils identified on the maps of adjacent counties. Differences result from a better knowledge of soils, modifications in series concepts, a higher or lower intensity of mapping, and variations in the extent of the soils in the counties.

soil descriptions

1. Kuma-Keith association

Deep, nearly level, well drained soils that have a silty subsoil; on uplands

This association is on high plains tableland. It commonly lacks a well defined surface drainage pattern. Slope ranges from 0 to 2 percent.

This association makes up about 25 percent of the county. It is about 45 percent Kuma soils, 40 percent Keith soils, and 15 percent minor soils.

The Kuma soils formed in loess on tableland, mainly in the highest position on the landscape. Typically, the surface layer is dark grayish brown silt loam about 5 inches thick. The subsurface layer is dark grayish brown, friable silt loam about 5 inches thick. The subsoil is about 24 inches thick. The upper part is grayish brown, friable silty clay loam, and the lower part is grayish brown, friable silt loam. Below this is a dark grayish brown, friable silt loam buried surface layer about 13 inches thick. The substratum to a depth of about 60 inches is pale brown, calcareous silt loam.

The Keith soils formed in loess on uplands, mainly on divides between drainageways. Typically, the surface layer is grayish brown silt loam about 6 inches thick. The subsurface layer is dark grayish brown, friable silt loam about 4 inches thick. The subsoil is friable silt loam about 26 inches thick. The upper part is grayish brown, and the lower part is light brownish gray. The substratum to a depth of about 60 inches is very pale brown, calcareous silt loam.

Of minor extent in this association are Bridgeport, Caruso, Colby, Pleasant, and Ulysses soils. The occasionally flooded Bridgeport and Caruso soils are on flood plains along upland drainageways. Colby and Ulysses soils are on side slopes. They are steeper than the major soils. The moderately well drained Pleasant soils are in upland depressions.

This association is used mainly for cultivated crops. A few small areas support native grass. The major soils are suited to all of the dryland and irrigated crops commonly grown in the county. Wheat and sorghum are the main dryland crops. Corn, sorghum, wheat, and alfalfa are the main irrigated crops. Conserving moisture and maintaining tilth and fertility are concerns in managing these soils.

2. Keith-Colby-Ulysses association

Deep, nearly level to moderately steep, well drained soils that have a silty subsoil; on uplands

This association is on broad ridgetops and on side slopes that are dissected by small drainageways and creeks. Slope ranges from 0 to 25 percent.

This association makes up about 55 percent of the county. It is about 50 percent Keith soils, 30 percent Colby soils, 10 percent Ulysses soils, and 10 percent minor soils (fig. 2).

The nearly level Keith soils formed in loess on broad ridgetops. Typically, the surface layer is grayish brown silt loam about 6 inches thick. The subsurface layer is dark grayish brown, friable silt loam about 4 inches thick. The subsoil is friable silt loam about 26 inches thick. The upper part is grayish brown, and the lower part is light brownish gray. The substratum to a depth of about 60 inches is very pale brown, calcareous silt loam.

The strongly sloping and moderately steep Colby soils formed in loess on side slopes. Typically, the surface layer is grayish brown silt loam about 6 inches thick. The next 6 inches is pale brown, friable silt loam. The

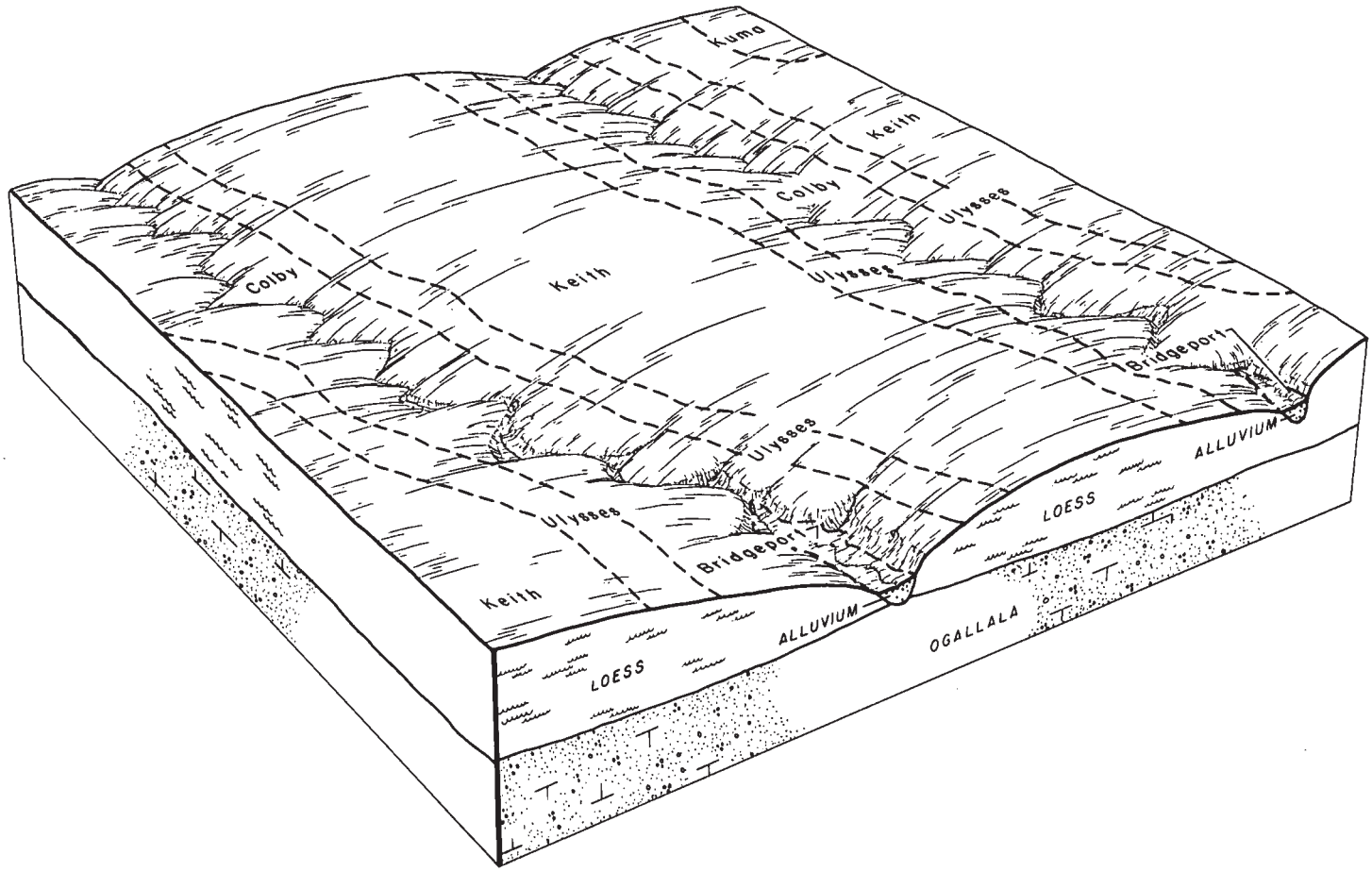

Figure 2.—Typical pattern of soils and parent material in the Keith-Colby-Ulysses association.

substratum to a depth of about 60 inches is pale brown and very pale brown, calcareous silt loam.

The moderately sloping Ulysses soils formed in loess on the upper side slopes. Typically, the surface layer is dark grayish brown silt loam about 9 inches thick. The subsoil is grayish brown, friable silt loam about 8 inches thick. The substratum to a depth of about 60 inches is light gray, calcareous silt loam.

Of minor extent in this association are Bridgeport, Campus, Caruso, and Kuma soils. Bridgeport and Caruso soils are on terraces and flood plains along drainageways. The moderately deep Campus soils are on side slopes below the Colby soils. The nearly level Kuma soils are on the upper parts of the landscape.

Most of the nearly level and moderately sloping areas in this association are cultivated. The steeper areas support native grass. Wheat and sorghum are the main dryland crops (fig. 3). A few areas are irrigated. Corn, sorghum, alfalfa, and wheat are the main irrigated crops. Controlling erosion and maintaining tilth and fertility are concerns in managing these soils.

3. Colby-Ulysses-Campus association

Deep and moderately deep, moderately sloping to steep, well drained soils that have a silty or loamy subsoil; on uplands

This association is on narrow ridgetops and in deeply dissected intermittent drainageways. Slope ranges from 2 to 50 percent.

This association makes up about 20 percent of the county. It is about 50 percent Colby soils, 15 percent Ulysses soils, 8 percent Campus soils, and 27 percent minor soils (fig. 4).

The deep, strongly sloping to steep Colby soils formed in loess on side slopes. Typically, the surface layer is grayish brown silt loam about 6 inches thick. The next 6 inches is pale brown, friable silt loam. The substratum to a depth of about 60 inches is pale brown and very pale brown, calcareous silt loam.

The deep, moderately sloping Ulysses soils formed in loess on the upper side slopes. Typically, the surface

Figure 3.—Harvesting wheat in an area of Keith silt loam, 0 to 2 percent slopes, that is terraced and farmed on the contour.

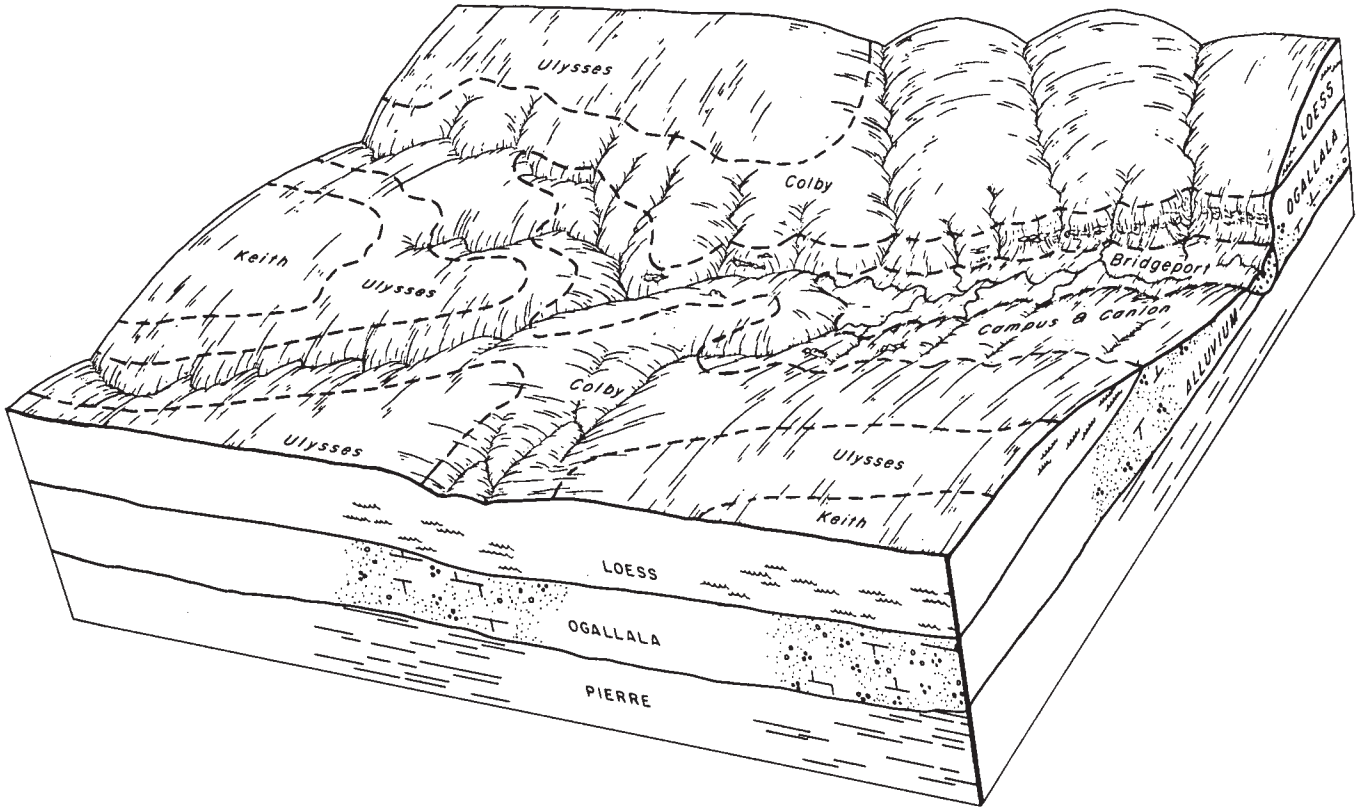

Figure 4.—Typical pattern of soils and parent material in the Colby-Ulysses-Campus association.

layer is dark grayish brown silt loam about 9 inches thick. The subsoil is grayish brown, friable silt loam about 8 inches thick. The substratum to a depth of about 60 inches is light gray, calcareous silt loam.

The moderately deep, strongly sloping Campus soils formed in loamy residuum of lime-cemented sandstone or caliche. They are on the lower side slopes. Typically, the surface layer is grayish brown loam about 8 inches thick. The subsoil is light brownish gray, friable loam about 6 inches thick. The substratum is very pale brown loam. White, hard caliche is at a depth of about 24 inches.

Of minor extent in this association are Bridgeport, Canlon, Caruso, and Keith soils. Bridgeport and Caruso soils are on terraces and flood plains along the drainageways. The shallow Canlon soils occur as areas intricately mixed with areas of the Campus soils. The nearly level Keith soils are on ridgetops.

This association is used mainly as rangeland. Controlled grazing helps to maintain a good plant cover and reduces the runoff rate and the risk of erosion. Proper stocking rates, rotation or deferred grazing, and well distributed salting and watering facilities help to keep the range in good condition.

detailed soil map units

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 and identifies the principal hazards and limitations to be considered in planning 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 substratum, 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 substratum. 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, Bridgeport silt loam, 0 to 2 percent slopes, is one of several phases in the Bridgeport 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. Campus-Canlon loams, 6 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.

The descriptions and names of the soils identified on the detailed maps of this county do not fully agree with those of the soils identified on the maps of adjacent counties. Differences result from a better knowledge of 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

Ba—Bridgeport silt loam, 0 to 2 percent slopes. This nearly level, well drained soil is on low terraces and alluvial fans near the larger streams. It is subject to rare flooding. Areas are irregular in shape and range from 10 to about 1,000 acres in size.

Typically, the surface layer is dark grayish brown silt loam about 4 inches thick. The subsurface layer is dark grayish brown, friable silt loam about 7 inches thick. The subsoil is friable silt loam about 16 inches thick. The upper part is grayish brown, and the lower part is light brownish gray. The substratum to a depth of about 60 inches is light brownish gray, calcareous silt loam. In some places the dark grayish brown surface soil is more than 20 inches thick, and in other places it is less than 7 inches thick.

Permeability is moderate, and surface runoff is slow. Available water capacity is high. Fertility also is high. The surface layer is mildly alkaline or moderately alkaline. It is friable and can be easily tilled.

Most areas are cultivated. This soil is well suited to dryland and irrigated crops. Wheat and sorghum are the main dryland crops. Alfalfa is grown in a few areas (fig. 5). Inadequate rainfall is the main limitation. Measures that conserve moisture and help to control soil blowing are the main management needs. Examples are summer fallowing, minimum tillage, and stubble mulching.

Many areas are irrigated. Corn, sorghum, and alfalfa are the main irrigated crops. Sugar beets also are suitable. Measures that maintain fertility and tilth, increase the organic matter content, and result in the efficient use of irrigation water are management needs. Minimum tillage and a cover of crop residue increase the organic matter content and improve tilth and fertility.

Figure 5.—Alfalfa on Bridgeport silt loam, 0 to 2 percent slopes.

Land leveling and water management improve water distribution.

This soil is suited to range. Controlled grazing helps to maintain the growth and vigor of the more productive taller grasses. Proper stocking rates, rotation or deferred grazing, and well distributed salting and watering facilities improve the range 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 septic tank absorption field. Overcoming this hazard is difficult without major flood-control measures. Seepage is a moderate limitation on sites for sewage lagoons. It can be controlled, however, by sealing the lagoon. Low strength is a severe limitation on sites for local roads and streets. Strengthening or replacing the base material, however, helps to overcome this limitation.

The capability subclass is IIc, dryland; capability class I, irrigated.

Bb—Bridgeport silt loam, 2 to 4 percent slopes. This gently sloping, well drained soil is on terraces, alluvial fans, and foot slopes. It is subject to rare flooding. Areas are irregular in shape and range from 10 to about 80 acres in size.

Typically, the surface layer is dark grayish brown silt loam about 10 inches thick. The subsoil is grayish brown, friable silt loam about 6 inches thick. The substratum to a depth of about 60 inches is light brownish gray, calcareous silt loam. In places the dark grayish brown surface layer is less than 7 inches thick.

Included with this soil in mapping are small areas of soils that have a sandy loam surface layer and subsoil. These soils are on the upper side slopes adjacent to the uplands. They make up 2 to 10 percent of the unit.

Permeability is moderate in the Bridgeport soil, and surface runoff is medium. Available water capacity is high. Fertility also is high. The surface layer is mildly alkaline or moderately alkaline. It is friable and can be easily tilled.

Most areas are cultivated. This soil is well suited to dryland and irrigated crops. Wheat and sorghum are the main dryland crops. If cultivated crops are grown, erosion is a hazard. Conserving moisture is an additional concern. Minimum tillage, terracing, contour farming, summer fallowing, and stubble mulching conserve moisture and help to control erosion and soil blowing. In some areas diversions are needed to control the runoff from the adjacent uplands.

Some areas are irrigated. Corn, sorghum, and alfalfa are the main irrigated crops. Erosion is the main hazard. It can be controlled by terracing and contour farming. Measures that improve fertility and tilth, increase the organic matter content, and result in the efficient use of irrigation water are additional management needs.

Minimum tillage and a cover of crop residue increase the organic matter content and improve tilth and fertility.

This soil is suited to range. Controlled grazing helps to maintain the growth and vigor of the more productive taller grasses. Proper stocking rates, rotation or deferred grazing, and well distributed salting and watering facilities improve the range 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 septic tank absorption field. Overcoming this hazard is difficult without major flood-control measures. Seepage and slope are moderate limitations on sites for sewage lagoons. Sealing the lagoon helps to control the seepage. Land shaping helps to overcome the slope. Low strength is a severe limitation on sites for local roads and streets. Strengthening or replacing the base material, however, helps to overcome this limitation.

The capability subclass is IIIe, dryland and irrigated.

Bf—Bridgeport silt loam, flooded. This nearly level, well drained soil is on flood plains along the larger streams. The flood plains are dissected by the stream channels. The soil is occasionally flooded. Areas are long and narrow and range from 40 to several hundred acres in size.

Typically, the surface layer is dark grayish brown silt loam about 6 inches thick. The subsurface layer is dark grayish brown, friable silt loam about 9 inches thick. The subsoil is grayish brown, friable silt loam about 8 inches thick. The substratum to a depth of about 60 inches is light brownish gray, calcareous silt loam. In some places the dark grayish brown surface soil is less than 7 inches thick, and in other places it is more than 20 inches thick. In some areas it has thin strata that are lighter colored.

Included with this soil in mapping are small areas of the somewhat poorly drained Caruso soils. These soils are on the slightly lower parts of the landscape. They make up 2 to 5 percent of the unit.

Permeability is moderate in the Bridgeport soil, and surface runoff is slow. Available water capacity is high. Fertility also is high. The surface layer is mildly alkaline or moderately alkaline. It is friable and can be easily tilled.

This soil is used for cultivated crops and for range. It is suited to dryland and irrigated crops. Sorghum and alfalfa are the main dryland crops. Flooding is the main hazard. Measures that help to control flooding and soil blowing and conserve moisture are the main management needs. Minimum tillage and stubble mulching conserve moisture and help to control soil blowing.

Some areas are irrigated. Corn, sorghum, and alfalfa are the main irrigated crops. Measures that help to control the flooding, improve fertility and tilth, increase the organic matter content, and result in the efficient use of irrigation water are management needs.

This soil is suited to range. Controlled grazing helps to maintain the growth and vigor of the more productive taller grasses. Proper stocking rates, rotation or deferred grazing, and well distributed salting and watering facilities improve the range condition.

Because the flooding is a severe hazard, this soil is generally unsuitable as a site for dwellings, septic tank absorption fields, or sewage lagoons. Low strength and flooding are severe limitations on sites for local roads and streets. Building the roads and streets on raised, well compacted fill material and providing adequate side ditches and culverts help to prevent the damage caused by flooding. Strengthening or replacing the base material helps to prevent the damage caused by low strength.

The capability subclass is IIw, dryland and irrigated.

Cc—Campus-Canlon loams, 6 to 30 percent slopes. These strongly sloping to steep soils are on the sides of deeply dissected drainageways. The moderately deep, well drained Campus soil is on the upper and lower side slopes. The shallow, somewhat excessively drained Canlon soil is on the mid slopes directly above areas where rock crops out. Areas are long and narrow and range from 10 to several hundred acres in size. They are 35 to 55 percent Campus soil and 25 to 35 percent Canlon soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Campus soil has a surface layer of grayish brown loam about 8 inches thick. The subsoil is light brownish gray, friable loam about 6 inches thick. The substratum is very pale brown loam. White, hard caliche is at a depth of about 24 inches. In some places the surface layer and the subsoil are clay loam. In other places the depth to hard caliche is more than 40 inches.

Typically, the Canlon soil has a surface layer of dark grayish brown loam about 5 inches thick. The substratum is light brownish gray, friable loam. White, hard caliche is at a depth of about 11 inches. In some places the dark grayish brown surface layer is more than 7 inches thick. In other places the surface layer and the substratum are clay loam.

Included with these soils in mapping are small areas of nearly level, loamy soils on narrow flood plains along drainageways and small areas of the deep Colby soils on the upper side slopes and on ridgetops. Also included are small areas of gravelly soils on side slopes and small areas where rock crops out. Included areas make up 15 to 20 percent of the unit.

Permeability is moderate in the Campus and Canlon soils. Surface runoff is rapid. Available water capacity is moderate in the Campus soil and very low in the Canlon soil. Fertility is medium in the Campus soil and low in the Canlon soil. Root penetration is restricted by the caliche at a depth of about 24 inches in the Campus soil and 11 inches in the Canlon soil.

Most areas are used as range. These soils are generally unsuitable for cultivation because of a severe erosion hazard and the restricted soil depth. They are best suited to range. The major concerns of

management are the moderate and very low available water capacity and the hazard of erosion. The soils are somewhat droughty because of the limited available water capacity and the rapid runoff. Controlled grazing helps to maintain a good plant cover and reduces the runoff rate and the risk of erosion. Proper stocking rates, rotation or deferred grazing, and well distributed salting and watering facilities help to keep the range in good condition.

Because the depth to rock and the slope are severe limitations, these soils are generally unsuitable as sites for dwellings, septic tank absorption fields, sewage lagoons, or local roads and streets.

The capability subclass is VIe.

Cd—Caruso silt loam. This nearly level, somewhat poorly drained soil is on flood plains along the channel of some of the larger streams. It is occasionally flooded. Areas are long and narrow and range from 10 to several hundred acres in size.

Typically, the surface layer is grayish brown silt loam about 9 inches thick. The subsurface layer is grayish brown, friable silt loam about 5 inches thick. The substratum to a depth of about 60 inches is light gray loam, silt loam, and clay loam. In the lower part it is distinctly mottled and has thin strata that are darker. In some places the surface soil is lighter colored. In other places the substratum is not mottled.

Included with this soil in mapping are small areas of the well drained Bridgeport soils on the slightly higher parts of the landscape and small areas, in depressions, where a seasonal high water table is at a depth of 0.5 to 2 feet. Also included are small areas where the surface layer is slightly affected by soluble salts. Included areas make up 2 to 10 percent of the unit.

Permeability is moderate in the Caruso soil, and surface runoff is slow. Available water capacity is high. Fertility also is high. A seasonal high water table is at a depth of 2 to 3 feet in the spring. The surface layer is friable and can be easily tilled.

Most areas are used as range. This soil is well suited to range. Grazing when the soil is too wet, however, causes surface compaction and poor tilth. Controlled grazing improves the growth and vigor of the more palatable and productive taller grasses. Proper stocking rates, rotation or deferred grazing, and well distributed salting and watering facilities improve the range condition.

This soil generally is suited to cultivated crops. It is poorly suited to wheat, however, because it is subject to flooding. Sorghum and alfalfa are the main dryland crops (fig. 6). The flooding is the main hazard and the seasonal high water table the main limitation. Measures that help to control flooding and soil blowing are the main management needs. Minimum tillage and stubble mulching help to control soil blowing. In some areas diversion terraces are needed to control the runoff from the adjacent uplands.

Some areas are irrigated. Corn, sorghum, and alfalfa are the main irrigated crops. Measures that help to control flooding, improve fertility and tilth, increase the organic matter content, and result in the efficient use of irrigation water are needed.

Because the flooding is a severe hazard, this soil is generally unsuitable as a site for dwellings, septic tank absorption fields, or sewage lagoons. Overcoming this hazard is difficult without major flood-control measures. Low strength and flooding are severe limitations on sites for local roads and streets. Building the roads and streets on raised, well compacted fill material and providing adequate side ditches and culverts help to prevent the damage caused by flooding. Strengthening or replacing the base material helps to prevent the damage caused by low strength.

The capability subclass is IIw, dryland and irrigated.

Co—Colby silt loam, 10 to 25 percent slopes. This strongly sloping and moderately steep, well drained soil is on uplands along drainageways. Areas are long and narrow and range from 10 to several hundred acres in size.

Typically, the surface layer is grayish brown silt loam about 6 inches thick. The next 6 inches is pale brown, friable silt loam. The substratum to a depth of about 60 inches is pale brown and very pale brown, calcareous silt loam. In places erosion has exposed the pale brown substratum.

Included with this soil in mapping are small areas of Bridgeport, Campus, Canlon, and Ulysses soils and areas where caliche crops out. The nearly level Bridgeport soils are on narrow flood plains along drainageways. The moderately deep Campus soils, the shallow Canlon soils, and the areas where caliche crops out are on side slopes. The Ulysses soils are in the smoother, less sloping areas. They have a dark surface layer. Included areas make up about 5 to 15 percent of the unit.

Permeability is moderate in the Colby soil, and surface runoff is rapid. Available water capacity is high. Fertility is medium. The surface layer is mildly alkaline or moderately alkaline.

Most areas are used as range. This soil is generally unsuited to cultivated crops because of a severe erosion hazard. It is best suited to range. Measures that help to control erosion and weeds are the main management needs. Controlled grazing helps to maintain or improve the growth and vigor of the more productive taller grasses, reduces the runoff rate, and helps to prevent exccessive soil losses. Winter grazing and spraying help to control the weeds. Proper stocking rates, rotation or deferred grazing, and well distributed salting and watering facilities improve the range condition.

The slope is a severe limitation if this soil is used as a site for dwellings, local roads and streets, septic tank absorption fields, or sewage lagoons. The smoother, less sloping included or adjacent areas should be selected as

Figure 6.—Alfalfa on Caruso silt loam along Beaver Creek.

sites for dwellings and septic tank absorption fields. The soil is generally unsuitable as a site for sewage lagoons and for roads and streets.

The capability subclass is VIe.

Cy—Colby silt loam, 25 to 50 percent slopes. This steep, well drained soil is on uplands along deeply entrenched drainageways, mainly in the northwestern part of the county. Areas are long and narrow and range from 10 to several hundred acres in size.

Typically, the surface layer is grayish brown silt loam about 4 inches thick. The next 5 inches is pale brown, friable silt loam. The substratum to a depth of about 60 inches is pale brown, calcareous silt loam. In some of the steeper areas, erosion has exposed the pale brown substratum.

Included with this soil in mapping are areas of Bridgeport, Campus, Canlon, and Ulysses soils and areas where caliche crops out. The nearly level Bridgeport soils are on narrow flood plains along drainageways. The moderately deep Campus soils, the shallow Canlon soils, and the areas where caliche crops out are on side slopes. The Ulysses soils are in the smoother, less sloping areas. They have a dark surface layer. Included areas make up about 10 to 15 percent of the unit.

Permeability is moderate in the Colby soil, and surface runoff is rapid. Available water capacity is high. Fertility is medium. The surface layer is mildly alkaline or moderately alkaline.

Most areas are used as range. This soil is generally unsuited to cultivated crops because of a severe erosion hazard. It is best suited to range. Measures that help to control erosion and weeds are the main management needs. Controlled grazing helps to maintain or improve the growth and vigor of the more productive taller grasses, reduces the runoff rate, and helps to prevent excessive soil losses. Winter grazing and spraying help to control the weeds. In some areas pipelines are needed to provide an adequate source of stock water. Proper stocking rates, rotation or deferred grazing, and well distributed salting and watering facilities improve the range condition.

Because the slope is a severe limitation, this soil is generally unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, or sewage lagoons.

The capability subclass is VIe.

Ke—Keith silt loam, 0 to 2 percent slopes. This nearly level, well drained soil is on uplands, mainly on divides between drainageways. Areas are irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface layer is grayish brown silt loam about 6 inches thick (fig. 7). The subsurface layer is dark grayish brown, friable silt loam about 4 inches thick. The subsoil is friable silt loam about 26 inches thick. The upper part is grayish brown, and the lower part is light brownish gray. The substratum to a depth of about 60 inches is very pale brown, calcareous silt loam. In some areas the depth to lime is less than 14 inches. In some places the soil is grayish brown to a depth of more than 20 inches. In other places the surface layer is silty clay loam.

Permeability is moderate, and surface runoff is slow. Available water capacity is high. Fertility also is high. The surface layer is slightly acid to mildly alkaline. The shrink-swell potential is moderate in the subsoil.

Most areas are cultivated. This soil is well suited to dryland and irrigated crops. Wheat and sorghum are the main dryland crops. Inadequate rainfall is the main limitation. Measures that conserve moisture and help to control soil blowing are the main management needs. Examples are summer fallowing, minimum tillage, and stubble mulching. Level terraces also conserve moisture.

In irrigated areas corn and sorghum are the main crops. Alfalfa and wheat also are grown, and sugar beets also are suitable. Measures that maintain fertility and tilth, increase the organic matter content, and result in the efficient use of irrigation water are management needs. Land leveling or contour farming reduces the runoff rate and improves water distribution in the areas irrigated by flooding. A cover of crop residue reduces the runoff rate in the areas irrigated by sprinklers. Tailwater pits help to recover irrigation water.

This soil is suited to range. Controlled grazing helps to maintain the growth and vigor of the more productive taller grasses. Proper stocking rates, rotation or deferred grazing, and well distributed salting and watering facilities improve the range condition.

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

The capability subclass is IIc, dryland; capability class I, irrigated.

Ku—Kuma silt loam, 0 to 1 percent slopes. This nearly level, well drained soil is on broad upland ridgetops. Areas range from 60 to several thousand acres in size.

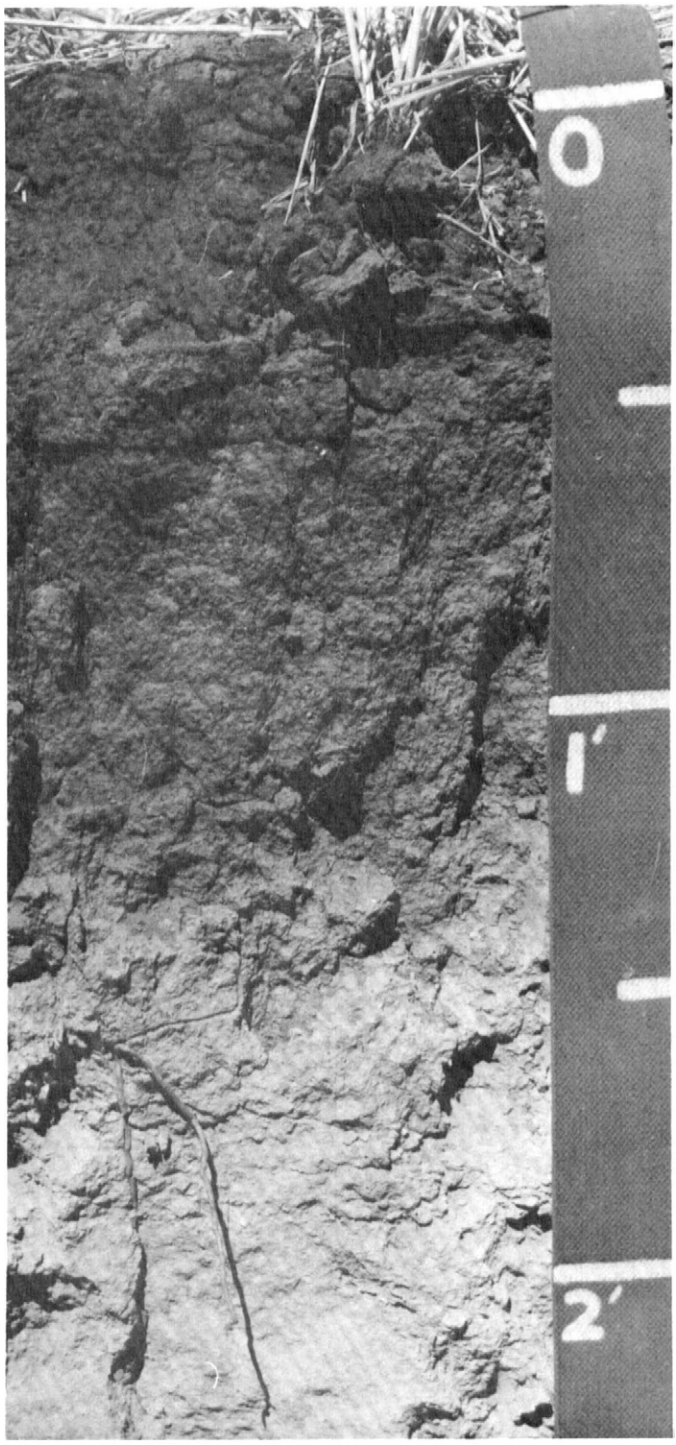

Figure 7.—Profile of Keith silt loam, 0 to 2 percent slopes. The surface soil is dark.

Typically, the surface layer is dark grayish brown silt loam about 5 inches thick. The subsurface layer is dark grayish brown, friable silt loam about 5 inches thick. The subsoil is about 24 inches thick. The upper part is grayish brown, friable silty clay loam, and the lower part is grayish brown, friable silt loam. Below this is a dark grayish brown silt loam buried surface layer about 13 inches thick. The substratum to a depth of about 60 inches is pale brown, calcareous silt loam. In places the soil is dark to a depth of less than 20 inches and does not have a buried layer.

Included with this soil in mapping are small areas of the moderately well drained Pleasant soils in shallow depressions. These soils make up less than 1 percent of the unit.

Permeability is moderate in the Kuma soil, and surface runoff is slow. Available water capacity is high. Fertility also is high. The surface layer is neutral or mildly alkaline. It is friable and can be easily tilled.

Most areas are cultivated. This soil is well suited to dryland and irrigated crops. Wheat and sorghum are the main dryland crops. Measures that conserve moisture and help to control soil blowing are the main management needs. Examples are summer fallowing, minimum tillage, and stubble mulching.

This soil is irrigated more than any other soil in the county. Corn and sorghum are the main irrigated crops. Alfalfa and wheat also are grown, and sugar beets also are suitable. Measures that maintain fertility and tilth, increase the organic matter content, and result in the efficient use of irrigation water are management needs. Minimum tillage and a cover of crop residue increase the organic matter content and improve tilth and fertility. Land leveling and water management improve water distribution.

This soil is suited to range. Controlled grazing helps to maintain the growth and vigor of the more productive taller grasses. Proper stocking rates, rotation or deferred grazing, and well distributed salting and watering facilities improve the range condition.

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

The capability subclass is IIc, dryland; capability class I, irrigated.

Pe—Pleasant silty clay loam. This nearly level, moderately well drained soil is in upland depressions that are occasionally ponded (fig. 8). Areas are irregular in shape and range from about 3 to 40 acres in size.

Typically, the surface layer is gray silty clay loam about 8 inches thick. The subsoil extends to a depth of 60 inches or more. The upper part is gray and grayish brown, firm silty clay, and the lower part is pale brown, friable silty clay loam. In some places the depth to lime is less than 50 inches. In other places the soil is dark to a depth of less than 20 inches.

Permeability is very slow, and surface runoff is ponded. Available water capacity is moderate. Fertility is high. The surface layer is slightly acid or neutral. It is

Figure 8.—An area of Pleasant silty clay loam surrounded by a large area of Kuma soils. The Pleasant soil is occasionally ponded.

friable but is easily compacted if tilled when wet. The shrink-swell potential is high in the subsoil.

Most areas are cultivated along with the surrounding soils. This soil is moderately well suited to dryland crops. Wheat and sorghum are the main dryland crops. Ponding of surface water and soil blowing are the main concerns of management. Stubble mulching, terracing, and contour farming on the surrounding soils help to control the ponding on this soil. Minimum tillage and stubble mulching on this soil help to control soil blowing.

This soil is poorly suited to irrigation. Only small areas adjacent to other irrigated soils are irrigated. Sorghum and corn are the main irrigated crops. In some areas this soil and the adjacent soils have been leveled. The leveling helps to prevent ponding.

Some areas are used as range. Ponding of surface water is the main limitation. It restricts the growth of most grasses in some of the larger areas that are ponded for long periods. Reducing the amount of water that runs off of the surrounding soils helps to control the ponding on this soil. Controlled grazing helps to maintain the growth and vigor of the more productive taller grasses. Proper stocking rates and rotation or deferred grazing improve the range condition.

Because the ponding is a severe limitation, this soil is generally unsuitable as a site for dwellings, septic tank absorption fields, and local roads and streets. The ponding also is a severe limitation on sites for sewage lagoons. High sides on the lagoon, however, can divert surface water.

The capability subclass is IVw, dryland and irrigated.

Uc—Ulysses silt loam, 2 to 7 percent slopes. This moderately sloping, well drained soil is on the upper side slopes along drainageways. Areas are long and narrow and range from 10 to several hundred acres in size.

Typically, the surface layer is dark grayish brown silt loam about 9 inches thick. The subsoil is grayish brown, friable silt loam about 8 inches thick. The substratum to a depth of about 60 inches is light gray, calcareous silt loam. In places the dark surface layer is less than 7 inches thick.

Permeability is moderate, and surface runoff is medium. Available water capacity is high. Fertility also is high. The surface layer is neutral or mildly alkaline. It is friable and can be easily tilled. The shrink-swell potential is moderate in the subsoil.

Most areas are cultivated. This soil is well suited to dryland crops but is poorly suited to irrigated crops. Wheat and sorghum are the main dryand crops. Sorghum is susceptible to chlorosis because of the high content of carbonates. Erosion and inadequate rainfall are the main concerns of management. Measures that conserve moisture and help to control erosion and soil blowing are the main management needs. Examples are summer fallowing, terracing, contour farming, and stubble mulching.

Some areas are irrigated, mainly by sprinklers. Corn, sorghum, and alfalfa are the main irrigated crops. Some wheat is also grown. Measures that help to control erosion, maintain fertility and tilth, increase the organic matter content, and result in the efficient use of irrigation water are management needs. Minimum tillage and a cover of crop residue increase the organic matter content and improve tilth and fertility. Terracing and contour farming help to control erosion.

This soil is suited to range. Controlled grazing helps to maintain the growth and vigor of the more productive taller grasses. Proper stocking rates, rotation or deferred grazing, and well distributed salting and watering facilities improve the range condition.

This soil is suitable as a site for dwellings with basements and as a septic tank absorption field. Seepage and slope are moderate limitations on sites for sewage lagoons. Sealing the lagoon helps to control the seepage. Land shaping helps to overcome the slope. Low strength is a severe limitation on sites for local roads and streets. Strengthening or replacing the base material, however, helps to overcome this limitation.

The capability subclass is IIIe, dryland and irrigated.

prime farmland

Prime farmland is one of several kinds of important farmlands defined by the U.S. Department of Agriculture. It is of major importance in providing the Nation's short- and long-range needs for food and fiber. Because the supply of high quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cropland, pasture, woodland, or other land, but it is not urban or built-up land or water areas. It either is used for food or fiber or is available for these uses. The soil qualities, growing season, and moisture supply are those needed for a well managed soil economically to produce a sustained high yield of crops. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland usually has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 7 percent. More detailed information about the criteria for prime farmland is available at local offices of the Soil Conservation Service.

About 32,000 acres in Rawlins County, or 5 percent of the total acreage, meets the requirements for prime

farmland. All of this prime farmland is used for irrigated crops, mainly corn, sorghum, and alfalfa. It occurs as scattered areas throughout the county but is mainly in the western part and along the larger stream valleys.

The map units considered prime farmland in the county are listed in this section. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described in the section "Detailed soil map units."

Soils that receive an inadequate amount of rainfall qualify as prime farmland only if this limitation is overcome by irrigation. Onsite evaluation is needed to determine whether or not this limitation has been overcome. The following map units in Rawlins County qualify as prime farmland in areas where they are irrigated:

Ba—Bridgeport silt loam, 0 to 2 percent slopes
Bb—Bridgeport silt loam, 2 to 4 percent slopes
Bf—Bridgeport silt loam, flooded
Cd—Caruso silt loam
Ke—Keith silt loam, 0 to 2 percent slopes
Ku—Kuma silt loam, 0 to 1 percent slopes
Uc—Ulysses silt loam, 2 to 7 percent slopes

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, lawns, 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 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 "Detailed soil map units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

About 58 percent of the acreage in Rawlins County is cropland. During the period 1967 to 1977, wheat was planted on 41 percent of the cropland, corn on 3 percent, sorghum on 8 percent, and alfalfa, rye, and oats on 4 percent. About 44 percent of the cropland was summer fallowed for dryland wheat. The acreage planted to barley and sorghum decreased during this period, whereas the acreage planted to all other crops increased by a small amount. The total acreage of cropland was about the same as that for the previous 10-year period. Corn is the principal irrigated crop. Other crops are also irrigated but on a minor acreage.

Water erosion is a problem on about 18 percent of the cropland in Rawlins County. Soil blowing and inadequate rainfall are problems on all of the cropland. Keith, Kuma, and Ulysses are the chief soils used for crops in the county.

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

Terraces and diversions reduce the length of slopes and help to control runoff and erosion (fig. 9). They are most practical on the deep, well drained soils that have uniform, regular slopes. Most of the arable soils in the county are examples of such soils.

Contour farming should generally be used in combination with terraces. It is best suited to those soils that have smooth, uniform slopes and can be terraced.

Leaving crop residue on the surface, either by stubble mulching (fig. 10) or by minimum tillage, increases the infiltration rate, reduces the runoff rate, and helps to control erosion and soil blowing. Crop residue is left on the surface of 80 percent of the cropland in the county.

Soil tilth is an important factor in the germination of seeds and the infiltration of water into the soil. Most of the soils used for crops have a silt loam surface layer that is moderate or moderately low in content of organic matter. Generally, the soil structure is weak, and intense rainfall causes the formation of a crust on the surface. Once formed, the crust reduces the infiltration rate and

Figure 9.—Flat channel terraces on Keith silt loam, 0 to 2 percent slopes, after 5 or 6 inches of high intensity rain. Unprotected cropland in this area was severely eroded by this storm.

Figure 10.—Stubble mulch on a field of young wheat on Kuma silt loam, 0 to 1 percent slopes. Leaving stubble on the surface helps to control soil blowing and water erosion.

increases the runoff rate. Regularly adding a large amount of crop residue to the soil or leaving some of the residue on the surface not only helps to control erosion but also improves the soil structure and helps to prevent surface crusting. Minimum tillage not only helps to prevent excessive soil loss in cultivated areas of sloping soils but also improves the tilth of those soils.

Information about the design of erosion control practices is available in the county office of the Soil Conservation Service. The latest information about growing crops can be obtained from the local office of 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.

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 (fig. 11), 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.

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.

Figure 11.—Sunflowers, a new crop in the county, on Bridgeport silt loam, 0 to 2 percent slopes.

The capability classification of each map unit is given in the section "Detailed soil map units."

rangeland

Loren J. Pearson, range conservationist, Soil Conservation Service, helped prepare this section.

About 275,000 acres in Rawlins County, or 40 percent of the total acreage, is native rangeland. Much of the local farm income is derived from the sale of livestock and livestock products. Many areas of rangeland are along Beaver and Sappa Creeks (fig. 12). Also, large areas of the loess soils in the northwestern part of the county are used as rangeland.

On many ranches the native forage is supplemented by sorghum stubble, small grain stubble, and some bromegrass on the bottom land. In winter it is supplemented by corn or sorghum forage, alfalfa, and protein concentrates.

Soils strongly influence the potential natural vegetation within the county. The loamy soils are suitable for the short and mid grasses that commonly grow in the

county. The productivity of the grasses can be maintained or increased by applying management that is effective on specific kinds of soil and range sites.

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 each soil 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. An 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.

Figure 12.—Rangeland along the valley of North Beaver Creek. Campus-Canlon loams, 6 to 30 percent slopes, are in the foreground, and Bridgeport soils are along the valley floor and the stream channel.

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. To achieve this objective, about 50 percent of the seasonal growth should remain at the end of the grazing period. Such management generally results in the optimum production of vegetation, control of undesirable brush species, conservation of water, and control of erosion and soil blowing. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Deferred grazing during the main part of the growing season of key forage plants improves or maintains the condition of a range site. If deferment is a recurring part of a planned grazing system, the key forage plants can produce seed and plant vigor is improved.

Range seeding may be necessary to convert cropland to rangeland or to improve depleted rangeland. Reseeding suitable species increases forage production in depleted areas.

windbreaks and environmental plantings

Keith A. Ticknor, forester, Soil Conservation Service, helped prepare this section.

The only native woodland in Rawlins County is along Beaver and Sappa Creeks. Eastern cottonwood, black willow, and green ash are the main trees along the streams. The trees are not concentrated in tracts large enough to be used for commercial wood products. They are valuable, however, as a source of firewood.

Trees and shrubs are grown as windbreaks or environmental plantings around most of the farmsteads and ranch headquarters in Rawlins County. Siberian elm and eastern redcedar are the most commonly planted trees. Honeylocust, Russian-olive, lilac, tamarisk, black locust, ponderosa pine, osageorange, Russian mulberry, common hackberry, and American plum also have been planted.

Tree planting around farmsteads is a continual need because old trees deteriorate after they pass maturity; because some trees die as a result of storms, insects, or diseases; and because new windbreaks are needed around new farmsteads.

The trees or shrubs selected for windbreaks should be those that are suited to the soils on the site. Matching the proper trees with the kind of soil helps to ensure survival and a maximum rate of growth. Permeability, available water capacity, and fertility are soil characteristics that greatly affect the growth rate.

The lack of an adequate moisture supply limits tree survival in Rawlins County. Proper site preparation prior to planting and control of weeds or other competing plants after planting are the major concerns in establishing and managing windbreaks or environmental plantings. Supplemental watering by drip irrigation or by other methods helps to overcome the moisture deficiencies.

Windbreaks protect livestock, buildings, and yards from wind and snow (fig. 13). 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.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, keep snow from blowing off the fields, and provide food and cover for wildlife.

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. 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.

Opportunities for recreation are somewhat limited in Rawlins County. Many residents travel east or north to the larger reservoirs to camp, boat, and fish. The potential for additional recreational development within the county is good. A good fishing area with camping and picnicking facilities would be used considerably.

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 (fig. 14), 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

Figure 13.—Windbreak on Keith silt loam, 0 to 2 percent slopes.

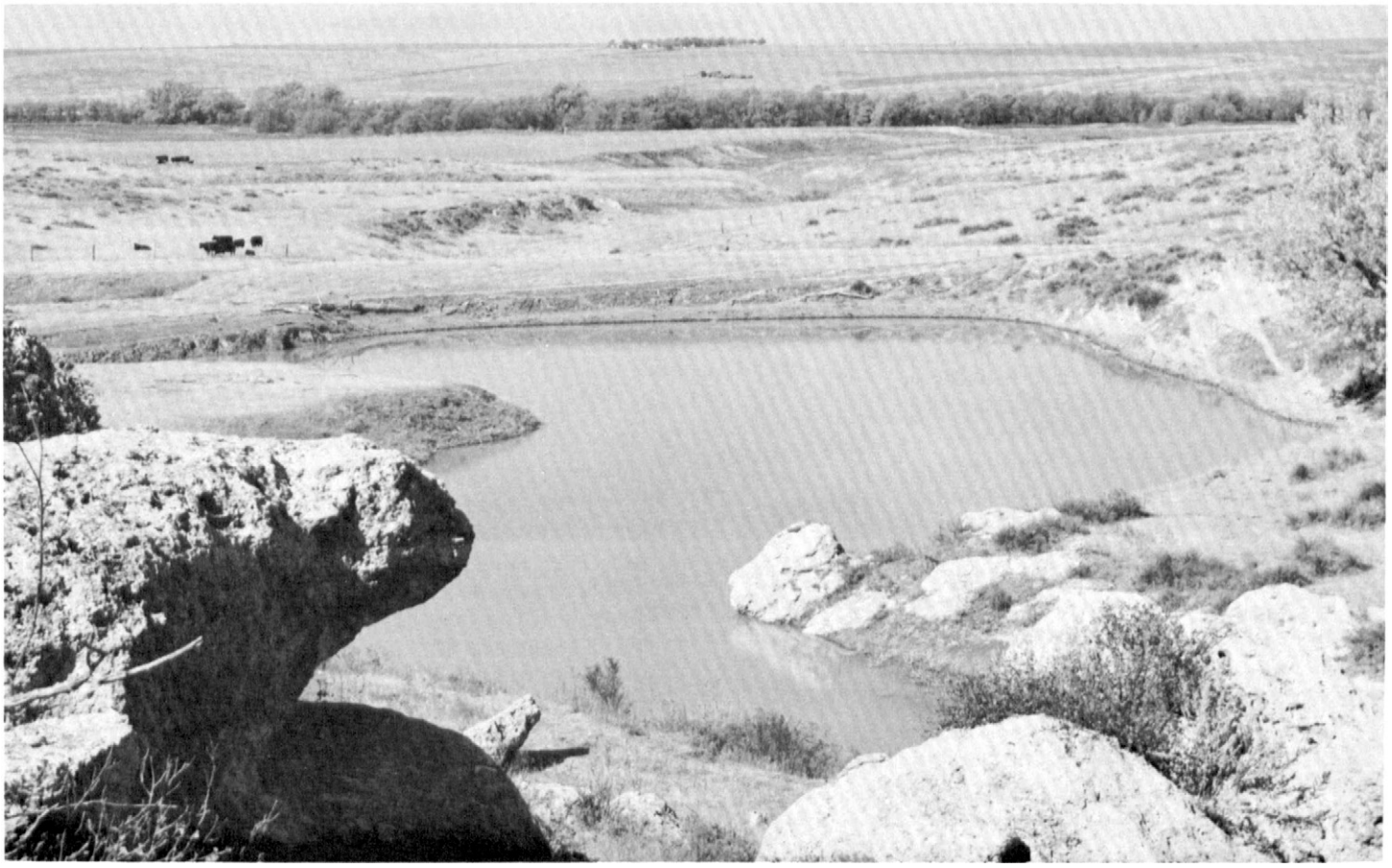

Figure 14.—Stock water pond in an area of Campus-Canlon loams, 6 to 30 percent slopes. The pond provides opportunities for recreation.

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.

Rawlins County provides a suitable habitat for many kinds of wildlife. Because cropland, grassland, and some brushy areas are interspersed, a wide variety of species inhabits the county.

Pheasant hunting is good, and some deer are hunted along the wooded valleys of Beaver and Sappa Creeks. Coyote hunting also is a popular sport for some residents. A few beaver inhabit the upper reaches of Beaver Creek.

Farm ponds and parts of Beaver Creek provide limited fishing. Channel catfish, bullheads, bass, and bluegill are caught in these waters.

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, and 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 bluestems, goldenrod, switchgrass, gamagrasses, ragweed, sunflowers, wheatgrass, and native legumes.

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 golden currant, snowberry, plum, fragrant sumac, prairie rose, and sagebrush.

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, cattails, saltgrass, prairie 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, mourning dove, pheasant, meadowlark, field sparrow, cottontail, and red fox.

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, redwing blackbirds, muskrat, and beaver (fig. 15).

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include pheasants, horned larks, killdeer, badgers, jackrabbits, prairie dogs, meadowlarks, coyotes, lark bunting, and hawks.

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

engineering

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

Figure 15.—Beaver dam on Beaver Creek in an area west of Atwood.

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 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, 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, 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 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, and flooding affect absorption of the effluent. Large stones and bedrock 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, 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 and bedrock 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, 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 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,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. 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 index 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 or alkalinity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable 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. All other soils are rated as an improbable source. 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 degree and kind of soil limitations are given for pond reservoir areas and embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are 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 increase in construction costs, and possibly increased maintenance are required.

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. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. 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 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, 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. 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 affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing 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 affect the construction of grassed waterways. A hazard of soil blowing, 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 index properties

Table 14 gives estimates of the engineering classification and of the range of index 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 their 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 the content of particles coarser than sand is as much as 15 or 20 percent, 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, SM-SC.

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.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

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 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.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 15, the estimated content of organic matter of the plow layer is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

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 and water in swamps and marshes are 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 soft or hard. If the rock is soft 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.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

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.

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 Ustoll (*Ust*, meaning intermittent 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 Argiustolls (*Argi*, meaning argillic horizon, plus *ustoll*, 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 *Aridic* identifies the subgroup that is drier than is typical for the great group. An example is Aridic Argiustolls.

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 Aridic Argiustolls.

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.

soil series and their 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 "Detailed soil map units."

Bridgeport series

The Bridgeport series consists of deep, well drained, moderately permeable soils on terraces and flood plains. These soils formed in calcareous, silty alluvial and colluvial material that is somewhat stratified in texture and color. Slope ranges from 0 to 4 percent.

Bridgeport soils are commonly adjacent to Campus, Canlon, Caruso, and Colby soils. The moderately deep Campus and shallow Canlon soils are on the steeper side slopes. Caruso soils are somewhat poorly drained and are on the lower flood plains. Colby soils are not stratified. They are steeper than the Bridgeport soils and are higher on the landscape.

Typical pedon of Bridgeport silt loam, 0 to 2 percent slopes, 200 feet west and 1,050 feet south of the northeast corner of sec. 22, T. 2 S., R. 32 W.

Ap—0 to 4 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; mildly alkaline; clear smooth boundary.

A12—4 to 11 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable; mildly alkaline; clear smooth boundary.

B2—11 to 19 inches; grayish brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; moderate medium subangular blocky structure; slightly hard, friable; strong effervescence; moderately alkaline; gradual smooth boundary.

B3—19 to 27 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; moderate medium subangular blocky structure; slightly hard, friable; few fine threads of lime; strong effervescence; moderately alkaline; gradual smooth boundary.

C—27 to 60 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; thin darker strata below 40 inches; massive; slightly hard, friable; few fine threads of lime; violent effervescence; moderately alkaline.

The thickness of the solum ranges from 10 to 30 inches. Free carbonates are within a depth of 15 inches. Thin, lighter or darker strata or sandier or more clayey strata are below the dark surface soil.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 to 3. It is mildly alkaline or moderately alkaline. It is dominantly silt loam, but the range includes fine sandy loam, loam, clay loam, and silty clay loam. The B2 horizon has hue of 10YR, value of 5 or 6 (4 or 5 moist), and chroma of 2 or 3. It is silt loam, silty clay loam, or loam. Some pedons do not have a B horizon. The C horizon has hue of 10YR, value of 5 to 7 (4 to 6 moist), and chroma of 2 or 3. It is loam, silt loam, or silty clay loam. Some pedons have contrasting sandy or clayey strata, mottles, or a buried soil, or a combination of these, below a depth of 40 inches.

Campus series

The Campus series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in loamy residuum of lime-cemented sandstone or caliche. Slope ranges from 6 to 10 percent.

Campus soils are similar to Canlon soils and are commonly adjacent to Bridgeport, Canlon, Colby, and Ulysses soils. The shallow Canlon soils typically are steeper than the Campus soils. The deep, silty Bridgeport soils are on terraces and flood plains. The deep, silty Colby and Ulysses soils are generally higher on the landscape than the Campus soils.

Typical pedon of Campus loam, in an area of Campus-Canlon loams, 6 to 30 percent slopes, 1,200 feet west and 600 feet north of the southeast corner of sec. 19, T. 4 S., R. 34 W.

A1—0 to 8 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable; many fine roots; about 2 percent fine fragments of caliche; strong effervescence; moderately alkaline; gradual smooth boundary.

B2—8 to 14 inches; light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; moderate fine subangular blocky structure; slightly hard, friable; many fine roots; many worm casts; about 4 percent fine fragments of caliche; strong effervescence; moderately alkaline; gradual smooth boundary.

C1ca—14 to 24 inches; very pale brown (10YR 7/3) loam, brown (10YR 5/3) moist; massive; slightly hard, friable; few fine roots; few worm casts; about 5 percent fine fragments of caliche; violent effervescence; moderately alkaline; gradual wavy boundary.

R—24 inches; white hard caliche.

The thickness of the solum ranges from 12 to 20 inches. The depth to partly consolidated bedrock ranges from 20 to 40 inches. The depth to free carbonates is less than 7 inches and to the calcic horizon less than 24 inches.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 to 3. It is mildly alkaline or moderately alkaline. It is dominantly loam, but the range includes sandy loam. The B2 horizon has hue of 10YR, value of 5 to 7 (3 to 5 moist), and chroma of 2 or 3. It is loam or clay loam. The C horizon has hue of 10YR, value of 6 to 8 (5 to 7 moist), and chroma of 2 or 3. It is loam or clay loam. In the lower part of this horizon, the content of calcium carbonate is 25 to 40 percent.

Canlon series

The Canlon series consists of shallow, somewhat excessively drained, moderately permeable soils on uplands along drainageways. These soils formed in loamy residuum of lime-cemented sandstone or caliche. Slope ranges from 6 to 30 percent.

Canlon soils are similar to Campus soils and are commonly adjacent to Bridgeport, Campus, Colby, and Ulysses soils. The moderately deep Campus soils are less sloping than the Canlon soils. The deep, silty Bridgeport soils are on terraces and flood plains. The deep, silty Colby and Ulysses soils are higher on the landscape than the Canlon soils.

Typical pedon of Canlon loam, in an area of Campus-Canlon loams, 6 to 30 percent slopes, 1,050 feet south and 520 feet east of the northwest corner of sec. 35, T. 4 S., R. 35 W.

A1—0 to 5 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; soft, friable; few worm casts; about 5 percent small caliche fragments; many fine roots; violent effervescence; moderately alkaline; clear smooth boundary.

C—5 to 11 inches; light brownish gray (10YR 6/2) loam, brown (10YR 5/3) moist; weak medium subangular blocky structure; soft, friable; few worm casts; about 20 percent small caliche fragments; few fine roots; violent effervescence; moderately alkaline; clear smooth boundary.

R—11 inches; white hard caliche.

The thickness of the solum ranges from 3 to 12 inches. The depth to hard caliche ranges from 10 to 20 inches. The A1 horizon has varying amounts of coarse sand, gravel, and gravel-size pieces of broken caliche.

The A horizon has hue of 7.5YR or 10YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 or 3. It is dominantly loam, but the range includes silt loam and fine sandy loam. The C horizon has hue of 10YR, value of 6 to 8 (5 to 7 moist), and chroma of 2 or 3. It is loam, silt loam, or fine sandy loam.

Caruso series

The Caruso series consists of deep, somewhat poorly drained, moderately permeable soils on flood plains. These soils formed in somewhat stratified loamy alluvium. Slope ranges from 0 to 2 percent.

Caruso soils are commonly adjacent to Bridgeport soils. These well drained adjacent soils are slightly higher on the flood plains than the Caruso soils or are on terraces.

Typical pedon of Caruso silt loam, 500 feet north and 700 feet west of the southeast corner of sec. 28, T. 3 S., R. 34 W.

Ap—0 to 9 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate very fine granular structure; slightly hard, friable; many fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

A12—9 to 14 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate very fine granular structure; hard, friable; many fine roots; strong effervescence; moderately alkaline; gradual smooth boundary.

C1—14 to 32 inches; light gray (10YR 7/2) loam, grayish brown (10YR 5/2) moist; moderate very fine granular structure; hard, friable; few fine roots; few worm casts; strong effervescence; moderately alkaline; gradual smooth boundary.

C2—32 to 45 inches; light gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) moist; common fine distinct brown (10YR 4/3) mottles; weak fine subangular blocky structure; hard, friable; few fine roots; many worm casts; strong effervescence; moderately alkaline; gradual smooth boundary.

C3—45 to 60 inches; light gray (10YR 7/1) clay loam, gray (10YR 5/1) moist; many coarse distinct pale brown (10YR 6/3) mottles; massive; hard, friable; many fine pores; strong effervescence; moderately alkaline; common films of calcium carbonate on peds and in pores.

The thickness of the solum and that of the mollic epipedon range from 7 to 20 inches. Free carbonates are within a depth of 10 inches. The soils are mildly alkaline or moderately alkaline 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 loam, sandy loam, and silty clay loam. The C horizon has hue of 7.5YR or 10YR, value of 5 to 7 (3 to 5 moist), and chroma of 1 to 3. It is loam, silt loam, or clay loam. It has thin strata that have a higher or lower value and that are more sandy or more clayey. The lower part of this horizon is commonly mottled with colors of higher chroma and lower value. Contrasting sandy or clayey strata are below a depth of 40 inches in some pedons.

Colby series

The Colby series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in calcareous, silty loess. Slope ranges from 10 to 50 percent.

Colby soils are commonly adjacent to Campus, Canlon, Keith, and Ulysses soils. Campus and Canlon soils generally are lower on the landscape than the Colby soils. Campus soils are moderately deep over hard caliche and have a higher content of carbonates than the Colby soils. Canlon soils are shallow over hard caliche. Keith and Ulysses soils have a mollic epipedon. They are less sloping than the Colby soils and generally are higher on the landscape. Also, Keith soils have an argillic horizon.

Typical pedon of Colby silt loam, 10 to 25 percent slopes, 2,460 feet east and 225 feet north of the southwest corner of sec. 30, T. 2 S., R. 33 W.

A1—0 to 6 inches; grayish brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; moderate fine granular structure; slightly hard, friable; few worm casts; many fine roots; strong effervescence; moderately alkaline; gradual smooth boundary.

AC—6 to 12 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; moderate fine subangular blocky structure; slightly hard, friable; many worm casts; few fine roots; strong effervescence; moderately alkaline; gradual smooth boundary.

C1ca—12 to 20 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; weak fine subangular blocky structure; slightly hard, friable; many worm

casts; few fine roots; violent effervescence; few soft carbonate accumulations; moderately alkaline; gradual smooth boundary.

C2—20 to 60 inches; very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) moist; massive; soft, friable; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 3 to 12 inches. Typically, free carbonates are at the surface, but in some pedons the upper 6 inches has no carbonates.

The A horizon has hue of 10YR, value of 5 to 7 (3 to 5 moist), and chroma of 2 or 3. In pedons where it has value of less than 5.5 when dry and less than 3.5 moist, it is less than 4 inches thick. It is dominantly silt loam, but the range includes loam. The AC and C horizons have hue of 10YR or 7.5YR, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. They are silt loam or loam. Visible accumulations of carbonate occur in the Cca horizon as films or soft masses.

Keith series

The Keith series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in calcareous, silty loess. Slope ranges from 0 to 2 percent.

Keith soils are similar to Kuma and Ulysses soils and are commonly adjacent to Colby, Kuma, Pleasant, and Ulysses soils. Kuma soils have a mollic epipedon that is more than 20 inches thick. They are on broad upland ridgetops. Ulysses soils are steeper than the Keith soils and generally are lower on the landscape. They do not have an argillic horizon. Their solum is thinner than that of the Keith soils. Colby soils do not have an argillic horizon or a mollic epipedon. They are steeper than the Keith soils and generally are lower on the landscape. Pleasant soils have a clayey subsoil. They are in shallow depressions.

Typical pedon of Keith silt loam, 0 to 2 percent slopes, 265 feet west and 1,850 feet north of the southeast corner of sec. 22, T. 4 S., R. 34 W.

Ap—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; few fine roots; neutral; clear smooth boundary.

A12—6 to 10 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; strong fine granular structure; slightly hard, friable; few fine roots; many worm casts; neutral; gradual smooth boundary.

B21t—10 to 18 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate very fine subangular blocky structure; slightly hard, friable; few fine roots; many worm casts; mildly alkaline; gradual smooth boundary.

B22t—18 to 27 inches; light brownish gray (10YR 6/2) silt loam, grayish brown (10YR 5/2) moist; moderate fine subangular blocky structure; slightly hard, friable; few fine roots; few worm casts; strong effervescence; mildly alkaline; gradual smooth boundary.

B3ca—27 to 36 inches; light brownish gray (10YR 6/2) silt loam, grayish brown (10YR 5/2) moist; weak fine subangular blocky structure; slightly hard, friable; few fine roots; few fine soft carbonate accumulations; violent effervescence; moderately alkaline; gradual smooth boundary.

C1—36 to 60 inches; very pale brown (10YR 8/3) silt loam, pale brown (10YR 6/3) moist; massive; soft, very friable; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 16 to 36 inches. The thickness of the mollic epipedon ranges from 8 to 20 inches. The depth to free carbonates averages about 20 inches but ranges from 14 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 slightly acid to mildly alkaline. The B2t 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 is silt loam or silty clay loam in which the content of clay is less than 33 percent. It is neutral or mildly alkaline. The C horizon has hue of 10YR, value of 6 to 8 (5 or 6 moist), and chroma of 2 or 3. It is mildly alkaline or moderately alkaline.

Kuma series

The Kuma series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in calcareous, silty loess. Slope is 0 to 1 percent.

Kuma soils are similar to Keith and Ulysses soils and are commonly adjacent to Colby, Keith, Pleasant, and Ulysses soils. Generally, Keith, Ulysses, and Colby soils are more sloping than the Kuma soils and are lower on the landscape. Keith soils have a mollic epipedon that is less than 20 inches thick. Ulysses soils do not have an argillic horizon. Their solum is thinner than that of the Kuma soils. Colby soils do not have a mollic epipedon or an argillic horizon. Pleasant soils have a clayey subsoil. They are in shallow depressions.

Typical pedon of Kuma silt loam, 0 to 1 percent slopes, 1,580 feet north and 790 feet east of the southwest corner of sec. 14, T. 2 S., R. 36 W.

Ap—0 to 5 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, friable; many fine roots; neutral; abrupt smooth boundary.

A12—5 to 10 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; soft, friable; many fine roots; neutral; clear smooth boundary.

B2t—10 to 27 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2)

moist; strong fine subangular blocky structure; slightly hard, friable; few fine roots; neutral; clear smooth boundary.

B3—27 to 34 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; slightly hard, friable; few fine roots; moderately alkaline; abrupt smooth boundary.

Acab—34 to 47 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; moderate medium prismatic structure parting to moderate fine subangular blocky; slightly hard, friable; few fine roots; thin patchy films of lime on faces of peds and threads of lime in pores; strong effervescence; moderately alkaline; clear smooth boundary.

Cca—47 to 60 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; massive; slightly hard, friable; few fine roots; few patchy threads and films of lime that decrease in number with increasing depth; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 30 to 60 inches. The thickness of the mollic epipedon ranges from 20 to 48 inches. The depth to free carbonates ranges from 14 to 35 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 neutral or mildly alkaline. The B2t horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 2 or 3. It is silt loam or silty clay loam. The Acab horizon has hue of 10YR or 7.5YR, value of 4 to 6 (2 to 4 moist), and chroma of 1 to 3. It has a slightly lower value or chroma than the overlying horizon and generally has visible secondary carbonates. The Cca horizon has hue of 10YR or 7.5YR, value of 5 to 7 (3 to 5 moist), and chroma of 2 or 3.

Pleasant series

The Pleasant series consists of deep, moderately well drained, very slowly permeable soils formed in silty and clayey alluvium that washed in from the adjacent uplands. These soils are in small depressions in the uplands. These depressions are a few inches to several feet below the surrounding soils. Slope is 0 to 1 percent.

Pleasant soils are commonly adjacent to Keith, Kuma, and Ulysses soils. These well drained, moderately permeable adjacent soils are in the slightly higher areas on uplands.

Typical pedon of Pleasant silty clay loam, 400 feet north and 660 feet west of the southeast corner of sec. 3, T. 2 S., R. 36 W.

Ap—0 to 4 inches; gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) moist; moderate medium granular structure; slightly hard, friable; few fine roots; slightly acid; clear smooth boundary.

A12—4 to 8 inches; gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) moist; moderate fine granular structure; hard, friable; few fine roots; slightly acid; clear smooth boundary.

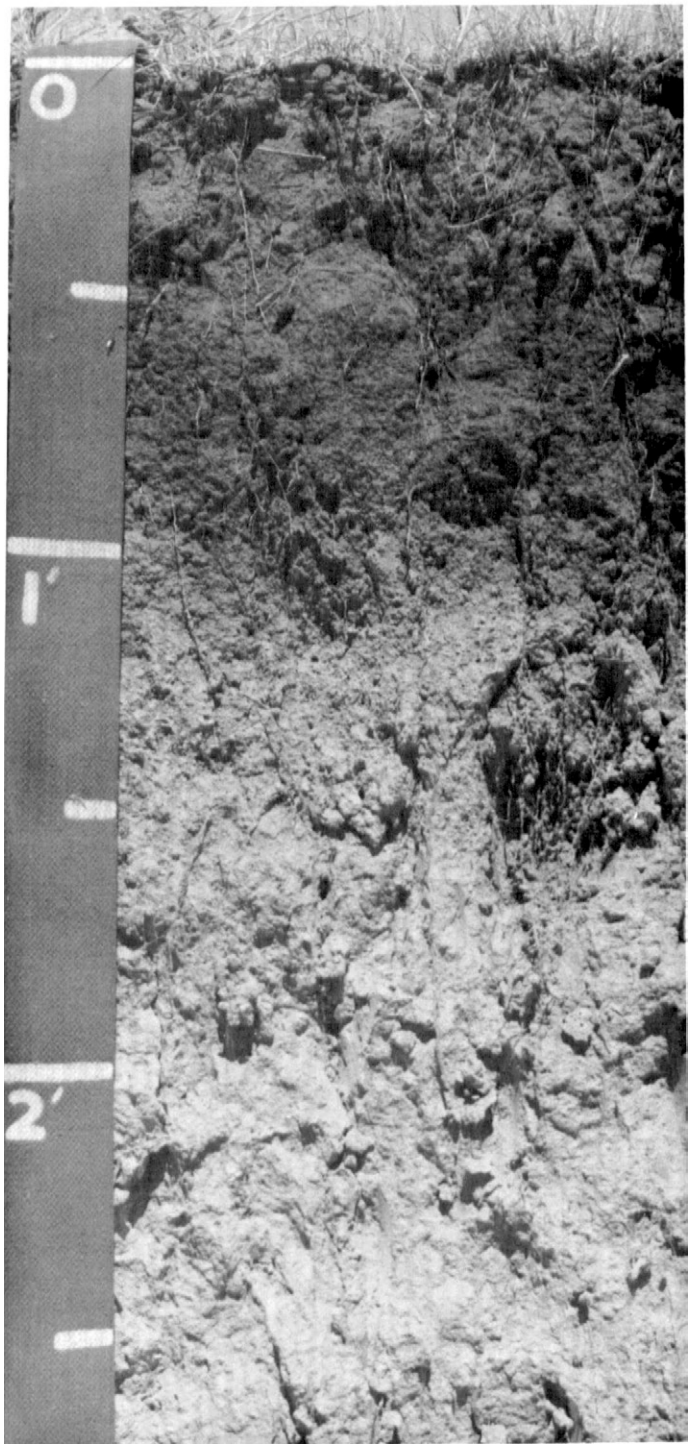

Figure 16.—Profile of Ulysses silt loam, 2 to 7 percent slopes. The dark surface layer is about 10 inches thick.

B21t—8 to 29 inches; gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) moist; strong fine and medium subangular blocky structure; very hard, firm; mildly alkaline; gradual smooth boundary.

B22t—29 to 45 inches; grayish brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) moist; strong fine and medium subangular blocky structure; very hard, firm; mildly alkaline; gradual smooth boundary.

B3—45 to 60 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; moderate medium subangular blocky structure; hard, friable; mildly alkaline.

The thickness of the solum ranges from 50 to more than 60 inches. The thickness of the mollic epipedon ranges from 20 to 50 inches. The depth to free carbonates is more than 50 inches.

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 silty clay loam, but the range includes silt loam. The B2t horizon has hue of 10YR, value of 4 to 7 (2 to 6 moist), and chroma of 1 to 3. It is silty clay loam, silty clay, or clay. Some pedons have buried horizons in the lower part of the solum and below the solum.

Ulysses series

The Ulysses series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in calcareous, silty loess. Slope ranges from 2 to 7 percent.

Ulysses soils are similar to Keith and Kuma soils and are commonly adjacent to Colby, Keith, Kuma, and Pleasant soils. Keith and Kuma soils have an argillic horizon. They are nearly level and are generally higher on the landscape than the Ulysses soils. Colby soils do not have a mollic epipedon. They are steeper than the Ulysses soils and generally are lower on the landscape. Pleasant soils have a clayey subsoil. They are in shallow depressions.

Typical pedon of Ulysses silt loam, 2 to 7 percent slopes, 2,350 feet south and 2,350 feet west of the northeast corner of sec. 20, T. 3 S., R. 33 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; neutral; abrupt smooth boundary.

A12—6 to 9 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, friable; neutral; gradual smooth boundary.

B2—9 to 17 inches; grayish brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; moderate medium granular structure; slightly hard, friable; many worm casts; slight effervescence; mildly alkaline; gradual smooth boundary.

C—17 to 60 inches; light gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) moist; massive; soft, very friable; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 10 to 24 inches. The depth to free carbonates ranges from 7 to 15 inches. The thickness of the mollic epipedon ranges from 7 to 20 inches (fig. 16).

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), chroma of 2 or 3. It is neutral or mildly alkaline. It is dominantly silt loam, but the range includes silty clay loam. The B horizon has hue of 10YR, value of 4 to 6 (3 or 4 moist), and chroma of 2 or 3. It is silt loam or silty clay loam. It is mildly alkaline or moderately alkaline. The C horizon has hue of 10YR, value of 5 to 7 (4 to 6 moist), and chroma of 2 or 3. It is silt loam or silty clay loam.

formation of the soils

This section explains how soils form and describes the effects of the factors of soil formation on the soils in Rawlins County.

Soil forms through processes that act on deposited or accumulated geologic material. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material; the climate during and after the accumulation of the soil material; the plant and animal life on and in the soil; the relief; and the length of time that the forces of soil formation have acted on the soil material.

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

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

parent material

Parent material is the unconsolidated material in which a soil forms. It mainly determines the chemical and mineralogical composition of the soil and the rate of soil formation. The parent materials of the soils in Rawlins County are loess, plains outwash of the Ogallala Formation, alluvium, and colluvium.

Soils that formed in loess are the most extensive soils in the county. These are the Colby, Keith, Kuma, and Ulysses soils. The loess is porous, calcareous silt loam that is more than 50 percent silt and less than 15 percent fine sand or coarser sand. It is many feet thick throughout most of the county (fig. 17).

Campus and Canlon soils formed in plains outwash. These are loamy soils that are more than 15 percent fine sand or coarser sand.

Bridgeport and Caruso soils formed in alluvium or colluvium, which was deposited by water on terraces and flood plains. They are deep and loamy and have weakly expressed profiles. Bridgeport soils are well drained and Caruso soils somewhat poorly drained. In many places these soils are underlain by sand and gravel.

Figure 17.—Road cut through deep loess in an area south of Atwood.

climate

Climate is an active factor of soil formation. It directly affects the formation of a soil by weathering the parent material. It indirectly affects formation through its effect on plants and animals.

The climate of Rawlins County is continental. It is characterized by intermittent dry and moist periods, which can last for less than a year or for 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 Keith soils is an indication of this excess moisture. As a result of the wetting and drying, some of the basic nutrients, and even clay particles, have been leached from the upper horizons of some soils.

plant and animal life

Plant and animal life is an important factor of soil formation. Plants generally affect the content of nutrients and organic matter in the soil and the color of the surface layer. Earthworms, cicadas, and burrowing animals help to keep the soil open and porous. Earthworms in Keith soils have left many worm casts. Bacteria and fungi help to decompose plants, thus releasing more nutrients for plant food.

The mid and tall prairie grasses have had the greatest effect on soil formation in Rawlins 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 next 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 high in content of carbonates.

relief

Relief affects the formation of soils through its effect on drainage, runoff, plant cover, and soil temperature. The temperature of the soil, for example, is slightly lower on the east- and north-facing slopes than on west- and south-facing slopes. Although climate and plants are the most active factors in the formation of soils, relief also is important, mainly because it controls the movement of water on the surface and into the soil.

On the sloping or steep soils in the uplands, the runoff rate is higher than that in the less sloping areas. As a result, geologic erosion is more extensive. Relief has retarded the formation of Campus and Canlon soils, which formed in the oldest parent material in the county. Runoff is rapid on these stongly sloping to steep soils, and the soil material is removed at about the same rate as it forms.

Runoff is slow or medium on the nearly level and gently sloping Bridgeport soils on stream terraces. Most of the precipitation received penetrates the surface. As a result, these soils have well defined horizons, even though they formed in the younger parent material in the county.

time

As water moves through the soil, soluble matter and fine particles gradually are leached from the surface layer to the subsoil. The amount of leaching depends on the amount of time that has elapsed and the amount of water that penetrates the soil. Differences in the length of time that the parent material has been exposed to the processes of soil formation are reflected in the degree of profile development. For example, the young Caruso soils, which formed in recent alluvium, show very little evidence of horizon development other than a slight darkening of the surface layer. In contrast, the older Pleasant soils, which have been exposed to soil-forming processes for thousands of years, have well defined horizons.

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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.

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.

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

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

Caliche. A more or less cemented deposit of calcium carbonate in soils of warm-temperate, subhumid to arid areas. Caliche occurs as soft, thin layers in the soil or as hard, thick beds just beneath the solum, or it is exposed at the surface by erosion.

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.

Catsteps. Very small, irregular terraces on steep hillsides, especially in pasture, formed by the trampling of cattle or the slippage of saturated soil.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard, compact layers to depths below normal plow depth.

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.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15.2 to 38.1 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

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

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.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. Postponing grazing or resting grazing land 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 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.
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.

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

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.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

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.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, and clay.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 37.5 centimeters) long.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Forb. Any herbaceous plant not a grass or a sedge.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

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.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

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.

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

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.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

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 capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

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.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of 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.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

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.

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.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

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).

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

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

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.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

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.

Percolation. The downward movement of water through 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 downward 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, 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.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

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

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

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

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock.

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.

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 ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

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.

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.

Slope (in tables). Slope is great enough that special practices are required to insure satisfactory performance of the soil for a specific use.

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.

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 soil blowing 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).

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 water soaks into the soil or flows slowly to a prepared outlet.

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 loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

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.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

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.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial melt water. In nonglaciated regions, alluvium deposited by heavily loaded 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. Constrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-76 at Atwood, Kansas]

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----	42.9	14.5	28.7	72	-16	.46	.10	.73	1	5.8
February---	48.6	19.5	34.1	78	-10	.58	.02	1.08	2	5.3
March------	54.4	24.8	39.6	86	-2	1.27	.29	2.43	3	9.4
April------	66.6	36.1	51.4	90	15	1.84	.77	2.67	4	2.4
May--------	75.9	46.8	61.4	98	28	3.07	1.69	4.06	6	.3
June-------	86.5	56.7	71.6	105	39	3.39	1.59	4.99	6	.0
July-------	91.9	62.2	77.1	107	49	3.06	1.80	4.11	5	.0
August-----	90.9	60.2	75.6	105	44	2.16	1.18	3.22	4	.0
September--	81.6	49.8	65.7	102	30	2.13	.50	2.65	4	.0
October----	70.8	36.7	53.8	93	18	1.25	.38	2.01	2	1.0
November---	54.1	24.6	39.4	78	-3	.75	.11	1.26	2	4.2
December---	44.5	17.4	31.0	72	-13	.53	.07	.88	2	5.8
Year-----	67.4	37.4	52.5	107	-16	20.49	15.57	25.12	41	34.2

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1931-60 at Atwood, Kansas]

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 26	May 8	May 24
2 years in 10 later than--	April 21	May 3	May 19
5 years in 10 later than--	April 12	April 23	May 9
First freezing temperature in fall:			
1 year in 10 earlier than--	October 10	September 30	September 21
2 years in 10 earlier than--	October 14	October 5	September 25
5 years in 10 earlier than--	October 24	October 14	October 5

TABLE 3.--GROWING SEASON

[Recorded in the period 1931-60 at Atwood, Kansas]

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	169	153	128
8 years in 10	178	160	136
5 years in 10	195	174	149
2 years in 10	211	188	163
1 year in 10	220	195	170

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Ba	Bridgeport silt loam, 0 to 2 percent slopes	12,500	1.8
Bb	Bridgeport silt loam, 2 to 4 percent slopes	7,700	1.1
Bf	Bridgeport silt loam, flooded	14,500	2.1
Cc	Campus-Canlon loams, 6 to 30 percent slopes	29,000	4.2
Cd	Caruso silt loam	4,220	0.6
Co	Colby silt loam, 10 to 25 percent slopes	187,344	27.2
Cy	Colby silt loam, 25 to 50 percent slopes	7,700	1.1
Ke	Keith silt loam, 0 to 2 percent slopes	259,000	37.6
Ku	Kuma silt loam, 0 to 1 percent slopes	92,500	13.4
Pe	Pleasant silty clay loam	700	0.1
Uc	Ulysses silt loam, 2 to 7 percent slopes	74,500	10.8
	Water	256	*
	Total	689,920	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. Absence of a yield 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	Winter wheat		Grain sorghum		Corn		Alfalfa hay	
	N	I	N	I	N	I	N	I
	Bu	Bu	Bu	Bu	Bu	Bu	Ton	Ton
Ba---------- Bridgeport	33	55	48	115	---	130	3.0	6.5
Bb---------- Bridgeport	30	50	42	105	---	120	3.0	6.5
Bf---------- Bridgeport	28	55	40	115	---	130	3.5	6.5
Cc---------- Campus-Canlon	---	---	---	---	---	---	---	---
Cd---------- Caruso	26	40	40	110	---	120	3.0	5.0
Co, Cy---------- Colby	---	---	---	---	---	---	---	---
Ke---------- Keith	35	55	48	120	---	135	---	6.5
Ku---------- Kuma	36	55	50	120	---	135	---	6.5
Pe---------- Pleasant	27	35	36	90	---	100	---	4.0
Uc---------- Ulysses	27	45	38	100	---	110	---	5.5

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Ba, Bb, Bf---------- Bridgeport	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
				Maximilian sunflower----------	5
Cc*:					
Campus----------	Limy Upland----------	Favorable	2,400	Little bluestem----------	30
		Normal	1,800	Sideoats grama----------	20
		Unfavorable	1,000	Big bluestem----------	10
				Switchgrass----------	5
				Blue grama----------	5
				Western wheatgrass----------	5
Canlon----------	Shallow Limy----------	Favorable	2,400	Little bluestem----------	25
		Normal	1,600	Sideoats grama----------	20
		Unfavorable	900	Big bluestem----------	10
				Switchgrass----------	5
				Hairy grama----------	5
				Plains muhly----------	5
				Blue grama----------	5
Cd---------- Caruso	Subirrigated----------	Favorable	7,500	Big bluestem----------	40
		Normal	6,500	Switchgrass----------	15
		Unfavorable	5,000	Prairie cordgrass----------	5
				Indiangrass----------	5
				Western wheatgrass----------	5
				Sedge----------	5
				Little bluestem----------	5
Co---------- Colby	Limy Upland----------	Favorable	2,400	Little bluestem----------	30
		Normal	1,800	Sideoats grama----------	15
		Unfavorable	1,000	Blue grama----------	10
				Western wheatgrass----------	10
				Tall dropseed----------	5
				Small soapweed----------	5
				Big bluestem----------	5
Cy---------- Colby	Loess Breaks----------	Favorable	2,400	Little bluestem----------	30
		Normal	1,800	Sideoats grama----------	15
		Unfavorable	1,000	Blue grama----------	10
				Western wheatgrass----------	10
				Tall dropseed----------	5
				Small soapweed----------	5
				Big bluestem----------	5
Ke---------- Keith	Loamy Upland----------	Favorable	2,400	Blue grama----------	25
		Normal	1,900	Western wheatgrass----------	15
		Unfavorable	1,300	Sideoats grama----------	10
				Little bluestem----------	10
				Buffalograss----------	10
				Big bluestem----------	10
Ku---------- Kuma	Loamy Upland----------	Favorable	2,400	Blue grama----------	25
		Normal	1,800	Western wheatgrass----------	15
		Unfavorable	1,000	Sideoats grama----------	10
				Little bluestem----------	10
				Buffalograss----------	10
				Big bluestem----------	10
				Small soapweed----------	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
Pe---------- Pleasant	Clay Upland----------	Favorable	2,400	Western wheatgrass----------	70
		Normal	1,800	Blue grama----------	10
		Unfavorable	1,000	Buffalograss----------	5
				Inland saltgrass----------	5
				Sedge----------	5
Uc---------- Ulysses	Loamy Upland----------	Favorable	2,400	Blue grama----------	25
		Normal	1,800	Western wheatgrass----------	15
		Unfavorable	1,000	Sideoats grama----------	10
				Little bluestem----------	10
				Buffalograss----------	10
				Big bluestem----------	10
				Small soapweed----------	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
Ba, Bb, Bf: Bridgeport	Lilac, American plum.	Amur honeysuckle	Eastern redcedar, ponderosa pine, Russian-olive, Russian mulberry, common hackberry, green ash.	Honeylocust, Austrian pine.	Siberian elm, eastern cottonwood.
Cc*:					
Campus	Skunkbush sumac, Siberian peashrub.	Rocky Mountain juniper, eastern redcedar, Russian-olive.	Ponderosa pine, honeylocust, eastern redcedar, Russian mulberry, Austrian pine, green ash.	Siberian elm	---
Canlon.					
Cd: Caruso	American plum	Common chokecherry, redosier dogwood.	Eastern redcedar, green ash, Austrian pine, Russian mulberry, common hackberry.	Honeylocust, golden willow.	Siberian elm, eastern cottonwood.
Co, Cy: Colby	Siberian peashrub, skunkbush sumac.	Russian-olive	Ponderosa pine, eastern redcedar, Rocky Mountain juniper, Russian mulberry, honeylocust, Austrian pine, green ash.	Siberian elm	---
Ke: Keith	Skunkbush sumac, lilac, Amur honeysuckle.	Common chokecherry, Russian-olive.	Eastern redcedar, ponderosa pine, green ash, honeylocust.	Siberian elm	---
Ku: Kuma	Skunkbush sumac, lilac, Amur honeysuckle.	Common chokecherry, Russian-olive.	Eastern redcedar, ponderosa pine, green ash, honeylocust.	Siberian elm	---
Pe: Pleasant	Skunkbush sumac, lilac.	Rocky Mountain juniper, eastern redcedar, silver buffaloberry.	Ponderosa pine, Russian-olive, green ash, honeylocust.	Siberian elm	---
Uc: Ulysses	Skunkbush sumac, lilac, Amur honeysuckle.	Common chokecherry, Russian-olive.	Eastern redcedar, ponderosa pine, green ash, honeylocust.	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
Ba: Bridgeport	Severe: floods.	Slight	Slight	Slight.
Bb: Bridgeport	Severe: floods.	Slight	Moderate: slope.	Slight.
Bf: Bridgeport	Severe: floods.	Slight	Moderate: floods.	Slight.
Cc*:				
Campus	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Canlon	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock, small stones.	Moderate: slope.
Cd: Caruso	Severe: floods.	Moderate: wetness.	Moderate: wetness, floods.	Slight.
Co, Cy: Colby	Severe: slope.	Severe: slope.	Severe: slope.	Severe: erodes easily.
Ke: Keith	Moderate: dusty.	Moderate: dusty.	Moderate: dusty.	Moderate: dusty.
Ku: Kuma	Slight	Slight	Slight	Slight.
Pe: Pleasant	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
Uc: Ulysses	Moderate: dusty.	Moderate: dusty.	Moderate: slope, dusty.	Moderate: dusty.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT POTENTIALS

[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	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
Ba---------- Bridgeport	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
Bb---------- Bridgeport	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Bf---------- Bridgeport	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
Cc*:									
Campus----------	Poor	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Fair.
Canlon----------	Very poor	Poor	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
Cd---------- Caruso	Fair	Fair	Good	Fair	Fair	Fair	Fair	Fair	Fair.
Co, Cy---------- Colby	Poor	Fair	Fair	Poor	Very poor	Very poor	Fair	Very poor	Poor.
Ke---------- Keith	Good	Good	Fair	Good	Very poor	Very poor	Good	Very poor	Good.
Ku---------- Kuma	Good	Good	Fair	Poor	Poor	Very poor	Fair	Very poor	Poor.
Pe---------- Pleasant	Fair	Fair	Fair	Fair	Poor	Very poor	Fair	Very poor	Fair.
Uc---------- Ulysses	Fair	Good	Fair	Poor	Poor	Poor	Fair	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
Ba, Bb: Bridgeport	Slight	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength.
Bf: Bridgeport	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength, floods.
Cc*:					
Campus	Severe: depth to rock.	Moderate: depth to rock, slope.	Severe: depth to rock.	Severe: slope.	Moderate: depth to rock, low strength, slope.
Canlon	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.
Cd: Caruso	Severe: wetness.	Severe: floods.	Severe: floods, wetness.	Severe: floods.	Severe: low strength, floods.
Co, Cy: Colby	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
Ke: Keith	Slight	Moderate: shrink-swell.	Slight	Moderate: shrink-swell.	Severe: low strength.
Ku: Kuma	Slight	Slight	Slight	Slight	Severe: low strength.
Pe: Pleasant	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell, low strength.
Uc: Ulysses	Slight	Moderate: shrink-swell.	Slight	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
Ba---------- Bridgeport	Moderate: floods.	Moderate: seepage.	Moderate: floods, too clayey.	Moderate: floods.	Fair: too clayey.
Bb---------- Bridgeport	Moderate: floods.	Moderate: seepage, slope.	Moderate: floods, too clayey.	Moderate: floods.	Fair: too clayey.
Bf---------- Bridgeport	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Fair: too clayey.
Cc*:					
Campus----------	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Canlon----------	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Poor: area reclaim, slope.
Cd---------- Caruso	Severe: floods, wetness, percs slowly.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Fair: too clayey, wetness.
Co, Cy---------- Colby	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Ke---------- Keith	Slight----------	Moderate: seepage.	Slight----------	Slight----------	Good.
Ku---------- Kuma	Slight----------	Moderate: seepage.	Slight----------	Slight----------	Good.
Pe---------- Pleasant	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
Uc---------- Ulysses	Slight----------	Moderate: seepage, slope.	Slight----------	Slight----------	Good.

* 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," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Ba, Bb, Bf: Bridgeport	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Cc*:				
Campus	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim.
Canlon	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, slope, small stones.
Cd: Caruso	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Co, Cy: Colby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Ke: Keith	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Ku: Kuma	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Pe: Pleasant	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
Uc: Ulysses	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.

* 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. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Ba---------- Bridgeport	Moderate: seepage.	Moderate: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
Bb---------- Bridgeport	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
Bf---------- Bridgeport	Moderate: seepage.	Moderate: piping.	Deep to water	Floods---------	Erodes easily	Erodes easily.
Cc*:						
Campus----------	Severe: slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Depth to rock, slope.	Slope, depth to rock.
Canlon----------	Severe: depth to rock, slope.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Depth to rock, slope.	Slope, depth to rock.
Cd---------- Caruso	Moderate: seepage.	Severe: piping.	Floods---------	Wetness, floods.	Wetness--------	Favorable.
Co, Cy---------- Colby	Severe: slope.	Severe: piping.	Deep to water	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
Ke---------- Keith	Moderate: seepage.	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
Ku---------- Kuma	Moderate: seepage.	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
Pe---------- Pleasant	Moderate: seepage.	Severe: hard to pack, ponding.	Percs slowly, ponding.	Percs slowly, ponding.	Percs slowly, ponding.	Percs slowly.
Uc---------- Ulysses	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

[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: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
Ba, Bb, Bf------- Bridgeport	0-19	Silt loam--------	CL	A-4, A-6	0	100	100	95-100	75-100	25-40	8-20
	19-60	Silt loam, silty clay loam, loam.	CL	A-4, A-6	0	100	100	95-100	85-100	25-40	8-20
Cc*:											
Campus----------	0-8	Loam----------	ML, CL	A-6, A-7, A-4	0	100	100	85-100	60-90	30-45	7-20
	8-14	Loam, clay loam	CL, ML	A-6, A-7, A-4	0	100	100	75-95	50-80	33-45	8-20
	14-24	Loam, clay loam	CL, ML, SC, SM	A-6, A-7, A-4	0	90-100	70-100	65-85	40-80	33-45	8-20
	24	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Canlon----------	0-11	Loam----------	CL, SC, CL-ML, SM-SC	A-4, A-6	0	75-100	55-100	50-95	36-85	20-40	4-20
	11	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Cd---------- Caruso	0-14	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	95-100	65-90	25-40	5-20
	14-60	Loam, clay loam, silt loam.	CL, CL-ML	A-4, A-6, A-7	0	100	100	95-100	65-85	25-45	5-20
Co, Cy---------- Colby	0-6	Silt loam--------	CL, ML, CL-ML	A-4, A-6	0	100	100	90-100	85-100	25-40	3-15
	6-60	Silt loam, loam	CL, ML	A-4, A-6	0	100	100	90-100	85-100	25-40	3-15
Ke---------- Keith	0-10	Silt loam--------	ML, CL, CL-ML	A-4	0	100	100	95-100	85-95	20-35	2-10
	10-36	Silt loam, silty clay loam.	CL	A-6	0	100	100	95-100	85-100	30-40	10-20
	36-60	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	95-100	85-95	20-35	2-12
Ku---------- Kuma	0-10	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	95-100	90-100	70-90	25-40	5-15
	10-34	Silty clay loam, silt loam, loam.	CL	A-6	0	100	95-100	90-100	85-95	30-40	10-15
	34-60	Silt loam, loam	CL, CL-ML	A-4, A-6	0	95-100	95-100	90-100	85-95	25-40	5-15
Pe---------- Pleasant	0-8	Silty clay loam	CL	A-6, A-7	0	95-100	90-100	70-95	50-85	35-50	15-25
	8-45	Silty clay loam, silty clay, clay.	CH, CL	A-7	0	95-100	95-100	90-100	80-100	40-65	25-45
	45-60	Silt loam, loam, silty clay loam.	ML, SM	A-4	0-5	80-100	50-100	45-90	40-75	25-40	NP-10
Uc---------- Ulysses	0-9	Silt loam--------	CL, ML	A-4, A-6	0	100	100	90-100	85-100	25-40	3-15
	9-17	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	85-100	25-43	11-20
	17-60	Silt loam, loam	CL, ML	A-4, A-6	0	100	100	90-100	85-100	25-40	3-15

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" 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	Clay	Moist bulk density	Permea-bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	G/cm³	In/hr	In/in	pH	Mmhos/cm					Pct
Ba, Bb---------- Bridgeport	0-19	18-27	1.30-1.40	0.6-2.0	0.20-0.24	6.6-8.4	<2	Low--------	0.32	5	4L	1-4
	19-60	18-30	1.35-1.50	0.6-2.0	0.20-0.24	7.4-8.4	<2	Low--------	0.43			
Bf---------- Bridgeport	0-19	18-27	1.30-1.40	0.6-2.0	0.20-0.24	6.6-8.4	<2	Low--------	0.32	5	4L	1-4
	19-60	18-30	1.35-1.50	0.6-2.0	0.17-0.22	7.4-8.4	<2	Low--------	0.43			
Cc*:												
Campus----------	0-8	18-35	1.25-1.35	0.6-2.0	0.17-0.22	7.4-8.4	<2	Low--------	0.28	4	4L	1-2
	8-14	18-35	1.30-1.40	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.28			
	14-24	18-35	1.40-1.60	0.6-2.0	0.15-0.19	7.9-8.4	<2	Low--------	0.28			
	24	---	---	---	---	---	---	----------	----			
Canlon----------	0-11	12-27	1.35-1.50	0.6-2.0	0.12-0.16	7.4-8.4	<2	Low--------	0.32	2	4L	---
	11	---	---	---	---	---	---	----------	----			
Cd---------- Caruso	0-14	18-27	1.30-1.40	0.6-2.0	0.19-0.23	7.4-8.4	<4	Low--------	0.28	5	4L	1-4
	14-60	18-35	1.35-1.50	0.2-2.0	0.16-0.22	7.4-8.4	<4	Low--------	0.28			
Co, Cy---------- Colby	0-6	15-30	1.20-1.30	0.6-2.0	0.20-0.24	7.4-8.4	<2	Low--------	0.43	5	4L	.5-2
	6-60	18-27	1.25-1.40	0.6-2.0	0.17-0.22	7.4-8.4	<2	Low--------	0.43			
Ke---------- Keith	0-10	15-25	1.40-1.60	0.6-2.0	0.22-0.24	6.1-7.8	<2	Low--------	0.32	5	6	2-4
	10-36	20-35	1.20-1.40	0.6-2.0	0.20-0.22	6.6-8.4	<2	Moderate	0.43			
	36-60	15-25	1.40-1.60	0.6-2.0	0.19-0.21	7.4-8.4	<2	Low--------	0.43			
Ku---------- Kuma	0-10	15-27	1.20-1.30	0.6-2.0	0.18-0.21	6.6-7.8	<2	Low--------	0.32	5	6	2-4
	10-34	18-35	1.30-1.40	0.6-2.0	0.18-0.21	6.6-8.4	<2	Low--------	0.37			
	34-60	15-27	1.25-1.35	0.6-2.0	0.16-0.18	7.4-8.4	<2	Low--------	0.32			
Pe---------- Pleasant	0-8	28-40	1.25-1.35	0.2-0.6	0.17-0.20	6.6-7.3	<2	Low--------	0.37	4	7	2-5
	8-45	35-45	1.30-1.40	0.06-0.2	0.14-0.18	6.6-7.8	<2	High-------	0.28			
	45-60	20-35	1.30-1.40	0.2-2.0	0.14-0.18	7.4-8.4	<2	Low--------	0.24			
Uc---------- Ulysses	0-9	10-27	1.15-1.25	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.32	5	6	1-3
	9-17	21-32	1.20-1.35	0.6-2.0	0.18-0.22	7.4-8.4	<2	Moderate	0.43			
	17-60	18-27	1.25-1.35	0.6-2.0	0.18-0.22	7.9-8.4	<2	Low--------	0.43			

* 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		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
Ba, Bb---------- Bridgeport	B	Rare---------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Low.
Bf---------- Bridgeport	B	Occasional	Very brief	Apr-Sep	>6.0	---	---	>60	---	Moderate	Low------	Low.
Cc*:												
Campus----------	B	None---------	---	---	>6.0	---	---	20-40	Hard	Low------	Low------	Low.
Canlon----------	D	None---------	---	---	>6.0	---	---	10-20	Hard	Low------	Low------	Low.
Cd---------- Caruso	C	Occasional	Very brief	Apr-Sep	2.0-3.0	Apparent	Mar-Jun	>60	---	Moderate	High-----	Moderate.
Co, Cy---------- Colby	B	None---------	---	---	>6.0	---	---	>60	---	Low------	Low------	Low.
Ke---------- Keith	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Low.
Ku---------- Kuma	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
Pe---------- Pleasant	C	None---------	---	---	+1-1.0	Perched	Apr-Aug	>60	---	Low------	High-----	Low.
Uc---------- Ulysses	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Bridgeport	Fine-silty, mixed, mesic Fluventic Haplustolls
Campus	Fine-loamy, mixed, mesic Typic Calciustolls
Canlon	Loamy, mixed (calcareous), mesic Lithic Ustorthents
Caruso	Fine-loamy, mixed, mesic Fluvaquentic Haplustolls
Colby	Fine-silty, mixed (calcareous), mesic Ustic Torriorthents
Keith	Fine-silty, mixed, mesic Aridic Argiustolls
Kuma	Fine-silty, mixed, mesic Pachic Argiustolls
Pleasant	Fine, montmorillonitic, mesic Torrertic Argiustolls
Ulysses	Fine-silty, mixed, mesic Aridic Haplustolls

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