United States
Department of
Agriculture

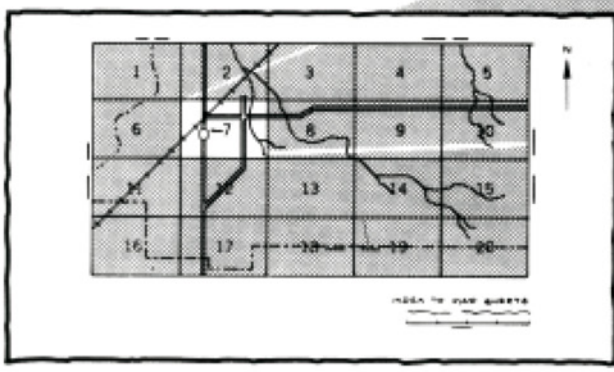
Soil
Conservation
Service

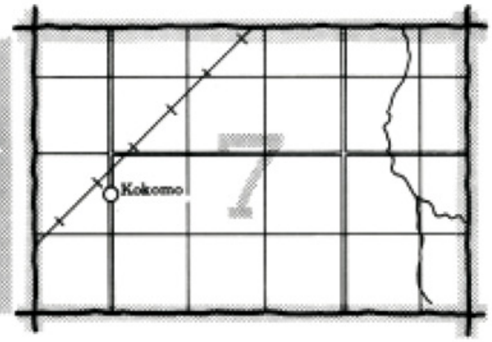
In Cooperation with
Kansas
Agricultural
Experiment
Station

Soil Survey of Clark County Kansas

HOW TO USE

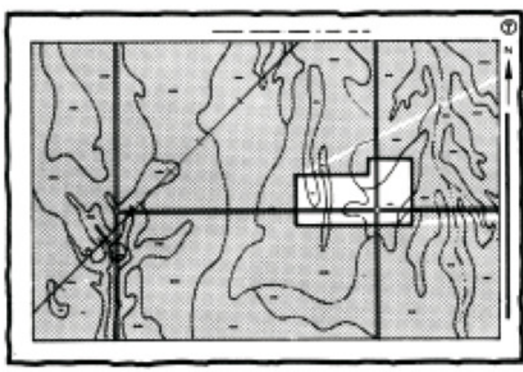
1. Locate your area of interest on the "Index to Map Sheets"

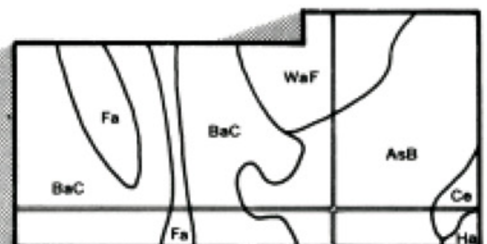




2. Note the number of the map sheet and turn to that sheet.

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





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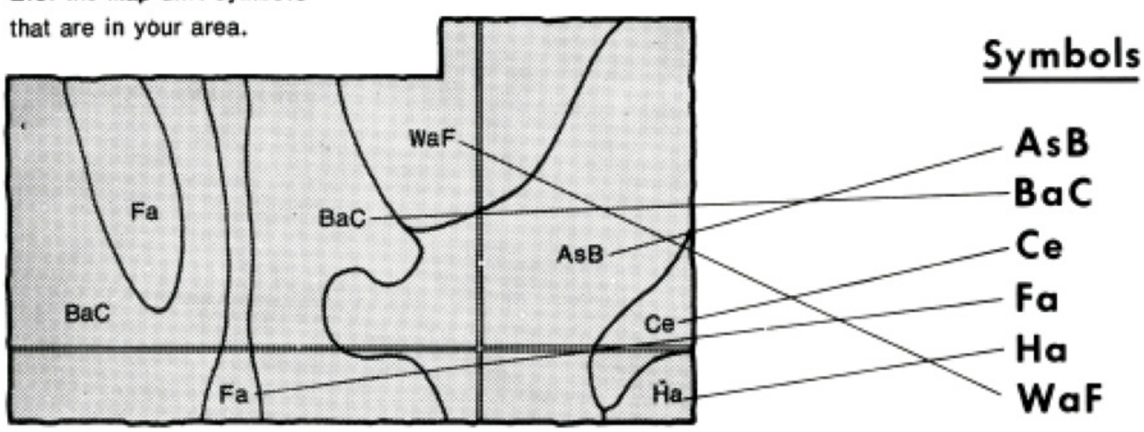
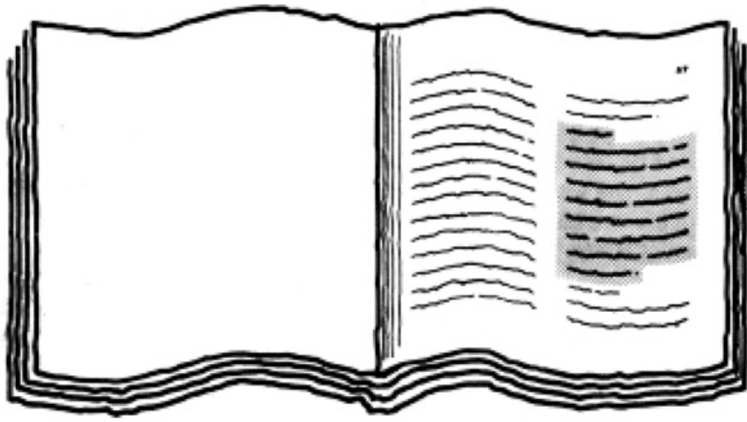
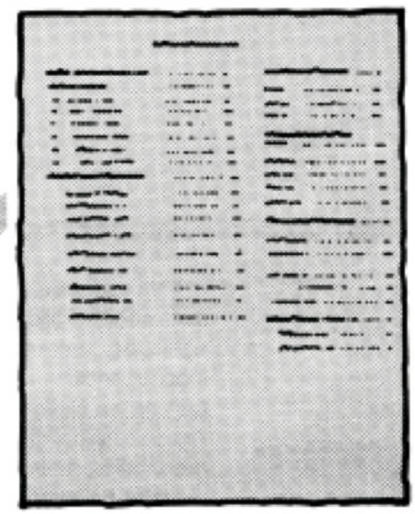


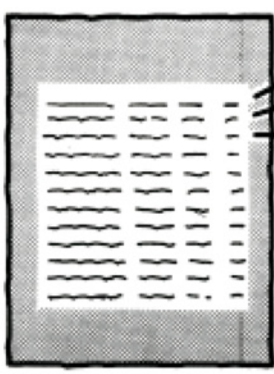
THIS SOIL SURVEY

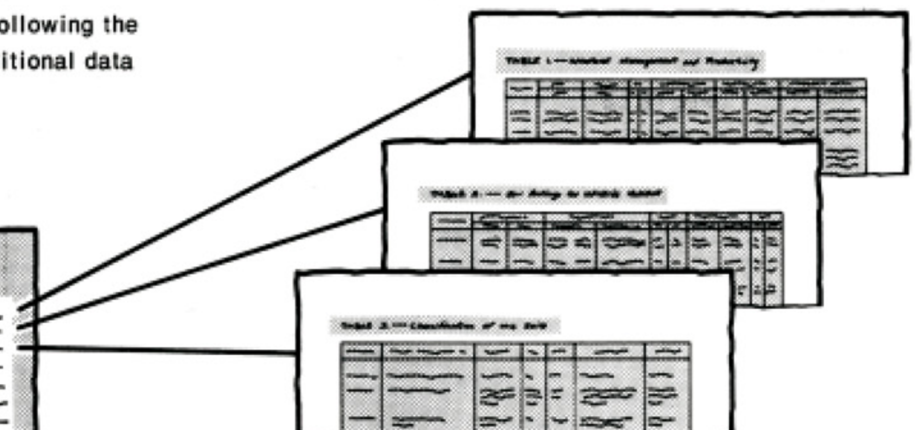
5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.





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





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

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

This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Clark County Conservation District. Major fieldwork was performed in the period 1972-80. Soil names and descriptions were approved in 1980. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1980.

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 Lincoln loamy fine sand along a narrow flood plain. Campus and Canlon soils are on the uplands in the background.

contents

soil series

Issued December 1982

index to map units

summary of tables

foreword

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

By Bob I. Tomasu and Thomas D. Grimwood, Soil Conservation Service

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

CLARK COUNTY is in the southwestern part of Kansas (fig. 1). It has an area of 629,760 acres, or 984 square miles. In 1979, it had a population of 2,674 and Ashland, the county seat, had a population of 1,173. The county was established in 1885.

Most of the county is in the Central Rolling Red Plains land resource area (fig. 2). The northwest corner, however, is in the Rolling Plains and Breaks land resource area. The Central Rolling Red Plains area is dissected by drainageways. Generally, the soils are deep to shallow, are nearly level to steep, and have a silty or loamy subsoil. The soils in the Rolling Plains and Breaks area are deep, silty, and nearly level to moderately sloping.

The western and southern parts of the county are drained mainly by the Cimarron River and its tributaries. The northeastern part is drained by Bluff Creek. Elevation ranges from 1,730 to 2,600 feet above sea level.

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

general nature of the county

This section describes the climate, water supply, and natural resources of the county.

climate

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

The climate of Clark County is typical continental, as can 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. Winter is cold because of the frequent incursions of polar air. It lasts from December through February. Warm summer temperatures last for about 6 months every year. They provide a long growing season for the crops commonly grown in the county. Spring and fall generally are short.

The county generally is west of the flow of moisture-laden air from the Gulf of Mexico and east of the strong rain-shadow effects of the Rocky Mountains. As a result, the amount of annual precipitation is marginal for cropping year after year. The precipitation falls during showers and thunderstorms that at times are extremely heavy.

Severe thunderstorms and tornadoes accompany the more severe thunderstorms, but they are infrequent and

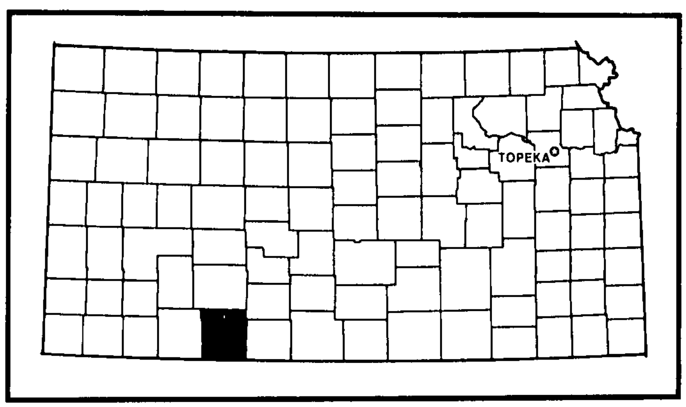


Figure 1.—Location of Clark County in Kansas.

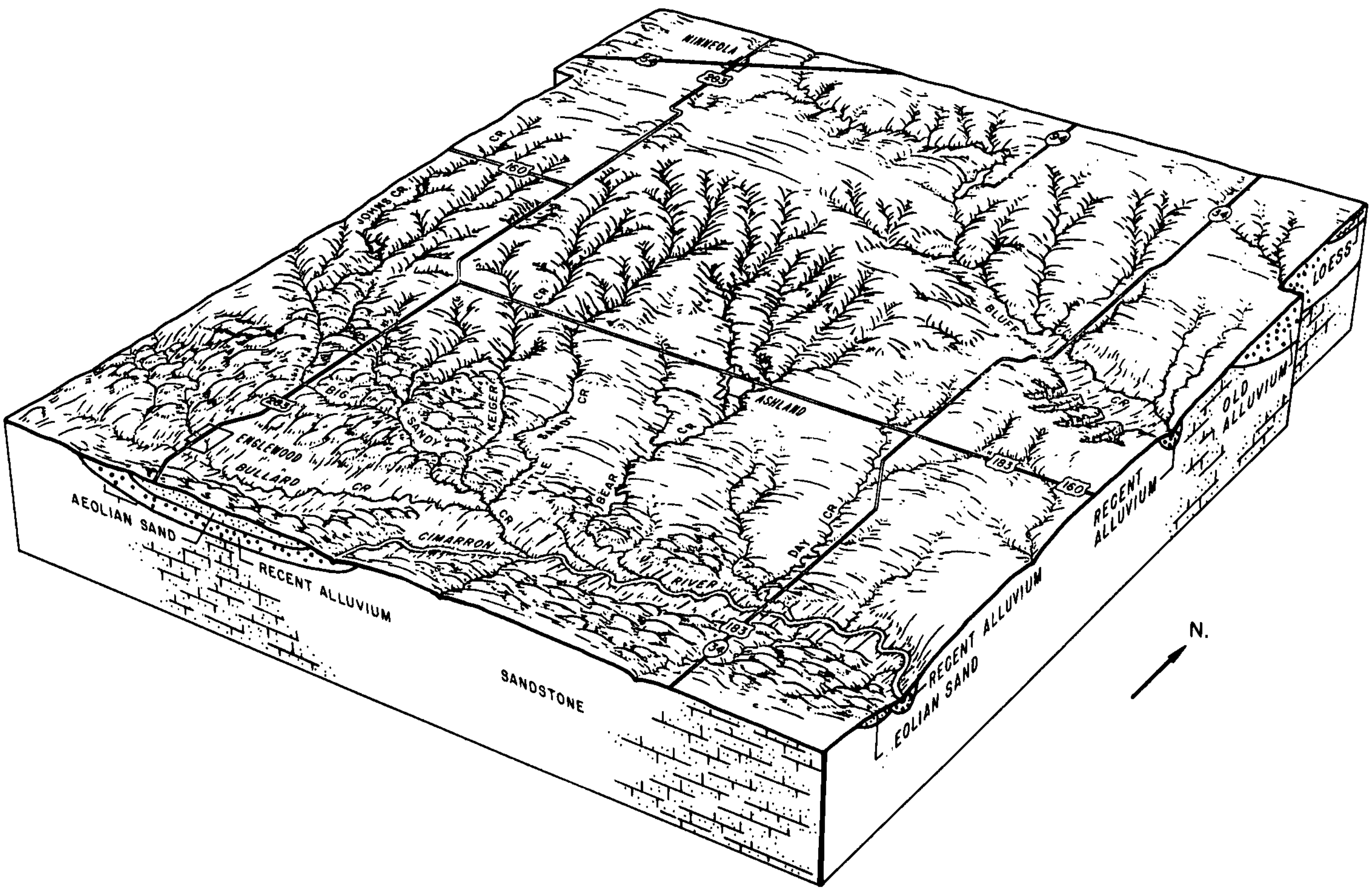


Figure 2.—Landscape of Clark County.

of local extent. Hail is a more severe hazard, but losses from hailstorms are not so great as those in the counties to the west.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Ashland. Most of the data were recorded 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 34.8 degrees F, and the average daily minimum temperature is 19.9 degrees. The lowest temperature on record, which occurred at Ashland on February 11, 1899, is -24 degrees. In summer the average temperature is 78.4 degrees, and the average daily maximum temperature is 92.9 degrees. The highest recorded temperature, which occurred at Ashland on August 13, 1936, is 114 degrees.

The total annual precipitation is 21.43 inches. Of this, 15.98 inches, or about 75 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 11.68 inches. The heaviest 1-day rainfall was 6.52 inches at Ashland on October 21, 1920.

Average seasonal snowfall is 14.6 inches. The greatest snowfall, 48.7 inches, occurred during the winter of 1911-12. On an average of 15 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year.

The sun shines 75 percent of the time possible in summer and 64 percent in winter. The prevailing wind is from the south. Average windspeed is highest, 15 miles per hour, in April. The generally high winds result in significant soil loss and crop damage in the drier years. Measures that conserve moisture and help to control soil blowing are needed.

water supply

Many upland areas do not have an adequate amount of high-quality water for domestic uses and for livestock. The principal source of water for livestock is surface water impoundments on intermittent streams. Wells supply water for livestock and domestic uses in some areas, but only a few yield a sufficient amount of high-quality irrigation water.

natural resources

Soil is the most important natural resource in the county. It provides a growing medium for cultivated crops and for the native grasses and forage crops grazed by livestock. Other natural resources are sand, gravel, gas, and oil. An adequate supply of sand and gravel is available for roads and other structures. Natural gas and oil are produced from numerous wells.

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, it 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, names, and delineations 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 the soils, modifications of series concepts, and variations in the intensity of mapping or the extent of the soils in the counties.

soil descriptions

1. Harney association

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

This association is on the tops and sides of upland ridges dissected by drainageways. Slope generally ranges from 0 to 3 percent.

This association makes up about 12 percent of the county. It is about 73 percent Harney soils and 27 percent minor soils (fig. 3).

The Harney soils formed in loess. Typically, the surface layer is grayish brown silt loam about 7 inches thick. The subsurface layer is dark grayish brown silt loam about 5 inches thick. The subsoil is silty clay loam about 18 inches thick. The upper part is dark grayish brown and firm, the next part is grayish brown and firm, and the lower part is brown, friable, and calcareous. The substratum to a depth of about 60 inches is calcareous silt loam. The upper part is pale brown, and the lower part is very pale brown.

Minor in this association are Ness, Penden, Satanta, and Uly soils. The poorly drained Ness soils are in depressional areas on broad ridgetops. The subsoil of Penden, Uly, and Satanta soils contains less clay than that of the Harney soils. Penden and Uly soils are on side slopes, and Satanta soils are on ridgetops and the upper slopes.

This association is used mainly for cultivated crops, but some small areas are used as range. Wheat and grain sorghum are the chief crops. Controlling erosion, conserving moisture, and maintaining tilth and fertility are the main concerns of management.

2. Penden-Campus-Canlon association

Deep to shallow, nearly level to steep, well drained and somewhat excessively drained soils that have a loamy subsoil; on uplands

This association is on the tops and sides of upland ridges dissected by widely spaced, deeply entrenched drainageways and creeks. Slope ranges from 0 to 30 percent.

This association makes up about 25 percent of the county. It is about 32 percent Penden soils, 25 percent Campus soils, 20 percent Canlon soils, and 23 percent minor soils (fig. 4).

The deep, well drained Penden soils formed in calcareous old alluvium on convex slopes and side slopes along drainageways. They are nearly level to strongly sloping. Typically, the surface layer is dark grayish brown, calcareous clay loam about 9 inches thick. The subsurface layer is grayish brown, calcareous clay loam about 7 inches thick. The subsoil is pale brown, calcareous clay loam about 12 inches thick. It has many soft masses and concretions of lime. The substratum to a depth of about 60 inches is very pale brown, calcareous clay loam.

The moderately deep, well drained Campus soils formed in loamy, calcareous residuum of caliche on the tops of ridges along drainageways. They are moderately sloping and strongly sloping. Typically, the surface layer is grayish brown, calcareous loam about 8 inches thick. The subsoil is light brownish gray, friable, calcareous clay loam about 7 inches thick. The substratum is light yellowish brown, calcareous clay loam. White caliche is at a depth of about 28 inches.

The shallow, somewhat excessively drained Canlon

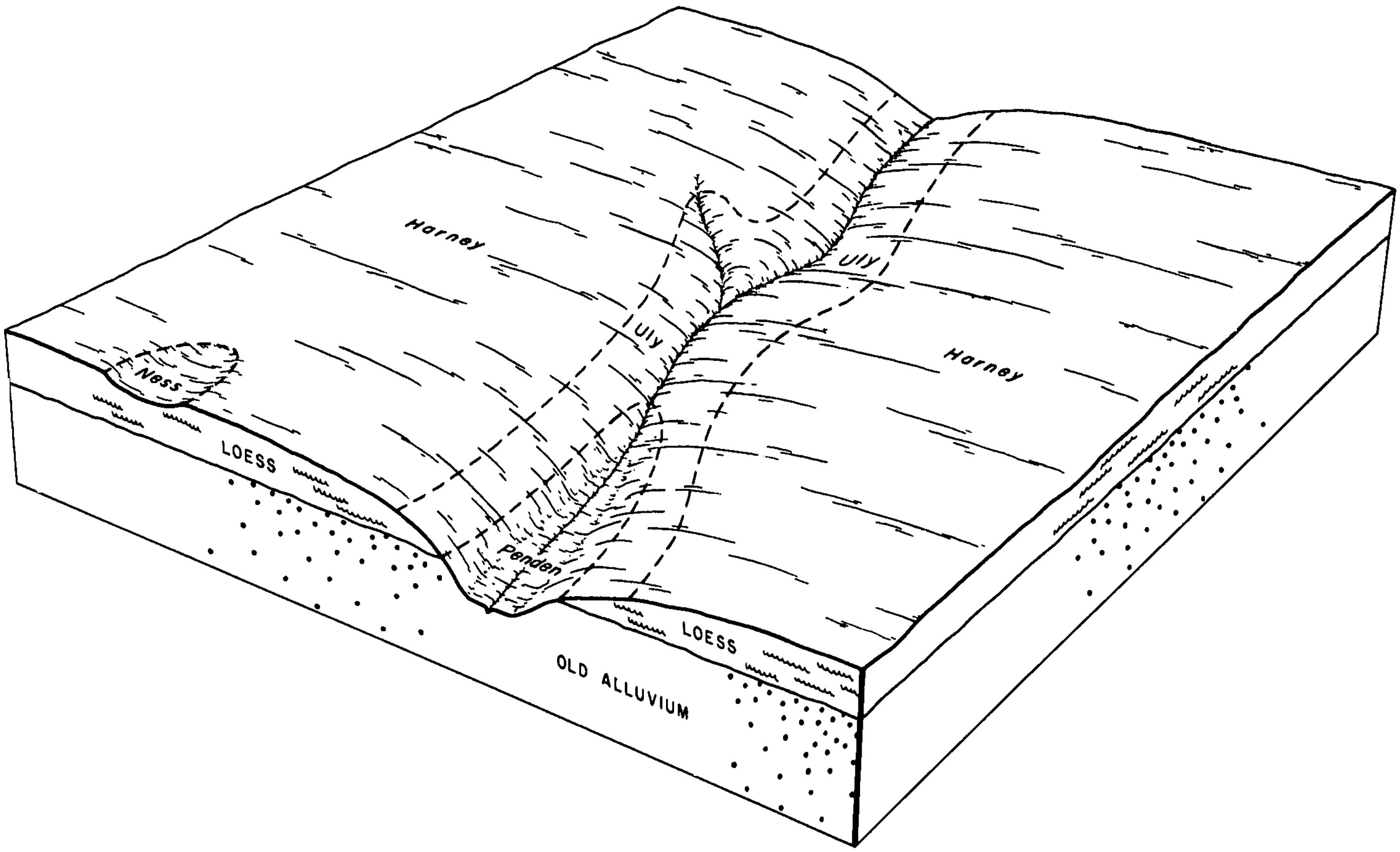


Figure 3.—Typical pattern of soils in the Harney association.

soils formed in material weathered from caliche on ridgetops and the upper side slopes. They are strongly sloping to steep. Typically, the surface layer is grayish brown, calcareous loam about 5 inches thick. The next 4 inches is light brownish gray, friable, calcareous loam. The substratum is very pale brown, calcareous loam. White, hard caliche is at a depth of about 13 inches.

Minor in this association are the well drained Bippus, Harney, Owens, Quinlan, and Woodward soils. The deep Bippus soils are on foot slopes. The silty Harney soils are on broad ridgetops and the upper side slopes. The shallow, clayey Owens soils are on the steeper slopes on the middle parts of the landscape. The shallow Quinlan and moderately deep Woodward soils are underlain by sandstone. They are on the steeper slopes on the lower parts of the landscape.

Most of this association is range. Some of the less sloping areas, however, are used for cultivated crops, mainly wheat and grain sorghum. Maintaining an adequate and vigorous stand of desirable grasses is the main concern in managing the range. Controlling erosion and conserving moisture are the main concerns in managing the cultivated areas.

3. Lincoln-Krier-Waldeck association

Deep, nearly level, somewhat excessively drained and somewhat poorly drained soils that have a sandy or loamy subsoil; on flood plains and terraces

This association is on flood plains and low terraces in the valleys along the major streams. The major soils are occasionally flooded. Slope generally ranges from 0 to 2 percent.

This association makes up about 5 percent of the county. It is about 38 percent Lincoln soils, 30 percent Krier soils, 11 percent Waldeck soils, and 21 percent minor soils.

The somewhat excessively drained Lincoln soils formed in sandy alluvium on flood plains. Typically, the surface layer is brown, calcareous loamy fine sand about 13 inches thick. The substratum to a depth of about 60 inches is very pale brown, calcareous fine sand.

The somewhat poorly drained Krier soils formed in loamy sediments over sandy alluvium. They are on terraces and flood plains. Typically, the surface layer is grayish brown, calcareous loam about 3 inches thick. The upper 10 inches of the substratum is grayish brown, dark grayish brown, and light brownish gray, mottled, calcareous, slightly saline and moderately saline loam and clay loam. The lower part to a depth of about 60 inches is pale brown, mottled sand.

The somewhat poorly drained Waldeck soils formed in alluvium on flood plains. Typically, the surface layer is grayish brown, calcareous fine sandy loam about 14 inches thick. The next 18 inches is brown, very friable, calcareous fine sandy loam. The upper 13 inches of the substratum is light brownish gray, mottled, calcareous fine sandy loam. The lower part to a depth of about 60 inches is very pale brown sand.

Minor in this association are Lesho, Likes, and Zenda soils. The somewhat poorly drained Lesho soils are on flood plains and stream terraces. They have a clay loam surface layer. The excessively drained Likes soils are on uplands and foot slopes. The somewhat poorly drained, loamy Zenda soils are on flood plains.

Most of this association is range. Some areas, however, are used for cultivated crops, mainly wheat, grain sorghum, and alfalfa. Maintaining an adequate and vigorous stand of desirable grasses is the main concern in managing the range. Controlling soil blowing and flooding and maintaining tilth and fertility are the main concerns in managing the cultivated areas.

4. Carey-Woodward-Quinlan association

Deep to shallow, nearly level to strongly sloping, well drained soils that have a loamy subsoil; on uplands

This association is on upland ridges and side slopes dissected by drainageways. Slope generally ranges from 0 to 15 percent, but the sides of a few drainageways are steep.

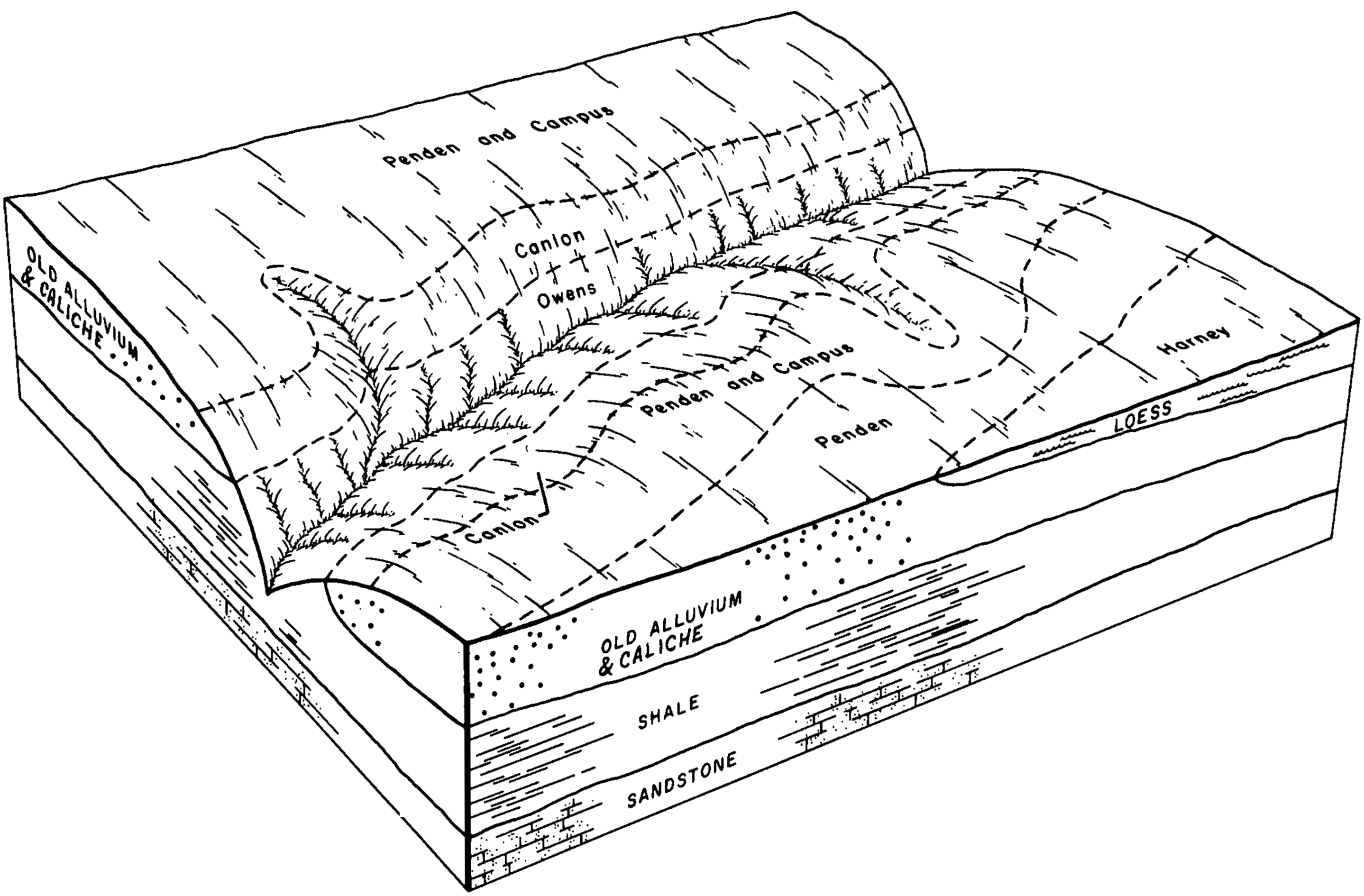


Figure 4.—Typical pattern of soils in the Penden-Campus-Canlon association.

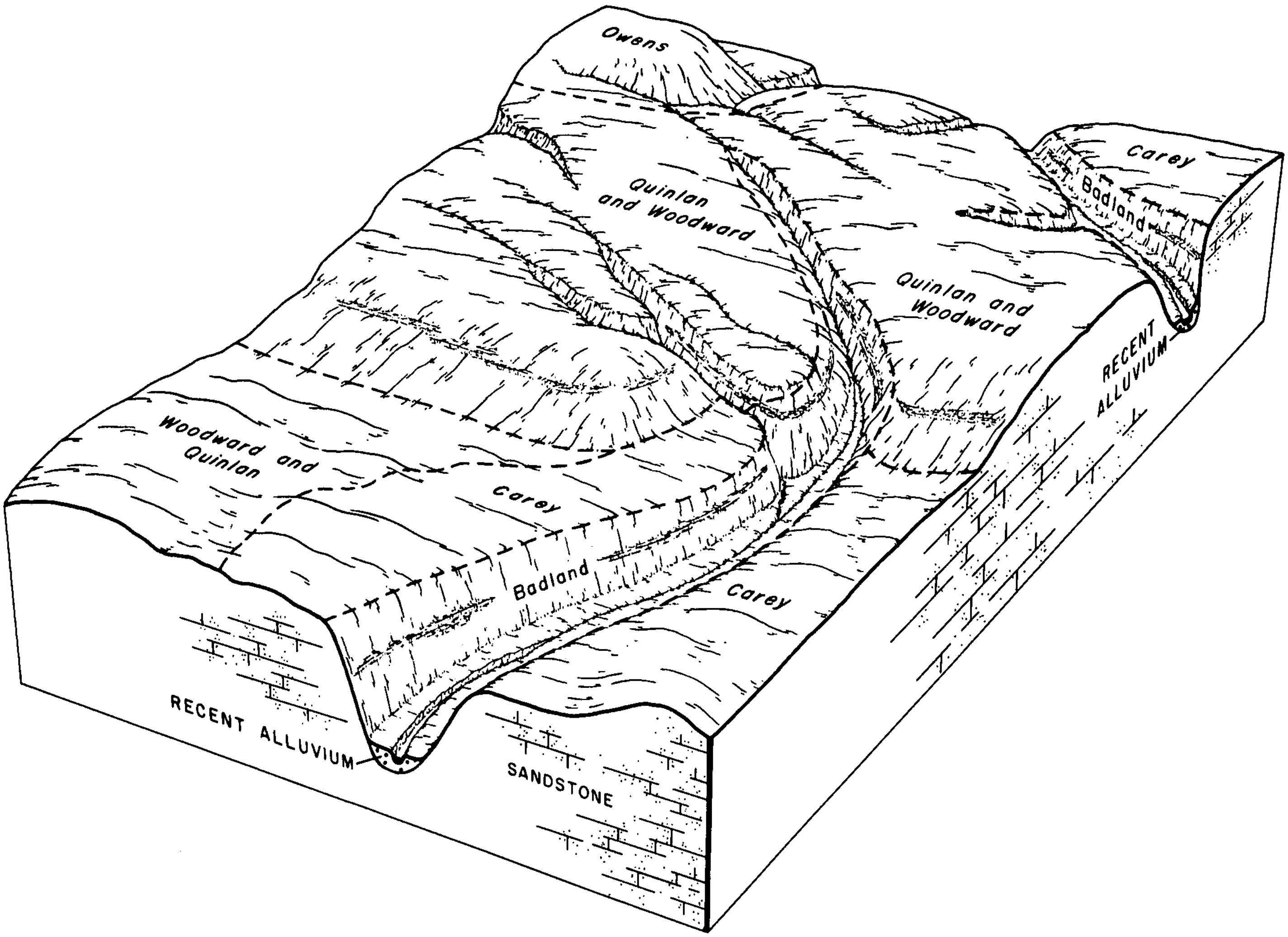


Figure 5.—Typical pattern of soils in the Carey-Woodward-Quinlan association.

This association makes up about 29 percent of the county. It is about 22 percent Carey soils, 20 percent Woodward soils, 15 percent Quinlan soils, and 43 percent minor soils (fig. 5).

The deep Carey soils formed in sediments weathered from silty and sandy red beds on broad flats and side slopes. They are nearly level to moderately sloping. Typically, the surface layer is brown silt loam about 7 inches thick. The subsurface layer is brown loam about 4 inches thick. The subsoil is friable loam about 13 inches thick. The upper part is dark brown, and the lower part is light brown and calcareous. The substratum to a depth of about 60 inches is light reddish brown, calcareous loam.

The moderately deep Woodward soils formed in material weathered from soft, calcareous, fine grained sandstone on the sides of convex ridges. They are gently sloping to strongly sloping. Typically, the surface layer is reddish brown, calcareous loam about 9 inches thick. The subsoil is friable, calcareous loam about 21 inches thick. The upper part is reddish brown, and the lower part is reddish yellow. Light red, weakly consolidated sandstone is at a depth of about 30 inches.

The shallow Quinlan soils formed in material weathered from soft, calcareous, fine grained sandstone on ridges and side slopes along drainageways. They are moderately sloping and strongly sloping. Typically, the surface layer is yellowish red, calcareous loam about 7 inches thick. The subsoil is red, friable, calcareous loam about 6 inches thick. Red, weakly consolidated sandstone is at a depth of about 13 inches.

Minor in this association are Missler, Owens, Penden, and Roxbury soils and Badland. The deep Missler soils are on broad uplands. The clayey Owens soils are on the steeper side slopes. The deep, calcareous Penden soils are on the lower side slopes. The deep Roxbury soils are on flood plains. The steep and very steep areas of Badland are on the sides of some drainageways. They are barren.

About half of this association is used for cultivated crops. The other areas, especially the steeper ones, are used as range. Wheat, sorghum, and alfalfa are the main crops. Controlling erosion, conserving moisture, and maintaining tilth and fertility are the main concerns in managing the cultivated areas. Maintaining an adequate and vigorous stand of grasses is the main concern in managing the range.

5. Albion-Shellabarger association

Deep, strongly sloping, somewhat excessively drained and well drained soils that have a loamy subsoil; on uplands

This association is on the tops and sides of upland ridges dissected by drainageways. Slope generally ranges from 6 to 12 percent.

This association makes up about 5 percent of the county. It is about 30 percent Albion soils, 20 percent Shellabarger soils, and 50 percent minor soils (fig. 6).

The somewhat excessively drained Albion soils formed in old loamy alluvial sediments over sand and gravel.

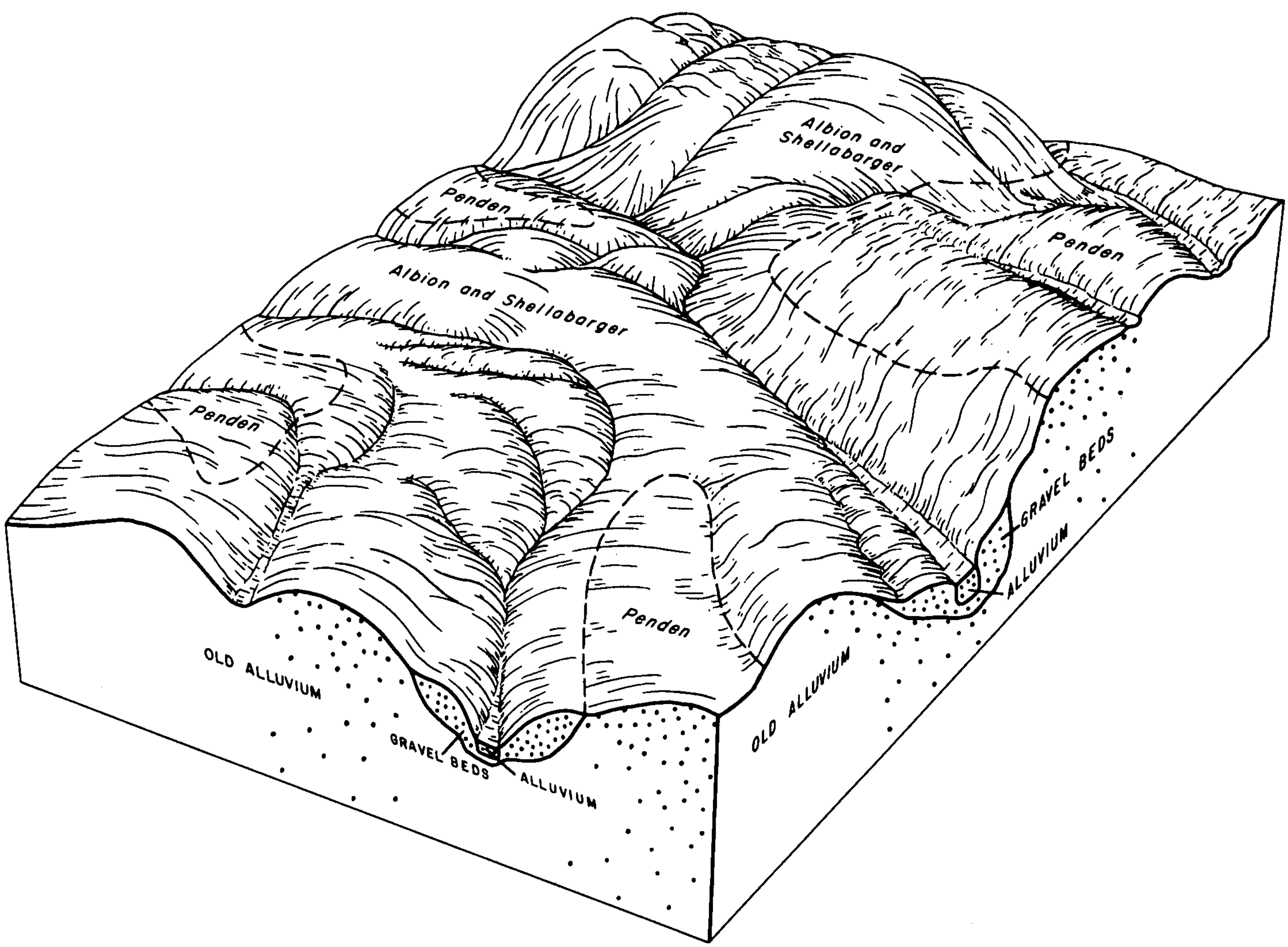


Figure 6.—Typical pattern of soils in the Albion-Shellabarger association.

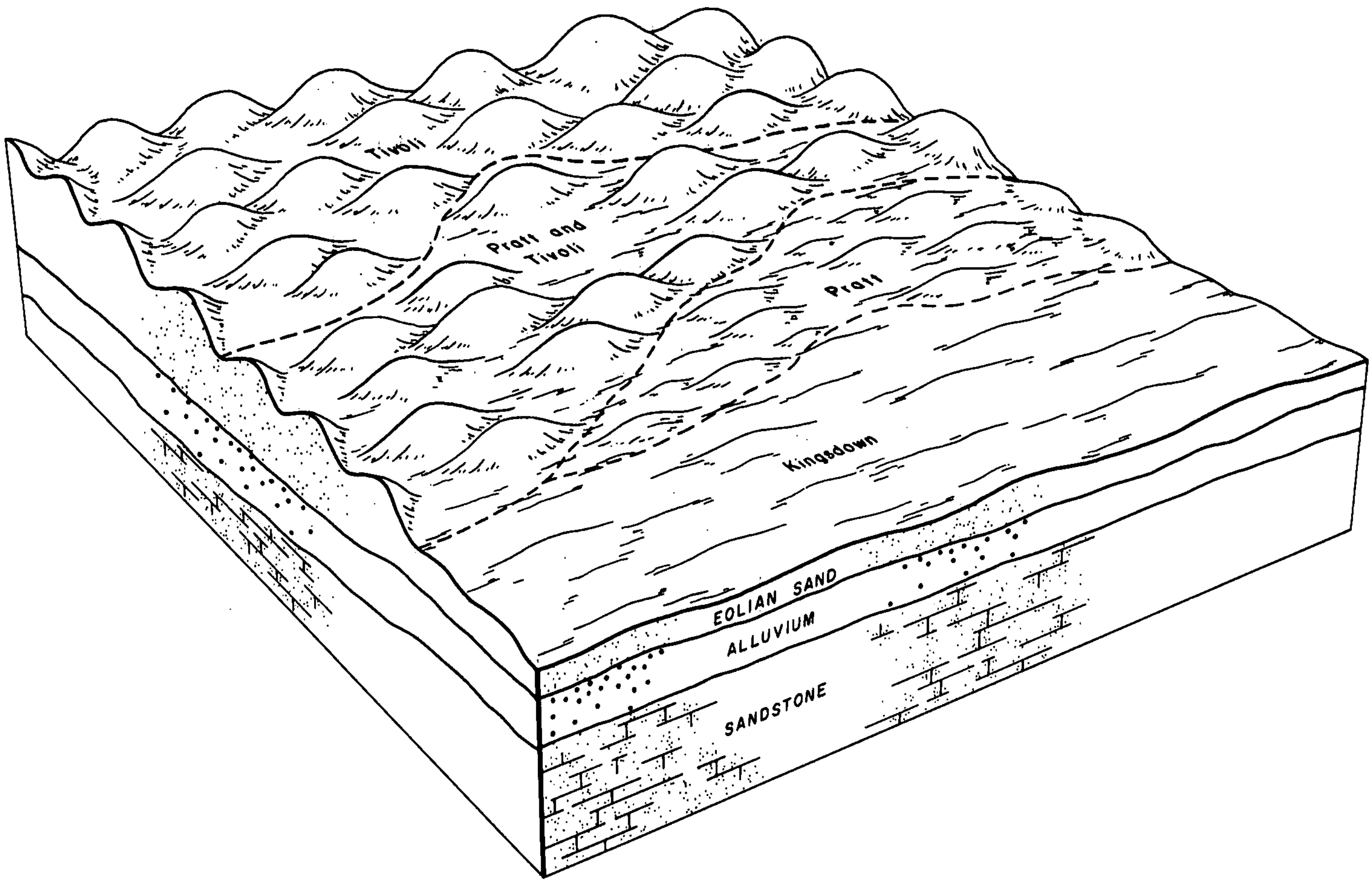


Figure 7.—Typical pattern of soils in the Pratt-Tivoli-Kingsdown association.

They are on the upper side slopes and the narrow, convex tops of ridges. Typically, the surface layer is brown sandy loam about 8 inches thick. The subsoil is about 14 inches thick. It is brown and friable. The upper part is sandy loam, and the lower part is coarse sandy loam. The substratum to a depth of about 60 inches is reddish yellow gravelly sand.

The well drained Shellabarger soils formed in old alluvium on the lower side slopes. Typically, the surface layer is reddish brown sandy loam about 10 inches thick. The subsoil is reddish brown, friable sandy clay loam about 26 inches thick. The substratum to a depth of about 60 inches is reddish yellow sandy loam.

Minor in this association are Carey, Owens, Penden, and Roxbury soils. Carey soils have a silty surface layer. They are gently sloping and moderately sloping and are on side slopes. The shallow Owens soils are strongly sloping to steep and are on the tops and sides of ridges. The calcareous Penden soils are moderately sloping and strongly sloping and are on side slopes. The calcareous Roxbury soils are on flood plains.

Most of this association is range. Some small areas, however, are used for cultivated crops, mainly wheat and sorghum. Maintaining the growth and vigor of native grasses is the main concern in managing the range. Controlling erosion and soil blowing is the main concern in managing the cultivated areas.

6. Pratt-Tivoli-Kingsdown association

Deep, nearly level to hilly, well drained and excessively drained soils that have a sandy or loamy subsoil; on uplands

This association is on knolls, hills, and smooth to undulating uplands. Slope ranges from 0 to 30 percent.

This association makes up about 16 percent of the county. It is about 42 percent Pratt soils, 24 percent Tivoli soils, 18 percent Kingsdown soils, and 16 percent minor soils (fig. 7).

The well drained Pratt soils formed in sandy eolian deposits in rolling and undulating areas. Typically, the surface layer is brown loamy fine sand about 11 inches thick. The subsoil is light brown, very friable loamy fine sand about 19 inches thick. The substratum to a depth of about 60 inches is light brown loamy fine sand.

The excessively drained Tivoli soils formed in sandy eolian deposits on hills, the crest of knolls, and the upper side slopes. Typically, the surface layer is brown fine sand about 6 inches thick. The substratum to a depth of about 60 inches is yellow fine sand.

The well drained Kingsdown soils formed in loamy eolian material in nearly level to undulating areas. Typically, the surface layer is dark grayish brown fine sandy loam about 10 inches thick. The subsoil is brown fine sandy loam about 12 inches thick. The substratum to a depth of about 60 inches is pale brown fine sandy loam.

Minor in this association are the calcareous Penden and silty Uly soils. These soils are nearly level and gently sloping on low flats between the undulating soils and are nearly level in areas outside the sandhills.

Most of this association is range. In some areas, however, the Pratt and Kingsdown soils are used for cultivated crops, mainly wheat and sorghum. Maintaining an adequate and vigorous stand of native grasses is the main concern in managing the range. Controlling soil blowing, maintaining fertility, and conserving moisture are the main concerns in managing the cultivated areas.

7. Penden-Harney-Uly association

Deep, nearly level to strongly sloping, well drained soils that have a loamy or silty subsoil; on uplands

This association is on the tops and sides of upland ridges dissected by many drainageways. Slope ranges from 0 to 15 percent.

This association makes up about 8 percent of the county. It is about 29 percent Penden soils, 28 percent Harney soils, 15 percent Uly soils, and 28 percent minor soils (fig. 8).

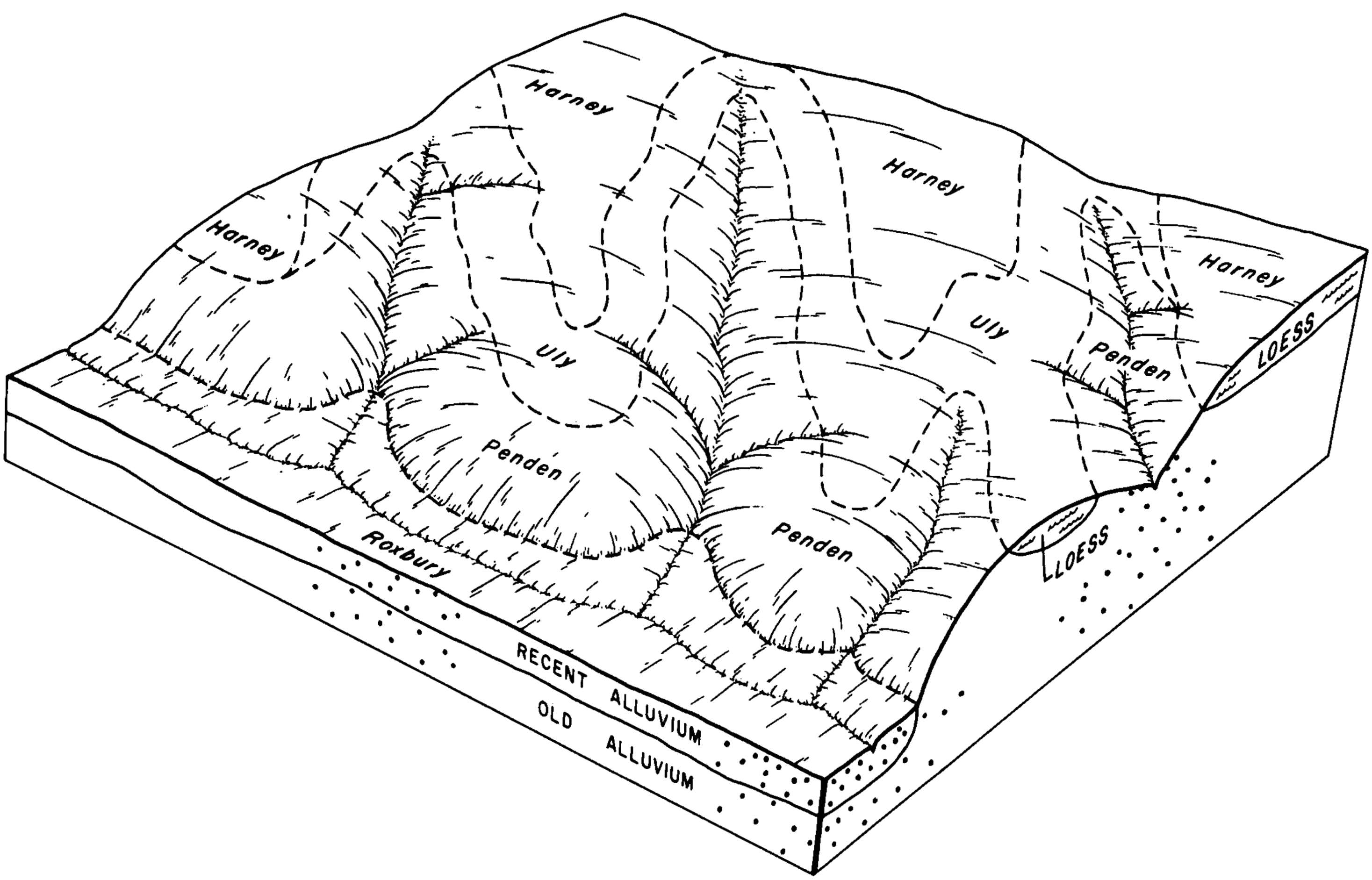


Figure 8.—Typical pattern of soils in the Penden-Harney-Uly association.

The moderately sloping and strongly sloping Penden soils formed in calcareous old alluvium on convex slopes and side slopes along drainageways. Typically, the surface layer is dark grayish brown, calcareous clay loam about 9 inches thick. The subsurface layer is grayish brown, calcareous clay loam about 7 inches thick. The subsoil is pale brown, calcareous, friable clay loam about 12 inches thick. The substratum to a depth of about 60 inches is very pale brown, calcareous clay loam.

The nearly level and gently sloping Harney soils formed in loess on the tops and sides of ridges. Typically, the surface layer is grayish brown silt loam about 7 inches thick. The subsurface layer is dark grayish brown silt loam about 5 inches thick. The subsoil is silty clay loam about 18 inches thick. The upper part is dark grayish brown and firm, the next part is grayish brown and firm, and the lower part is brown, friable, and calcareous. The substratum to a depth of about 60 inches is calcareous silt loam. The upper part is pale brown, and the lower part is very pale brown.

The nearly level to moderately sloping Uly soils formed in loess on the sides and convex tops of ridges. Typically, the surface layer is grayish brown silt loam about 7 inches thick. The subsoil is friable silty clay loam about 11 inches thick. The upper part is dark grayish brown, and the lower part is brown and calcareous. The substratum to a depth of about 60 inches is pale brown, calcareous silt loam.

Minor in this association are Bippus, Lincoln, and Roxbury soils. The deep Bippus soils are on foot slopes. The sandy Lincoln and calcareous Roxbury soils are on flood plains.

About half of this association is cropland, and half is range. Wheat and sorghum are the main cultivated crops. Controlling erosion, conserving moisture, and maintaining tilth and fertility are the main concerns in managing the cultivated areas. Maintaining an adequate and vigorous stand of native grasses is the main concern in managing the range.

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, Penden clay loam, 1 to 3 percent slopes, is one of several phases in the Penden 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. Likes-Quinlan complex, 3 to 15 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, names, and delineations 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 the soils, modifications of series concepts, and variations in the intensity of mapping or 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

Ab—Albion-Shellabarger sandy loams, 6 to 12 percent slopes. These strongly sloping soils are on uplands dissected by entrenched drainageways. The somewhat excessively drained Albion soil is on the upper sides and narrow, convex tops of ridges. It is moderately deep over gravelly sand. The deep, well drained Shellabarger soil is on the lower side slopes. Individual areas are irregular in shape and range from 25 to several hundred acres in size. They are about 50 percent Albion soil and 30 percent Shellabarger soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Albion soil has a brown sandy loam surface layer about 8 inches thick. The subsoil is about 14 inches thick. It is brown and friable. The upper part is sandy loam, and the lower part is coarse sandy loam. The substratum to a depth of about 60 inches is reddish yellow gravelly sand.

Typically, the Shellabarger soil has a reddish brown sandy loam surface layer about 10 inches thick. The subsoil is reddish brown, friable sandy clay loam about 26 inches thick. The substratum to a depth of about 60 inches is reddish yellow sandy loam. In some areas the soil is calcareous at a depth of 8 to 34 inches.

Included with these soils in mapping are small areas of Penden soils and small areas of sandy and gravelly deposits. The calcareous, well drained Penden soils are on the steeper sides of the drainageways. The sand and gravel deposits are on convex slopes. Included areas make up about 20 percent of the map unit.

Permeability is moderately rapid in the upper part of the Albion soil and rapid in the substratum. It is moderate in the Shellabarger soil. Available water capacity is low in the Albion soil and high in the Shellabarger soil. Runoff is slow on the Albion soil and medium on the Shellabarger soil. Natural fertility is medium in both soils.

Most of the acreage is used as range. These soils generally are unsuited to cultivated crops because they are droughty and subject to erosion. They are best suited to range. The main concern in managing the range is droughtiness. An adequate plant cover and ground mulch reduce the runoff rate and increase the available water capacity. Overgrazing results in a deterioration of the natural plant community and the invasion of weeds. Proper stocking rates and timely deferment of grazing help to keep the range in good condition.

These soils are moderately well suited to dwellings. The slope is a limitation. Some land shaping commonly is needed.

The Albion soil is poorly suited to onsite waste disposal. Because of the sandy substratum, it does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of shallow ground water. Seepage and slope are limitations on sites for sewage lagoons. Because it is deeper over the underlying sandy material, the Shellabarger soil is a better site for waste disposal systems. The slope, however, is a limitation. The less sloping areas should be selected as sites for septic tank absorption fields and sewage lagoons. In places the floor of the sewage lagoons should be sealed to prevent seepage. The Albion soil is a probable source of sand and gravel.

The capability subclass is VIe.

Bd—Badland-Woodward complex. This map unit dominantly occurs as areas of barren Badland intricately mixed with areas of a moderately deep, well drained Woodward soil. It is on uplands. The steep and very steep Badland is on side slopes. The gently sloping Woodward soil is on ridgetops. Individual areas are irregular in shape and range from 75 to several hundred acres in size. They are 50 to 70 percent Badland and 20 to 40 percent Woodward soil. The Badland and the Woodward soil occur as areas so intricately mixed that mapping them separately is not practical.

Badland is barren land. The soil material is massive, reddish shale locally referred to as red beds.

Typically, the Woodward soil has a brown, calcareous loam surface layer about 7 inches thick. The subsoil is brown, calcareous loam about 17 inches thick. Weakly consolidated sandstone bedrock is at a depth of about 24 inches. In some areas it is at a depth of 10 to 20 inches.

Included with the Badland and Woodward soil in mapping are areas of the deep Roxbury soils on flood plains along intermittent drainageways. These soils make up less than 10 percent of the map unit.

Permeability is moderate in the Woodward soil, and available water capacity is low. Runoff is medium on the Woodward soil and very rapid on the Badland. Natural fertility is medium in the Woodward soil. The surface layer is mildly alkaline.

Nearly all areas of the Woodward soil support native grasses. This map unit is moderately well suited to range. The grasses grow well on the Woodward soil, but the Badland is barren and is subject to geologic erosion. Overstocking and overgrazing reduce the extent of the protective plant cover and cause deterioration of the plant community. Under these conditions, the taller, more desirable grasses are replaced by less productive short grasses or by weeds. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition.

This map unit generally is unsuitable as a site for dwellings, septic tank absorption fields, and sewage lagoons because of the slope and the depth to bedrock.

The capability subclass is VIIe.

Bp—Bippus clay loam, 0 to 2 percent slopes. This deep, nearly level, well drained soil is on colluvial and alluvial fans and in a few areas on long, narrow terraces paralleling streams. Individual areas are irregular in shape and range from about 15 to several hundred acres in size.

Typically, the surface soil is dark grayish brown, calcareous clay loam about 23 inches thick. The subsoil to a depth of about 60 inches is brown, friable, calcareous clay loam. In some areas the surface layer and subsoil are silty clay loam.

Included with this soil in mapping are small areas of Penden soils, which make up about 10 percent of the map unit. These soils are along drainageways. Their surface layer is thinner than that of the Bippus soil.

Permeability is moderate in the Bippus soil, and available water capacity is high. Runoff is medium. Natural fertility is high. Tilth is good. The soil is mildly alkaline or moderately alkaline throughout. The shrink-swell potential is moderate.

Most of the acreage is used for cultivated crops, but a few areas are used as range. This soil is well suited to wheat and sorghum. Inadequate rainfall is the main limitation. Summer fallowing, minimizing tillage, and returning crop residue to the soil conserve moisture and increase the infiltration rate.

This soil is well suited to range. It receives extra moisture from the higher lying adjacent uplands. Overgrazing reduces the vigor and retards the growth of the tall, palatable grasses. Under these conditions, the shorter, less productive grasses are established. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition.

This soil is moderately well suited to dwellings. The shrink-swell potential is a limitation. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse material, however, help to prevent the structural damage caused by shrinking and swelling. In some areas the soil is subject to flooding because of the runoff from the higher lying adjacent uplands. Diversion terraces reduce this hazard.

This soil is well suited to septic tank absorption fields and is moderately well suited to sewage lagoons. Seepage is a limitation on sites for sewage lagoons. It can be controlled, however, by sealing the lagoon.

The capability subclass is IIc.

Bu—Bippus clay loam, 2 to 5 percent slopes. This gently sloping, well drained soil is in concave areas on foot slopes. Individual areas are irregular in shape and range from about 10 to 50 acres in size.

Typically, the surface layer is dark grayish brown, calcareous clay loam about 20 inches thick. The subsoil to a depth of about 60 inches is brown, friable, calcareous clay loam. In some areas it has thin strata of sand.

Included with this soil in mapping are small areas of Penden soils, which make up about 10 percent of the map unit. These soils are slightly higher on the landscape than the Bippus soil. Also, their surface layer is thinner.

Permeability is moderate in the Bippus soil, and available water capacity is high. Runoff is medium. Natural fertility is high. Tilth is good. The soil is mildly alkaline or moderately alkaline throughout. The shrink-swell potential is moderate.

Most of the acreage supports native grasses. This soil is well suited to range. If the range is overgrazed, however, the natural plant community deteriorates and desirable grasses are replaced by less productive grasses and by weeds. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition.

This soil is moderately well suited to wheat and sorghum. If cultivated crops are grown, erosion is a hazard. Summer fallowing, terracing, farming on the contour, and keeping crop residue on the surface help to control erosion and conserve moisture.

This soil is moderately well suited to dwellings. The shrink-swell potential is a limitation. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse material, however, help to prevent the structural damage caused by shrinking and swelling. In some areas the soil is subject to flooding because of the runoff from the higher lying adjacent slopes. Diversion terraces reduce this hazard.

This soil is well suited to septic tank absorption fields and is moderately well suited to sewage lagoons. Seepage and slope are limitations on sites for sewage lagoons. Sealing the lagoon helps to control seepage. Some land shaping commonly is needed.

The capability subclass is IIIe.

Cc—Campus-Canlon loams, 5 to 15 percent slopes. These moderately sloping and strongly sloping soils are on the tops and sides of upland ridges dissected by deeply entrenched drainageways. The moderately deep, well drained Campus soil is on ridgetops. The shallow, somewhat excessively drained Canlon soil is on the steeper slopes. Individual areas are irregular in shape and range from about 50 to several hundred acres in size. They are about 55 percent Campus soil and 40 percent Canlon soil. The two soils occur as areas so intricately mixed or small that mapping them separately is not practical.

Typically, the Campus soil has a grayish brown, calcareous loam surface layer about 8 inches thick. The subsoil is light brownish gray, friable, calcareous clay loam about 7 inches thick. The substratum is light yellowish brown, calcareous clay loam. White caliche bedrock is at a depth of about 28 inches (fig. 9). In some areas the depth to bedrock is more than 40 inches.

Typically, the Canlon soil has a grayish brown, calcareous loam surface layer about 5 inches thick. The next 4 inches is light brownish gray, calcareous loam. The substratum is very pale brown, calcareous loam. White, hard caliche bedrock is at a depth of about 13 inches.

Included with these soils in mapping are small areas where caliche crops out. These areas are on the steeper slopes. They make up about 5 percent of the unit.

Permeability is moderate in the Campus and Canlon soils. Available water capacity is low in the Campus soil and very low in the Canlon soil. Runoff is rapid on both soils. Natural fertility is medium. Root penetration is restricted by the caliche at a depth of about 28 inches in the Campus soil and about 13 inches in the Canlon soil. The surface layer of both soils is mildly alkaline or moderately alkaline.

Almost all of the acreage is used as range (fig. 10). These soils are unsuited to cultivated crops because they are droughty and are highly susceptible to erosion. They are best suited to range. The main concern of management is the droughtiness caused by the low or very low available water capacity. An adequate plant cover and ground mulch help to prevent excessive runoff and improve the available water capacity. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition.

These soils generally are unsuitable as sites for dwellings, septic tank absorption fields, and sewage lagoons because of the slope and the depth to bedrock.

The capability subclass is VIe.

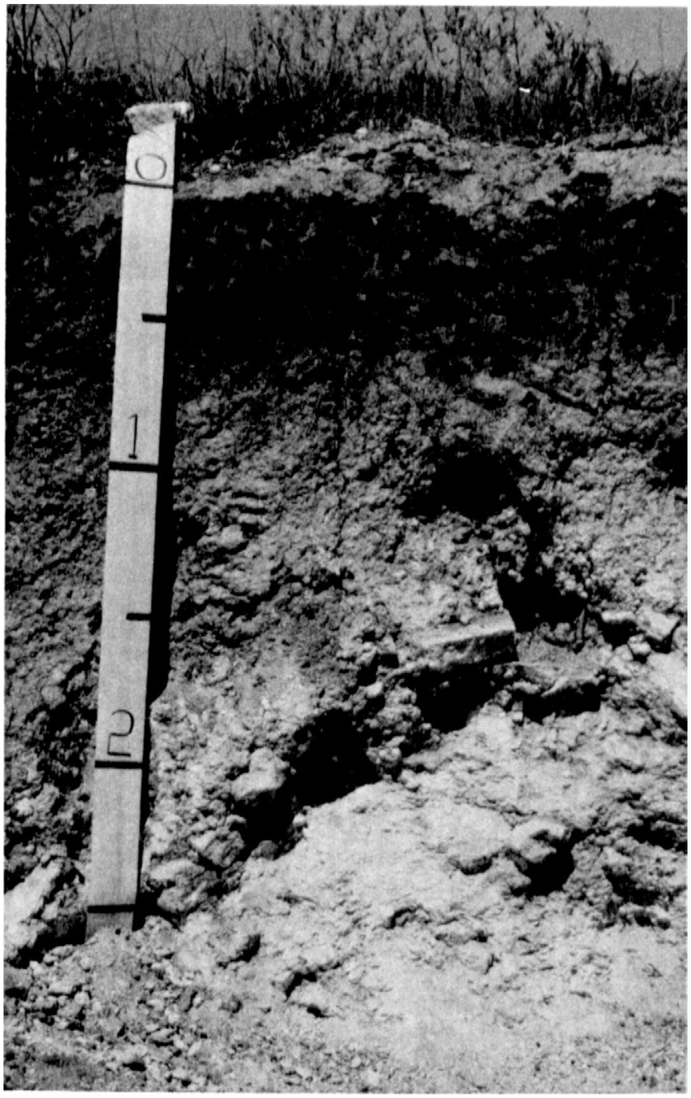


Figure 9.—Typical profile of Campus loam. Caliche bedrock is at a depth of about 28 inches. Depth is marked in feet.

Ch—Canlon-Rock outcrop complex, 5 to 30 percent slopes. This moderately sloping to steep map unit occurs as areas of a shallow, somewhat excessively drained Canlon soil intricately mixed with areas of Rock outcrop. It is on uplands. The Canlon soil is on ridgetops and the upper side slopes, and the Rock outcrop is on the steeper slopes (fig. 11). Individual areas are irregular in shape and range from 50 to several hundred acres in size. They are about 70 percent Canlon soil and 10 percent Rock outcrop. The Canlon soil and Rock outcrop occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the Canlon soil has a grayish brown, calcareous loam surface layer about 5 inches thick. The next 4 inches is light brownish gray, friable, calcareous loam. The substratum is very pale brown, calcareous loam. White, hard caliche bedrock is at a depth of about 13 inches (fig. 12). In some areas it is within a depth of 10 inches.

The Rock outcrop is slightly weathered or hard caliche.

Included with the Canlon soil and Rock outcrop in mapping are small areas of Albion, Campus, and Penden soils, which make up about 20 percent of the map unit. Albion soils are on convex ridges and side slopes along narrow drainageways. They are more sandy than the Canlon soil. The moderately deep, well drained Campus soils and deep, well drained Penden soils are on the higher parts of the landscape.

Permeability is moderate in the Canlon soil, and available water capacity is very low. Runoff is rapid. Natural fertility is medium. Root penetration is restricted by the caliche at a depth of about 13 inches.

Nearly all areas of the Canlon soil support native grasses. This map unit is best suited to range. The major

Figure 10.—An area of Campus-Canlon loams, 5 to 15 percent slopes, used as range. The well in the foreground is used for watering cattle.

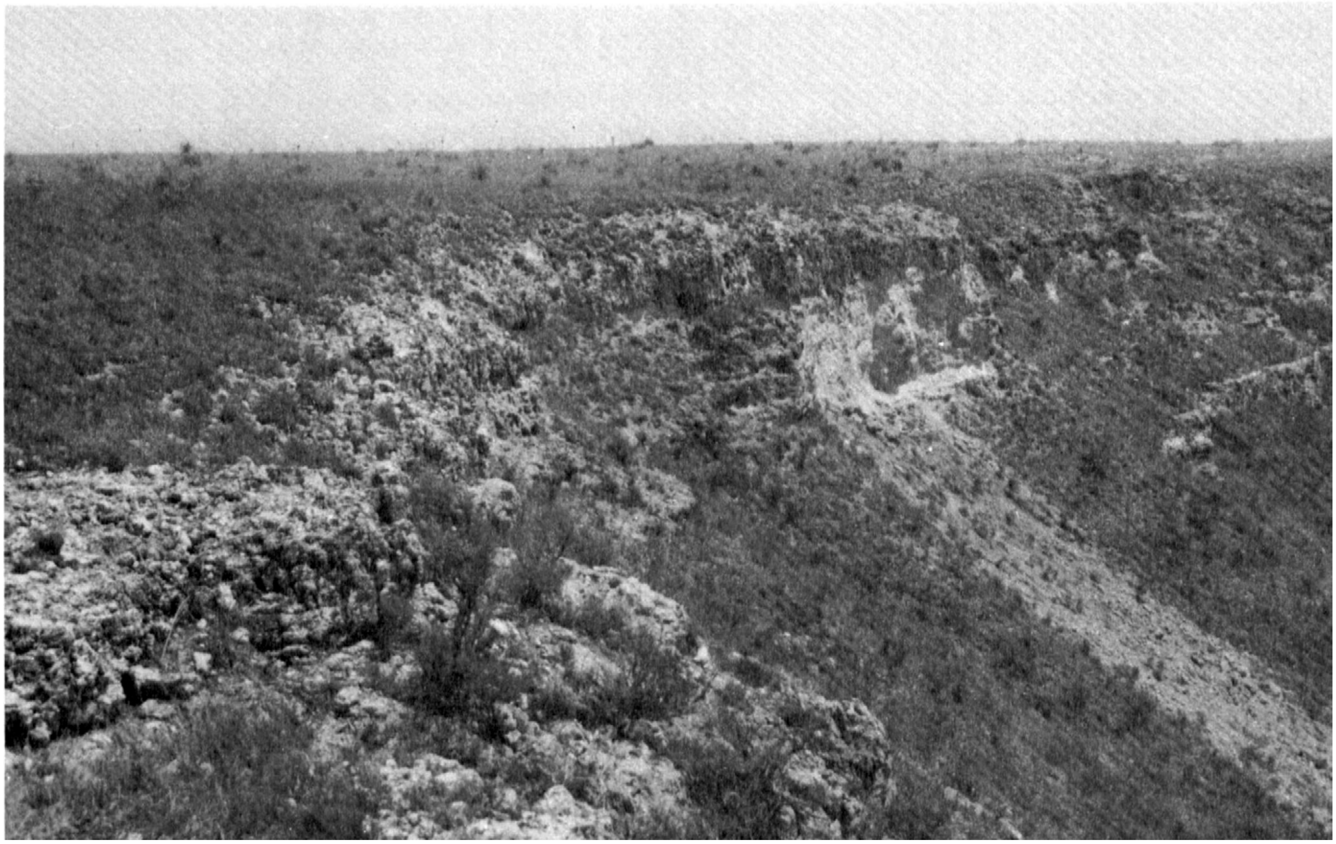


Figure 11.—An area of Canlon-Rock outcrop complex, 5 to 30 percent slopes.

concern in managing the range is the droughtiness caused by the very low available water capacity. An adequate plant cover helps to prevent excessive runoff and conserves moisture. Overgrazing reduces the extent of the protective plant cover and causes deterioration of the plant community. Under these conditions, the taller, more desirable grasses are replaced by less productive short grasses. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition.

This map unit generally is unsuitable as a site for dwellings, septic tank absorption fields, and sewage lagoons because of the depth to bedrock and the slope.

The capability subclass is VIIs.

Cr—Carey silt loam, 0 to 1 percent slopes. This deep, nearly level, well drained soil is on uplands. Individual areas are irregular in shape and range from 160 to several hundred acres in size.

Typically, the surface layer is brown silt loam about 7 inches thick. The subsurface layer is brown loam about 4 inches thick. The subsoil is friable loam about 13 inches thick. The upper part is dark brown, and the lower part is light brown and calcareous. The substratum to a depth of about 60 inches is light reddish brown, calcareous loam. In some areas the surface layer is calcareous.

Included with this soil in mapping are small areas of the moderately deep Woodward soils on side slopes. These soils make up about 10 percent of the map unit.

Permeability is moderate in the Carey soil, and available water capacity is high. Runoff is slow. Natural fertility is high. Tilth is good. The surface layer is neutral or mildly alkaline.

Nearly all of the acreage is used for cultivated crops. This soil is well suited to wheat, sorghum, and alfalfa (fig. 13). Inadequate rainfall is the main limitation, and soil blowing is the main hazard. Summer fallowing, minimizing tillage, and stubble mulching conserve moisture and help to control soil blowing. In some areas the crops receive runoff from the higher lying adjacent soils.

This soil is well suited to dwellings and septic tank absorption fields and is moderately well suited to sewage lagoons. Seepage is a limitation on sites for sewage lagoons. It can be controlled by sealing the lagoon.

The capability subclass is IIc.

Cs—Carey silt loam, 1 to 3 percent slopes. This deep, gently sloping, well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 80 to several hundred acres in size.

Typically, the surface layer is brown silt loam about 6 inches thick. The subsurface layer is brown loam about 4 inches thick. The subsoil is friable loam about 13 inches thick. The upper part is brown, and the lower part is light brown and calcareous. The substratum to a depth of about 60 inches is reddish brown, calcareous loam. In some areas the surface layer is calcareous.

Included with this soil in mapping are small areas of the shallow Quinlan and moderately deep Woodward soils on the lower side slopes. These soils make up about 15 percent of the map unit.

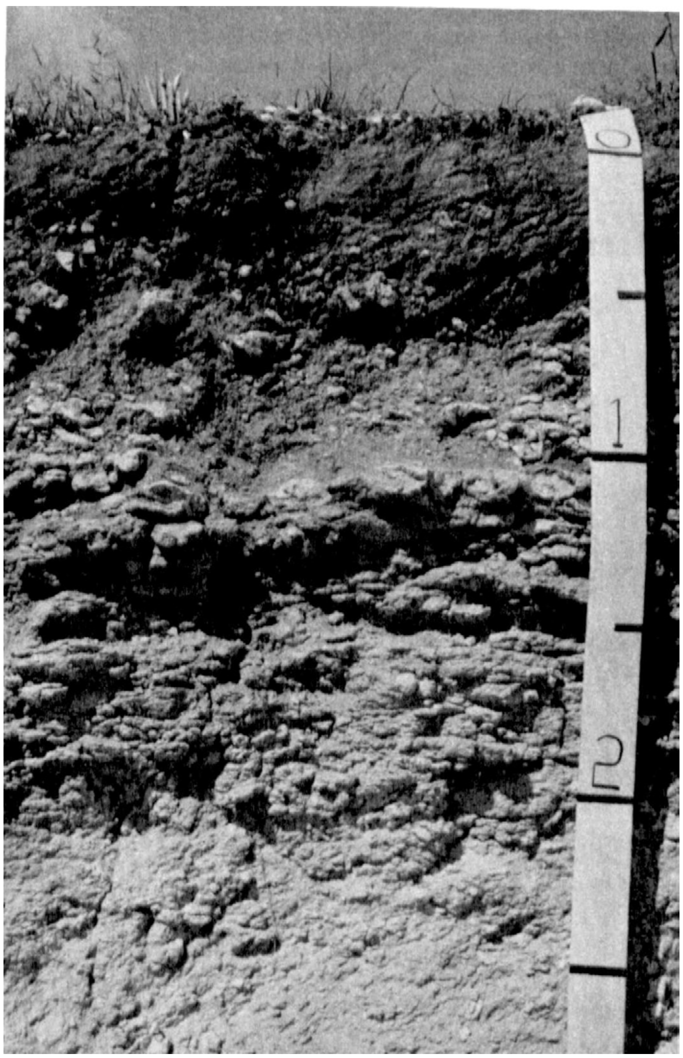


Figure 12.—Typical profile of Canlon loam. Caliche bedrock is at a depth of about 13 inches. Depth is marked in feet.

Permeability is moderate in the Carey soil, and available water capacity is high. Runoff is medium. Natural fertility is high. Tilth is good. The surface layer is neutral or mildly alkaline.

Most of the acreage is used for cultivated crops, but a few areas are used as range. This soil is well suited to wheat and sorghum. If cultivated crops are grown, measures that help to control erosion and soil blowing and conserve moisture are the main management needs. Examples are summer fallowing, terraces, grassed waterways, contour farming, and minimum tillage.

This soil is well suited to range. Overgrazing, however, reduces the vigor and retards the growth of the tall, palatable grasses. Under these conditions, the shorter, less productive grasses are established. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition.

This soil is well suited to dwellings and septic tank absorption fields and is moderately well suited to sewage lagoons. Slope and seepage are limitations on sites for sewage lagoons. Some land shaping commonly is needed. Sealing the lagoon helps to control seepage.

The capability subclass is IIe.

Cy—Carey silt loam, 3 to 6 percent slopes. This deep, moderately sloping, well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 40 to several hundred acres in size.

Typically, the surface layer is brown silt loam about 9 inches thick. The subsoil is friable loam about 12 inches thick. The upper part is dark brown, and the lower part is light brown and calcareous. The substratum to a depth of about 60 inches is reddish brown, calcareous loam. In some areas the surface layer is calcareous.

Included with this soil in mapping are small areas of the shallow Quinlan and moderately deep Woodward soils on the lower side slopes. These soils make up about 15 percent of the map unit.

Permeability is moderate in the Carey soil, and available water capacity is high. Runoff is medium. Natural fertility is high. Tilth is good. The surface layer is neutral or mildly alkaline.

Most of the acreage is used for cultivated crops, but a few areas are used as range. This soil is moderately well suited to wheat and sorghum. If cultivated crops are grown, measures that help to control erosion and conserve moisture are the main management needs. Examples are summer fallowing, terraces, grassed waterways, contour farming, and minimum tillage.

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

Figure 13.—Hay on Carey silt loam, 0 to 1 percent slopes.

palatable grasses. Under these conditions, the shorter, less productive grasses are established. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition.

This soil is well suited to dwellings and septic tank absorption fields and is moderately well suited to sewage lagoons. Slope and seepage are limitations on sites for sewage lagoons. Some land shaping commonly is needed. Sealing the lagoon helps to control seepage.

The capability subclass is IIIe.

Ha—Harney silt loam, 0 to 1 percent slopes. This deep, nearly level, well drained soil is on broad upland ridgetops. Individual areas are irregular in shape and are several hundred acres in size.

Typically, the surface layer is grayish brown silt loam about 7 inches thick. The subsurface layer is dark grayish brown silt loam about 5 inches thick. The subsoil is silty clay loam about 18 inches thick. The upper part is dark grayish brown and firm, the next part is grayish brown and firm, and the lower part is brown, friable, and calcareous (fig. 14). The substratum to a depth of about 60 inches is calcareous silt loam. The upper part is pale brown, and the lower part is very pale brown. In some areas the surface layer is silty clay loam.

Permeability is moderately slow, and available water capacity is high. Runoff is slow. Natural fertility is high. Tilth is good. The surface layer is medium acid to neutral. The shrink-swell potential is moderate in the subsoil.

Nearly all of the acreage is used for cultivated crops. This soil is well suited to wheat and sorghum. Conserving moisture and controlling soil blowing are the main concerns of management. Summer fallowing and minimum tillage conserve moisture. Stripcropping and leaving crop residue on the surface help to control soil blowing.

This soil is moderately well suited to dwellings, septic tank absorption fields, and sewage lagoons. The shrink-swell potential is a limitation on sites for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse material, however, help to prevent the structural damage caused by shrinking and swelling. The moderately slow permeability restricts the absorption of effluent in septic tank absorption fields. It can be overcome, however, by enlarging the field or by installing the lateral lines below the subsoil. Seepage is a limitation on sites for sewage lagoons, but it can be controlled by sealing the lagoon.

The capability subclass is IIc.

Hb—Harney silt loam, 1 to 3 percent slopes. This deep, gently sloping, well drained soil is on the convex tops and sides of upland ridges. Individual areas are irregular in shape and are several hundred acres in size.

Typically, the surface layer is grayish brown silt loam about 5 inches thick. The subsurface layer is dark grayish brown silty clay loam about 4 inches thick. The subsoil is silty clay loam about 17 inches thick. The upper part is dark grayish brown and firm, the next part is grayish brown and firm, and the lower part is brown, friable, and calcareous. The substratum to a depth of about 60 inches is calcareous silt loam. The upper part is pale brown, and the lower part is very pale brown.

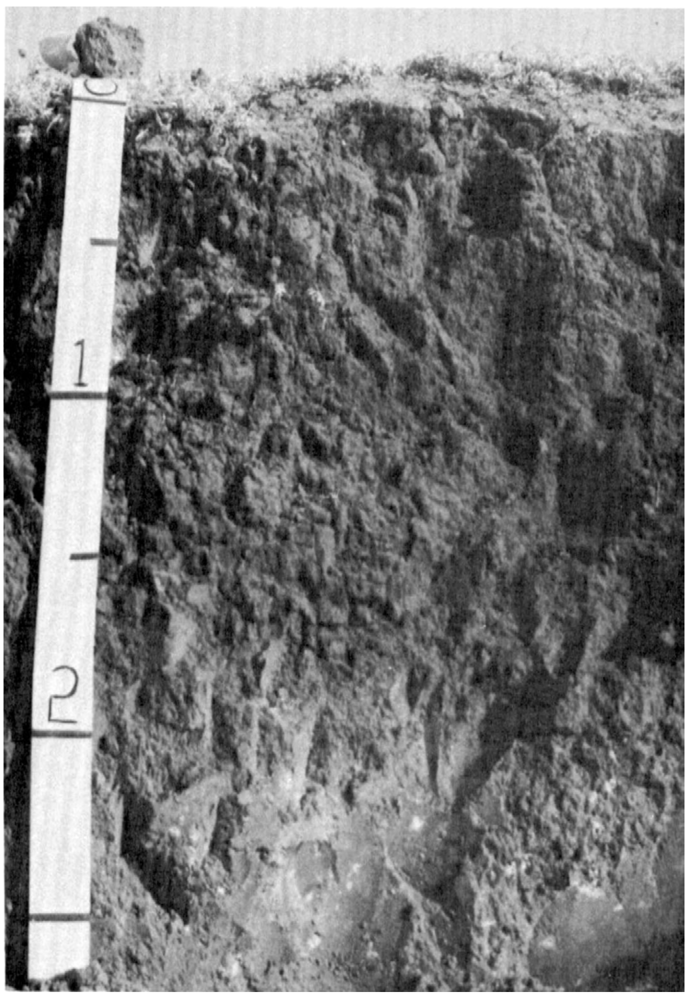


Figure 14.—Typical profile of Harney silt loam, 0 to 1 percent slopes. Lime is below at a depth of about 25 inches. Depth is marked in feet.

Included with this soil in mapping are small areas of Uly soils, which make up about 10 percent of the map unit. These soils generally are adjacent to the steeper drainageways. Their subsoil is less clayey than that of the Harney soil.

Permeability is moderately slow in the Harney soil, and available water capacity is high. Runoff is medium. Natural fertility is high. Tilth is good. The surface layer is medium acid or neutral. The shrink-swell potential is moderate in the subsoil.

Nearly all of the acreage is used for cultivated crops. This soil is well suited to wheat and sorghum. If cultivated crops are grown, erosion is a hazard. Terracing, farming on the contour, returning crop residue to the soil, and minimizing tillage help to prevent excessive runoff and erosion and conserve moisture.

This soil is moderately well suited to dwellings, septic tank absorption fields, and sewage lagoons. The shrink-swell potential is a limitation on sites for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse material, however, help to prevent the structural damage caused by shrinking and swelling. The moderately slow permeability restricts the absorption of effluent in septic tank absorption fields. It can be overcome, however, by enlarging the field or by installing the lateral lines below the subsoil. Slope and seepage are limitations on sites for sewage lagoons. Some land shaping commonly is needed. Sealing the lagoon helps to control seepage.

The capability subclass is IIe.

Ka—Kingsdown fine sandy loam, 0 to 2 percent slopes. This deep, nearly level, well drained soil is on uplands. Individual areas are irregular in shape and range from about 25 to several hundred acres in size.

Typically, the surface layer is dark grayish brown fine sandy loam about 10 inches thick. The subsoil is brown, very friable, calcareous fine sandy loam about 12 inches thick. The substratum to a depth of about 60 inches is pale brown, calcareous fine sandy loam. In some areas the subsoil is loamy fine sand.

Included with this soil in mapping are small areas of Uly soils, which make up about 10 percent of the map unit. These soils are more silty than the Kingsdown soil. They are in slightly concave areas.

Permeability is moderately rapid in the Kingsdown soil, and available water capacity is moderate. Runoff is slow. Natural fertility is medium. Tilth is good. The surface layer is neutral or mildly alkaline.

Most of the acreage is used for cultivated crops. This soil is moderately well suited to grain sorghum and wheat. Soil blowing is a serious hazard unless the surface is protected by a cover of crops or crop residue. Stripcropping helps to control soil blowing and conserves moisture.

This soil is well suited to dwellings and septic tank absorption fields. It is poorly suited to sewage lagoons, however, because of seepage. Sealing the lagoon helps to control seepage.

The capability subclass is IIe.

Kb—Kingsdown fine sandy loam, 2 to 5 percent slopes. This deep, undulating, well drained soil is on uplands. Individual areas are irregular in shape and range from about 30 to 100 acres in size.

Typically, the surface layer is dark grayish brown fine sandy loam about 7 inches thick. The subsoil is brown, very friable, calcareous fine sandy loam about 12 inches thick. The substratum to a depth of about 60 inches is pale brown, calcareous fine sandy loam.

Included with this soil in mapping are small areas of Penden soils, which make up about 10 percent of the map unit. These soils are in concave areas. Their subsoil contains more clay than that of the Kingsdown soil.

Permeability is moderately rapid in the Kingsdown soil, and available water capacity is moderate. Runoff is slow. Natural fertility is medium. Tilth is good. The surface layer is neutral or mildly alkaline.

Most of the acreage is used for cultivated crops. The rest is used as range. This soil is moderately well suited to grain sorghum and wheat. If cultivated crops are grown, soil blowing is a hazard. Returning crop residue to the soil, stripcropping, and minimizing tillage help to control soil blowing and conserve moisture.

This soil is well suited to range. Overgrazing, however, reduces the vigor and retards the growth of the tall grasses. Under these conditions, the shorter, less productive grasses are established. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition.

This soil is well suited to dwellings and septic tank absorption fields. It is poorly suited to sewage lagoons, however, because of seepage. Sealing the lagoon helps to control seepage.

The capability subclass is IIIe.

Kr—Krier loam. This deep, nearly level, somewhat poorly drained soil is on flood plains and stream terraces. It is occasionally flooded for very brief periods. Individual areas are irregular in shape and range from 50 to several hundred acres in size.

Typically, the surface layer is grayish brown, calcareous loam about 3 inches thick. The upper 10 inches of the substratum is grayish brown, dark grayish brown, and light brownish gray, mottled, calcareous loam and clay loam. The lower part to a depth of about 60 inches is pale brown, mottled sand.

Included with this soil in mapping are small areas of the somewhat excessively drained Lincoln soils on the slightly higher parts of the landscape. These soils make up about 10 percent of the map unit.

Permeability is rapid in the Krier soil, and available water capacity is low. Runoff is slow. A seasonal high water table is at a depth of 1 to 3 feet. Natural fertility is low. The surface layer is mildly alkaline or moderately alkaline. The content of sodium and soluble salts in the substratum adversely affects the growth of most plants.

Most areas are used as range. This soil generally is unsuited to cultivated crops because of the saline-alkali condition and the low available water capacity. It is moderately well suited to range. The growth and composition of the grasses varies because of the differences in the degree of salinity and the content of sodium. A uniform distribution of grazing is needed. The distribution of livestock can be controlled by fences and by properly distributed salting facilities. The less desirable grasses and brush invade overgrazed areas. Proper stocking rates and timely deferment of grazing help to keep the range in good condition.

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

The capability subclass is VIs.

Lb—Lesho clay loam. This nearly level, somewhat poorly drained soil is on flood plains. It is occasionally flooded for very brief periods. Individual areas are irregular in shape and range from about 10 to 160 acres in size.

Typically, the surface layer is dark grayish brown, calcareous clay loam about 10 inches thick. The upper part of the substratum is brown and dark grayish brown, calcareous clay loam. The lower part to a depth of about 60 inches is pale brown sand.

Included with this soil in mapping are small areas of Lincoln and Waldeck soils in similar positions on the landscape. These soils are more sandy than the Lesho soil. They make up about 20 percent of the map unit.

Permeability is moderately slow in the Lesho soil, and available water capacity is low. Runoff is slow. A seasonal high water table is at a depth of 2 to 4 feet. Natural fertility is medium. The shrink-swell potential is moderate in the upper part of the soil.

Most of the acreage is used as range, but a few areas are used for cultivated crops. This soil is well suited to range. Overgrazing, however, reduces the vigor and retards the growth of the desirable grasses. Under these conditions, the shorter, less productive grasses are established. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition. Livestock are likely to damage the turf by trampling if the range is grazed during wet periods.

This soil is moderately well suited to wheat and sorghum. The flooding is the main concern of management. Dikes, levees, and other structures help to control floodwater.

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

The capability subclass is IIIw.

Le—Lesho clay loam, saline. This nearly level, somewhat poorly drained soil is on flood plains and terraces characterized by many irregularly shaped microdepressions. It is subject to rare flooding. Individual areas are irregular in shape and range from 50 to several hundred acres in size.

Typically, the surface layer is dark grayish brown, calcareous clay loam about 10 inches thick. The upper part of the substratum is dark grayish brown and light brownish gray, mottled, calcareous clay loam. The lower part to a depth of about 60 inches is pale brown sand.

Included with this soil in mapping are small areas of Waldeck soils in similar positions on the landscape. These soils are more sandy than the Lesho soil. They make up about 10 percent of the map unit.

Permeability is moderately slow in the Lesho soil, and available water capacity is moderate. Runoff is slow. A seasonal high water table is at a depth of 2 to 4 feet. The soil is mildly alkaline or moderately alkaline throughout. The upper part of the substratum is moderately affected by soluble salts and exchangeable sodium. The microdepressions are more strongly affected than the higher lying areas. The shrink-swell potential is moderate in the upper part of the soil.

Nearly all of the acreage supports native grasses. This soil is poorly suited to cultivated crops because of the excess salts and sodium. It is moderately well suited to range. If the range is overgrazed, the natural plant community deteriorates and the desirable grasses are replaced by less productive grasses and by weeds and brush. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition.

This soil generally is unsuitable as a site for dwellings, septic tank absorption fields, and sewage lagoons because of the flooding and the wetness. Overcoming the flooding is difficult without major flood control measures.

The capability subclass is IVs.

Lf—Likes loamy sand, undulating. This deep, excessively drained soil is on foot slopes. Individual areas are irregular in shape and range from about 10 to several hundred acres in size.

Typically, the surface layer is brown loamy sand about 10 inches thick. The substratum to a depth of about 60 inches is loamy sand. It is brown in the upper part and reddish yellow in the lower part.

Included with this soil in mapping are small areas of Kingsdown, Penden, and Waldeck soils, which make up about 15 percent of the map unit. Kingsdown and Penden soils are on uplands. Their subsoil is more clayey than that of the Likes soil. The somewhat poorly drained Waldeck soils are on flood plains.

Permeability is rapid in the Likes soil, and available water capacity is low. Runoff is slow. Natural fertility is low. The surface layer is mildly alkaline or moderately alkaline.

Nearly all of the acreage supports native grasses. This soil is best suited to range. A permanent cover of native grasses helps to prevent excessive soil blowing. Proper stocking rates, timely deferment of grazing, and a uniform distribution of grazing help to keep the range in good condition. Fences and well distributed salting facilities help to control the distribution of grazing.

This soil is well suited to dwellings. It generally is unsuitable, however, as a site for sewage lagoons and septic tank absorption fields because of seepage and a poor filtering capacity. Some areas of the loamy included soils are suitable sites for septic tank absorption fields.

The capability subclass is VIe.

Lh—Likes-Quinlan complex, 3 to 15 percent slopes. These moderately sloping and strongly sloping soils are on knolls, ridges, and side slopes on uplands dissected by shallow drainageways. The deep, excessively drained Likes soil is in the less sloping areas. The shallow, well drained Quinlan soil is on the convex tops of ridges and on the sides of drainageways. Individual areas are irregular in shape and range from 100 to several hundred acres in size. They are about 60 percent Likes soil and 30 percent Quinlan soil. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the Likes soil has a grayish brown loamy sand surface layer about 8 inches thick. The substratum to a depth of about 60 inches is reddish yellow sand.

Typically, the Quinlan soil has a reddish brown loam surface layer about 6 inches thick. The subsoil is reddish brown, friable loam about 7 inches thick. Red sandstone bedrock is at a depth of about 13 inches.

Included with these soils in mapping are small areas of the deep, well drained Kingsdown and Penden soils, which make up about 10 percent of the map unit. Kingsdown soils are in positions on the landscape similar to those of the Likes soil. Penden soils are on convex slopes.

Permeability is rapid in the Likes soil and moderately rapid in the Quinlan soil. Available water capacity is low in the Likes soil and very low in the Quinlan soil. Runoff is slow on the Likes soil and rapid on the Quinlan soil. Natural fertility is low in both soils.

Nearly all of the acreage is used as range. These soils generally are unsuited to cultivated crops because they are droughty and highly susceptible to erosion. They are best suited to range. The main concern in managing the range is the droughtiness caused by the low or very low available water capacity. An adequate plant cover and ground mulch reduce the runoff rate and increase the available water capacity. Overgrazing results in deterioration of the natural plant community and the invasion of weeds. Proper stocking rates and timely deferment of grazing help to keep the range in good condition.

The Likes soil is well suited to dwellings, but the Quinlan soil is poorly suited, mainly because it is shallow. Both soils generally are unsuitable as sites for sewage lagoons and septic tank absorption fields because of seepage and a poor filtering capacity in the Likes soil and the shallowness to bedrock in the Quinlan soil. The deep, loamy included soils are suitable sites for septic tank absorption fields.

The capability subclass is VIe.

Ln—Lincoln loamy fine sand. This deep, nearly level, somewhat excessively drained soil is on flood plains. In most areas it is occasionally flooded for very brief periods, but in some areas it is rarely flooded. Individual areas are irregular in shape and range from about 50 to several hundred acres in size.

Typically, the surface layer is brown, calcareous loamy fine sand about 13 inches thick. The substratum to a depth of about 60 inches is very pale brown, calcareous fine sand. In some areas it is coarse sand or gravelly sand.

Included with this soil in mapping are small areas of the somewhat poorly drained Krier soils in swales. These soils make up about 10 percent of the map unit.

Permeability is rapid in the Lincoln soil, and available water capacity is low. Runoff is slow. A seasonal high water table is at a depth of 5 to 8 feet. Natural fertility is low. The surface layer is mildly alkaline or moderately alkaline.

Nearly all of the acreage supports native grasses. This soil is best suited to range. It generally is unsuited to cultivated crops because it is droughty. The major concerns in managing the range are soil blowing and the invasion of brush. An adequate plant cover helps to prevent excessive soil blowing. Overgrazing reduces the vigor and retards the growth of the tall, palatable grasses. Under these conditions, the shorter, less productive grasses are established. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition and help to prevent the invasion of undesirable vegetation.

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

The capability subclass is VIs.

Lr—Lincoln-Krier complex. These deep, nearly level soils are on flood plains. They are occasionally flooded for brief or very brief periods. The somewhat excessively drained Lincoln soil is slightly higher on the landscape than the somewhat poorly drained Krier soil. Individual areas are irregular in shape and range from 50 to several hundred acres in size. They are 50 to 75 percent Lincoln soil and 15 to 40 percent Krier soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Lincoln soil has a grayish brown loamy fine sand surface layer about 8 inches thick. The substratum to a depth of about 60 inches is very pale brown, calcareous fine sand. In some areas the surface layer is very dark grayish brown sandy loam or loam.

Typically, the Krier soil has a grayish brown sandy loam surface layer about 4 inches thick. The upper part of the substratum is light brownish gray sandy loam. The lower part to a depth of about 60 inches is pale brown, mottled fine sand.

Included with these soils in mapping are small areas of Lesho and Waldeck soils and small areas of marsh. Lesho and Waldeck soils are more than 20 inches deep over sandy sediments. They are on the higher parts of the landscape. The areas of marsh are in depressions. Included areas make up about 15 percent of the map unit.

Permeability is rapid in the Lincoln and Krier soils, and available water capacity is low. Runoff is slow. A seasonal high water table is at a depth of 5 to 8 feet in the Lincoln soil and 1 to 3 feet in the Krier soil. The surface layer in both soils is moderately alkaline. The Krier soil is slightly saline or moderately saline.

Nearly all of the acreage supports native grasses. Because of droughtiness and excess salts and sodium, these soils generally are unsuited to cultivated crops. They are best suited to range. Overgrazing reduces the extent of the protective plant cover and results in a deterioration of the plant community. Under these conditions, the taller, more desirable grasses are replaced by less productive grasses and by brush. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition. Hay should be cut early enough for the grasses to maintain plant vigor.

These soils generally are unsuitable as sites for dwellings, septic tank absorption fields, and sewage lagoons because of the wetness and the flooding. Overcoming the flooding is difficult without major flood control measures.

The capability subclass is VIs.

Ms—Missler silty clay loam, 0 to 2 percent slopes. This deep, nearly level, well drained soil is in broad upland areas dissected by a few intermittent streams. Individual areas are irregular in shape and range from 30 to several hundred acres in size.

Typically, the surface layer is dark grayish brown silty clay loam about 10 inches thick. The subsoil is brown, firm silty clay loam about 14 inches thick. The substratum to a depth of about 60 inches is pale brown silty clay loam. In some areas the surface layer is calcareous. In other areas the subsoil is reddish brown.

Included with this soil in mapping are small areas of the loamy Penden soils in similar positions on the landscape. These soils make up about 10 percent of the map unit.

Permeability is moderately slow in the Missler soil, and available water capacity is high. Runoff is slow. Natural fertility is high. Tilth is good. The surface layer and subsoil are mildly alkaline or moderately alkaline. The shrink-swell potential is moderate.

Most of the acreage is used for cultivated crops. Only a few areas are used as range. This soil is well suited to wheat and sorghum (fig. 15). Inadequate rainfall is the main limitation. Summer fallowing, minimizing tillage, and leaving crop residue on the surface conserve moisture, increase the infiltration rate, and improve tilth. Level terraces also conserve moisture.

This soil is well suited to sewage lagoons. It is moderately well suited to dwellings and septic tank absorption fields. The shrink-swell potential is a limitation on sites for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse material, however, help to prevent the structural damage caused by shrinking and swelling. The moderately slow permeability restricts the absorption of effluent in septic tank absorption fields. It can be overcome, however, by enlarging the field.

The capability subclass is IIc.

Ns—Ness silty clay. This deep, nearly level, poorly drained soil is in upland depressions. It is frequently ponded. Individual areas are oval or oblong and range from 5 to 100 acres in size.

Typically, the surface layer is gray silty clay about 11 inches thick. The subsurface layer is gray, very firm silty clay about 25 inches thick. The substratum to a depth of about 60 inches is light gray, calcareous silty clay loam.

Included with this soil in mapping are small areas of Harney soils, which make up about 5 percent of the map unit. These soils are less clayey than the Ness soil. Also, they are slightly higher on the landscape.

Permeability is very slow in the Ness soil, and

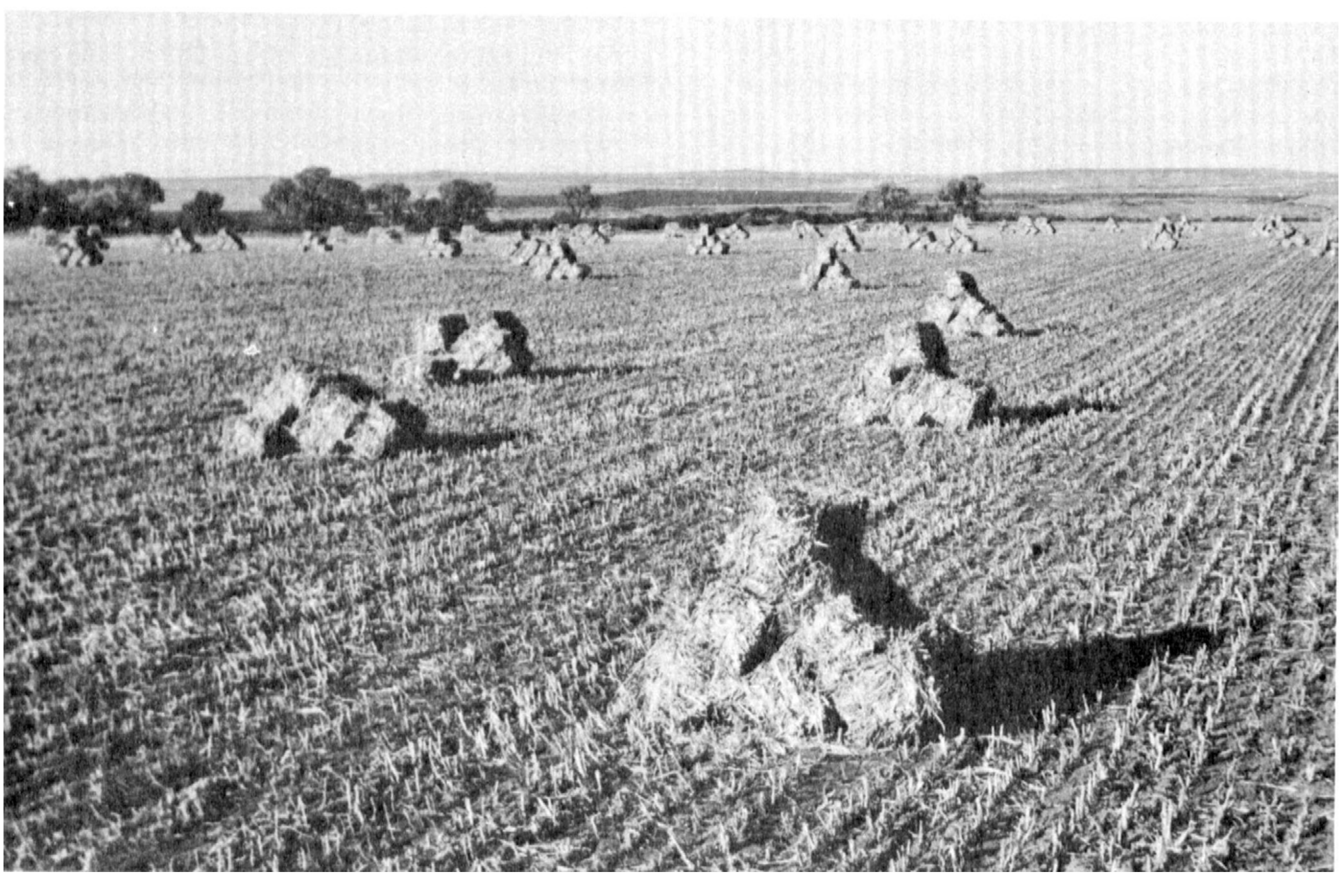


Figure 15.—Baled forage sorghum on Missler silty clay loam, 0 to 2 percent slopes.

Figure 16.—An area of Owens silty clay, 6 to 25 percent slopes.

available water capacity is moderate. Runoff is ponded. A seasonal high water table is near or above the surface in the spring. Natural fertility is high. The surface layer is very firm and cannot be easily tilled. It is neutral or mildly alkaline. The shrink-swell potential is high in the surface layer and subsurface layer.

In most areas this soil is cultivated along with the surrounding soils. It is poorly suited to cultivated crops. Wheat and grain sorghum are the main crops. The ponding delays planting and harvesting. In periods of heavy rainfall, crops are frequently drowned out unless the soil dries out in time for replanting. An open drainage system helps to control the ponding. Soil blowing is a hazard during dry periods. It can be controlled, however, by leaving crop residue on the surface and by emergency tillage.

This soil is not well suited to range because the ponding damages native grasses. Plant composition and forage production vary. Most uncultivated areas are ponded, are bare, or support a sparse stand of weeds and western wheatgrass.

Habitat for wetland wildlife can be established on this soil. Because of the ponding during wet periods, shallow water areas are available to waterfowl and other kinds of wetland wildlife. The fields of grain sorghum supply food for pheasants, and the wheat fields commonly supply food and nesting areas.

This soil generally is unsuitable as a site for dwellings, septic tank absorption fields, and sewage lagoons because of the ponding. The well drained surrounding soils are better sites.

The capability subclass is VIw.

Os—Owens silty clay, 6 to 25 percent slopes. This shallow, strongly sloping to steep, well drained soil is on narrow divides and side slopes on uplands incised by drainageways (fig. 16). Individual areas are irregular in shape and range from about 50 to several hundred acres in size.

Typically, the surface layer is grayish brown, calcareous silty clay about 6 inches thick. The subsoil is light yellowish brown, very firm, calcareous silty clay about 11 inches thick. Light brownish gray, clayey shale bedrock is at a depth of about 17 inches. In some areas the shale is at a depth of more than 20 inches. In other areas the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Quinlan, Roxbury, and Woodward soils and small areas where limestone and sandstone crop out. The loamy Quinlan and Woodward soils and the areas where rocks crop out are on the steeper sides of drainageways. Roxbury soils have a loamy subsoil. They are on flood plains along drainageways. Included areas make up about 20 percent of the map unit.

Permeability is very slow in the Owens soil, and available water capacity is very low. Runoff is rapid. Natural fertility is low. The shrink-swell potential is high.

Almost all of the acreage is used as range. This soil generally is unsuited to cultivated crops because it is droughty and is highly susceptible to erosion. It is best suited to range. The main concern in managing the range is the droughtiness caused by the very low available water capacity. An adequate plant cover and ground mulch reduce the runoff rate and improve the available water capacity. Overgrazing reduces the vigor and retards the growth of the tall, palatable grasses. Under these conditions, the shorter, less productive grasses are established. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition.

This soil generally is unsuitable as a site for dwellings, septic tank absorption fields, and sewage lagoons. The slope and the depth to bedrock are the main limitations. Also, the shrink-swell potential is a limitation on sites for dwellings and the very slow permeability is a limitation in septic tank absorption fields.

The capability subclass is VIIs.

Pa—Penden clay loam, 0 to 1 percent slopes. This deep, nearly level, well drained soil is on uplands. Individual areas are irregular in shape and range from 30 to 160 acres in size.

Typically, the surface layer is dark grayish brown, calcareous clay loam about 10 inches thick. The subsurface layer is grayish brown, calcareous clay loam about 8 inches thick. The subsoil is pale brown, friable, calcareous clay loam about 15 inches thick. It has many soft masses and concretions of lime. The substratum to a depth of about 60 inches is very pale brown, calcareous clay loam. In some areas the surface layer is silt loam.

Included with this soil in mapping are small areas of Kingsdown soils on convex ridges. These soils are more sandy than the Penden soil. They make up about 5 to 10 percent of the map unit.

Permeability is moderate in the Penden soil, and available water capacity is high. Runoff is slow. Natural fertility is medium. Tilth is good. The surface layer is mildly alkaline or moderately alkaline. The shrink-swell potential is moderate.

Most of the acreage is cultivated. This soil is well suited to wheat and sorghum. Inadequate rainfall is the main limitation, and soil blowing is the main hazard. Summer fallowing and minimum tillage conserve moisture. Stripcropping and a cover of crop residue help to control soil blowing.

This soil is moderately well suited to dwellings, septic tank absorption fields, and sewage lagoons. The shrink-swell potential is a limitation on sites for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse material, however, help to prevent the structural damage caused by shrinking and swelling. The moderate permeability restricts the absorption of effluent in septic tank absorption fields. It can be overcome, however, by enlarging the field. Seepage is a limitation on sites for sewage lagoons. It can be controlled, however, by sealing the lagoon.

The capability subclass is IIc.

Pb—Penden clay loam, 1 to 3 percent slopes. This deep, gently sloping, well drained soil is on uplands. Individual areas are irregular in shape and range from 20 to several hundred acres in size.

Typically, the surface layer is dark grayish brown, calcareous clay loam about 9 inches thick. The subsurface layer is grayish brown, calcareous clay loam about 7 inches thick. The subsoil is pale brown, friable, calcareous clay loam about 12 inches thick. It has many soft masses and concretions of lime. The substratum to a depth of about 60 inches is very pale brown, calcareous clay loam. In some areas the surface layer is silt loam. In other areas hard caliche bedrock is at a depth of 20 to 40 inches.

Included with this soil in mapping are small areas of Kingsdown soils on convex ridges. These soils are more sandy than the Penden soil. They make up about 10 percent of the map unit.

Permeability is moderate in the Penden soil, and available water capacity is high. Runoff is medium. Natural fertility also is medium. Tilth is good. The surface layer is mildly alkaline or moderately alkaline. The shrink-swell potential is moderate.

Most of the acreage is used for cultivated crops. Only a few areas are used as range. This soil is well suited to wheat and sorghum. If cultivated crops are grown, measures that control erosion and soil blowing are needed. Examples are terraces, grassed waterways, contour farming, a cover of crop residue, and minimum tillage. Summer fallowing conserves moisture.

This soil is moderately well suited to dwellings, septic tank absorption fields, and sewage lagoons. The shrink-swell potential is a limitation on sites for dwellings. Properly designing and reinforcing foundations and backfilling with suitable coarse material, however, help to prevent the structural damage caused by shrinking and swelling. The moderate permeability restricts the absorption of effluent in septic tank absorption fields. It can be overcome, however, by enlarging the field. Seepage and slope are limitations on sites for sewage lagoons. Sealing the lagoon helps to control seepage. Some land shaping commonly is needed.

The capability subclass is IIe.

Pc—Penden clay loam, 3 to 7 percent slopes. This deep, moderately sloping, well drained soil is on convex upland slopes, generally along intermittent drainageways. Individual areas are irregular in shape and range from 20 to 160 acres in size.

Typically, the surface layer is dark grayish brown, calcareous clay loam about 9 inches thick. The subsurface layer is grayish brown, calcareous clay loam about 5 inches thick. The subsoil is pale brown, friable, calcareous clay loam about 12 inches thick. It has many soft masses and concretions of lime (fig. 17). The substratum to a depth of about 60 inches is very pale brown, calcareous clay loam. In some areas the surface layer is silt loam. In other areas hard caliche bedrock is at a depth of 20 to 40 inches.

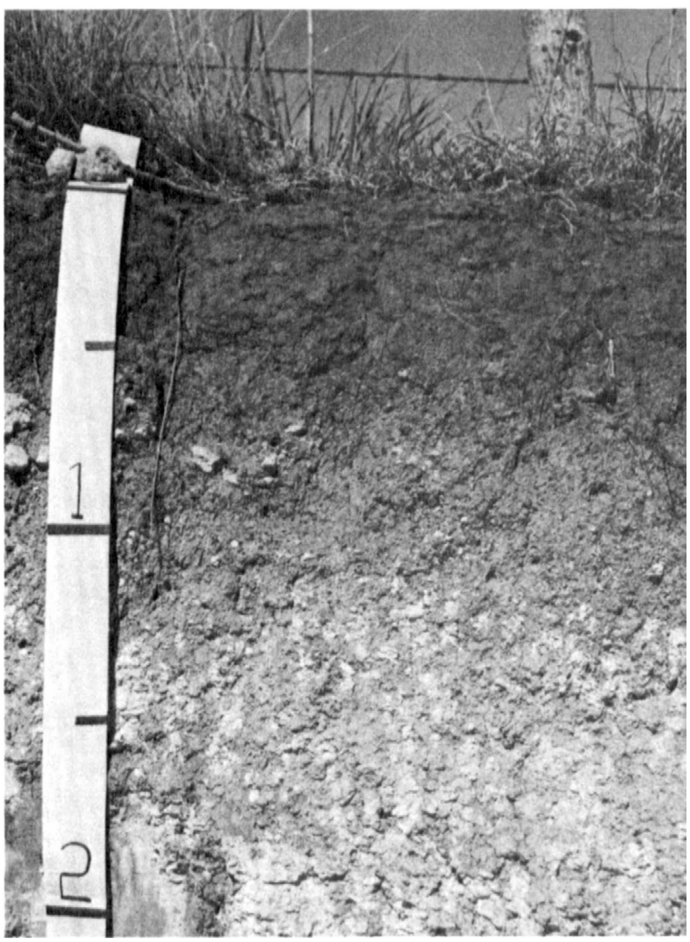


Figure 17.—Profile of Penden clay loam, 3 to 7 percent slopes. Lime concretions are at a depth of about 14 inches. Depth is marked in feet.

Included with this soil in mapping are small areas of Harney soils, which make up about 5 to 10 percent of the map unit. These soils are in slightly concave areas. Their subsoil is more clayey than that of the Penden soil.

Permeability is moderate in the Penden soil, and available water capacity is high. Runoff is medium. Natural fertility also is medium. Tilth is good. The surface layer is mildly alkaline or moderately alkaline. The shrink-swell potential is moderate.

Most of the acreage is used as range, but some areas are used for cultivated crops. This soil is moderately well suited to wheat and sorghum. If cultivated crops are grown, erosion is a hazard. Terracing, establishing grassed waterways, farming on the contour, returning crop residue to the soil, and minimizing tillage help to control erosion and conserve moisture.

This soil is well suited to range. Overgrazing, however, reduces the vigor and retards the growth of the tall, palatable grasses. Under these conditions, the shorter, less productive grasses are established. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition.

This soil is moderately well suited to dwellings, septic tank absorption fields, and sewage lagoons. The shrink-swell potential is a limitation on sites for dwellings. Properly designing and reinforcing foundations and backfilling with suitable coarse material, however, help to prevent the structural damage caused by shrinking and swelling. The moderate permeability restricts the absorption of effluent in septic tank absorption fields. It can be overcome, however, by enlarging the field. Seepage and slope are limitations on sites for sewage lagoons. Sealing the lagoon helps to control seepage. Some land shaping commonly is needed.

The capability subclass is IIIe.

Pf—Penden clay loam, 2 to 7 percent slopes, eroded. This deep, moderately sloping, well drained soil is on convex upland slopes, generally along intermittent drainageways. Individual areas are irregular in shape and range from 20 to 160 acres in size.

Typically, the surface layer is grayish brown, calcareous clay loam about 5 inches thick. Erosion has removed part of the original surface layer, and plowing has mixed material from the subsoil with the remaining surface layer. The subsoil is pale brown, friable, calcareous clay loam about 12 inches thick. It has many soft masses and concretions of lime. The substratum to a depth of about 60 inches is very pale brown, calcareous clay loam. In some areas the surface layer is loam and is more than 10 inches thick. In other areas caliche bedrock is at a depth of 20 to 40 inches.

Included with this soil in mapping are small areas of Harney soils, which make up about 10 percent of the map unit. These soils are more clayey than the Penden soil. They generally are in areas between convex ridges.

Permeability is moderate in the Penden soil, and available water capacity is high. Runoff is rapid. Natural fertility is medium. Tilth is fair. The shrink-swell potential is moderate.

Most of the acreage is used for cultivated crops. This soil is moderately well suited to wheat and sorghum. Further erosion is a hazard if cultivated crops are grown. It can be controlled, however, by terraces, grassed waterways, and contour farming. Returning crop residue to the soil and minimum tillage improve tilth.

This soil is well suited to range. A cover of native grasses is effective in controlling erosion. Range seeding is needed to restore productivity on abandoned cropland. Overgrazing reduces the vigor and retards the growth of the grasses and increases the runoff rate. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition.

This soil is moderately well suited to dwellings, septic tank absorption fields, and sewage lagoons. The shrink-swell potential is a limitation on sites for dwellings. Properly designing and reinforcing foundations and backfilling with suitable coarse material, however, help to prevent the damage caused by shrinking and swelling. The moderate permeability restricts the absorption of effluent in septic tank absorption fields. It can be overcome, however, by enlarging the field. Seepage and slope are limitations on sites for sewage lagoons. Sealing the lagoon helps to control seepage. Some land shaping commonly is needed.

The capability subclass is IVe.

Pg—Penden clay loam, 7 to 15 percent slopes. This deep, strongly sloping, well drained soil is on the sides of drainageways in the uplands. Individual areas are irregular in shape and range from 30 to several hundred acres in size.

Typically, the surface layer is dark grayish brown, calcareous clay loam about 10 inches thick. The subsurface layer is grayish brown, calcareous clay loam about 6 inches thick. The subsoil is pale brown, friable, calcareous clay loam about 12 inches thick. It has many soft masses and concretions of lime. The substratum to a depth of about 60 inches is very pale brown, calcareous clay loam. In some areas caliche bedrock is at a depth of 20 to 40 inches.

Included with this soil in mapping are small areas of Kingsdown and Roxbury soils and pockets of gravel. Kingsdown soils are in positions on the landscape similar to those of the Penden soil. Their subsoil is more sandy than that of the Penden soil. Roxbury soils are on flood plains. Their subsoil is less sandy than that of the Penden soil. The pockets of gravel are on the steeper slopes. Included areas make up about 15 percent of the map unit.

Permeability is moderate in the Penden soil, and available water capacity is high. Runoff is rapid. Natural fertility is medium. The shrink-swell potential is moderate.

Nearly all of the acreage supports native grasses. This soil is best suited to range. It generally is unsuited to cultivated crops because erosion is a severe hazard. Overgrazing reduces the vigor and retards the growth of the grasses and increases the runoff rate. An adequate plant cover reduces the runoff rate. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition. Many areas are potential sites for pond reservoirs.

This soil is moderately well suited to dwellings. The shrink-swell potential and the slope are limitations. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse material help to prevent the structural damage caused by shrinking and swelling. Some land shaping commonly is needed.

This soil is moderately well suited to septic tank absorption fields and is poorly suited to sewage lagoons. The slope is the main limitation. Also, the moderate permeability restricts the absorption of effluent in septic tank absorption fields. It can be overcome, however, by enlarging the field. Because of the slope, the lateral lines should be installed on the contour. The less sloping included soils are better sites for sewage lagoons.

The capability subclass is VIe.

Pr—Pratt loamy fine sand, undulating. This deep, well drained soil is on uplands. Individual areas range from 30 to several hundred acres in size.

Typically, the surface layer is brown loamy fine sand about 11 inches thick. The subsoil is light brown, very friable loamy fine sand about 19 inches thick. The substratum to a depth of about 60 inches is light brown loamy fine sand. In some areas the subsoil is fine sandy loam. In other areas the soil is calcareous below a depth of 6 inches.

Permeability is rapid, and available water capacity is low. Runoff is slow. Natural fertility is low. The surface layer and subsoil are medium acid to neutral.

About half of the acreage is used for cultivated crops, and half is used as range. This soil is moderately well suited to grain sorghum and is poorly suited to wheat. If cultivated crops are grown, soil blowing is a hazard. Leaving crop residue on the surface, minimizing tillage, and stripcropping help to control soil blowing and conserve moisture.

This soil is suited to range. If the range is overstocked and overgrazed, however, the extent of the protective plant cover is reduced and the taller grasses are replaced by less productive short grasses and by weeds and brush. Proper stocking rates, timely deferment of grazing, and a uniform distribution of grazing help to keep the range in good condition.

This soil is well suited to dwellings. Because of seepage and a poor filtering capacity, however, it generally is unsuitable as a site for sewage lagoons and is poorly suited to septic tank absorption fields. It readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of shallow ground water. The areas where the subsoil is loamy are better sites for the absorption fields.

The capability subclass is IIIe.

Pt—Pratt-Tivoli loamy fine sands, rolling. These deep soils are on uplands. The well drained Pratt soil is on the lower side slopes, and the excessively drained Tivoli soil is on the crest of knolls and on the upper slopes. Individual areas are irregular in shape and range from about 50 to several hundred acres in size. They are about 75 percent Pratt soil and 25 percent Tivoli soil. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the Pratt soil has a brown loamy fine sand surface layer about 8 inches thick. The subsoil is brown, very friable loamy fine sand about 22 inches thick. The substratum to a depth of about 60 inches is light brown loamy fine sand. In some areas the subsoil is fine sandy loam.

Typically, the Tivoli soil has a light brownish gray loamy fine sand surface layer about 6 inches thick. The substratum to a depth of about 60 inches is very pale brown fine sand.

Permeability is rapid in both soils, and available water capacity is low. Runoff is slow on the Pratt soil and very slow on the Tivoli soil. Natural fertility is low in both soils.

Nearly all of the acreage supports native grasses (fig. 18). These soils generally are unsuitable for cultivation because of a severe hazard of soil blowing. They are suited to range. Overgrazing, however, reduces the extent of the protective plant cover and thus increases the susceptibility to soil blowing. Under these conditions, the taller grasses are replaced by less productive short

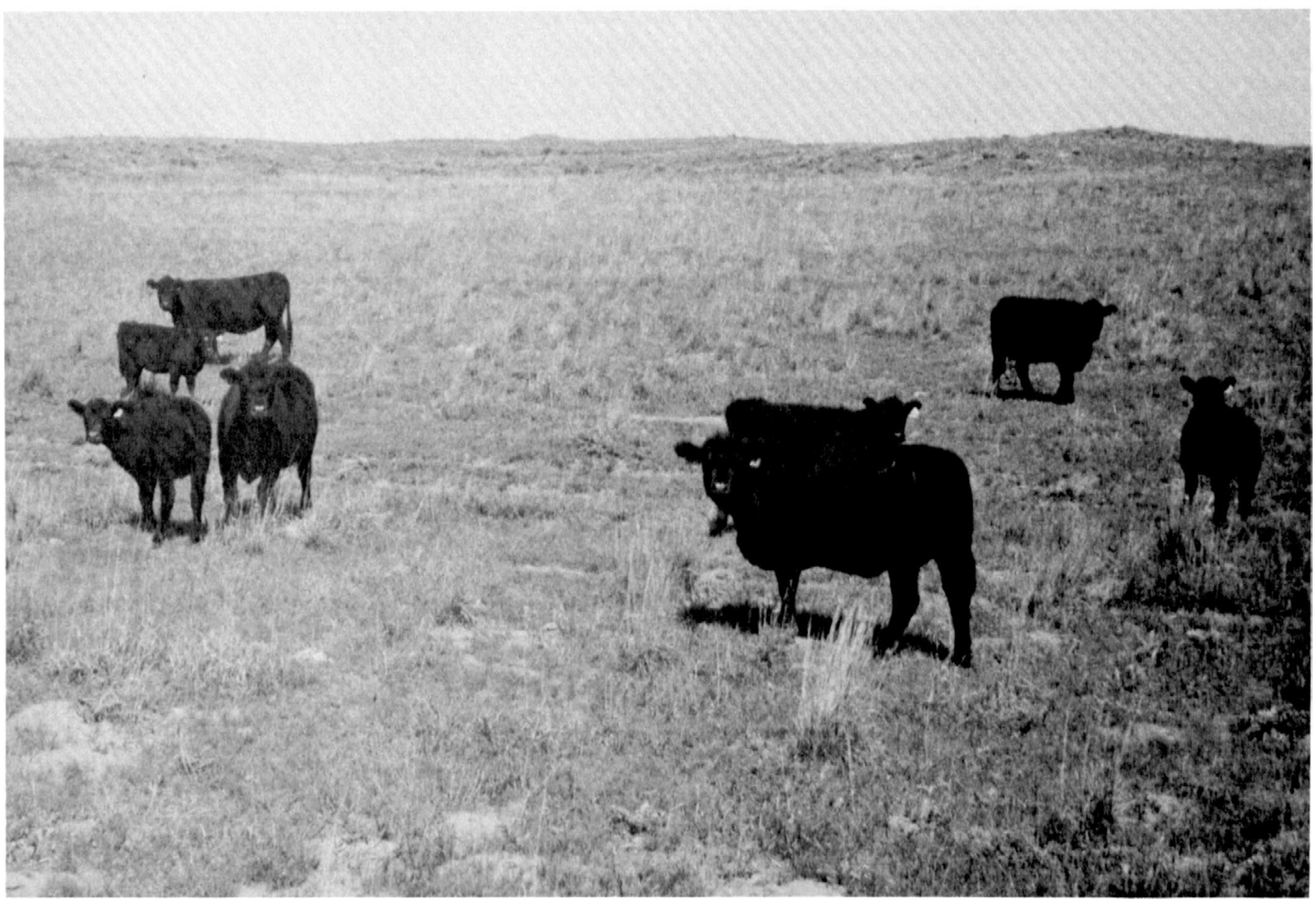


Figure 18.—Cattle grazing native grass in an area of Pratt-Tivoli loamy fine sands, rolling.

grasses and by weeds and brush. Proper stocking rates, timely deferment of grazing, and a uniform distribution of grazing help to keep the range in good condition and help to prevent excessive soil blowing.

These soils are moderately well suited to dwellings. The slope is a limitation. As a result, some land shaping commonly is needed. The soils generally are unsuitable as sites for sewage lagoons because of seepage. They are poorly suited to septic tank absorption fields. They readily absorb but do not adequately filter the effluent in these fields. The poor filtering capacity may result in the pollution of shallow ground water. The areas where the subsoil is loamy are better sites.

The capability subclass is VIe.

Qw—Quinlan-Woodward loams, 6 to 15 percent slopes. These strongly sloping, well drained soils are on uplands dissected by deeply entrenched drainageways. The shallow Quinlan soil is on ridges and on the steeper sides of intermittent drainageways. The moderately deep Woodward soil is on side slopes and the more gently sloping ridges. Individual areas are irregular in shape and range from 20 to several hundred acres in size. They are about 40 percent Quinlan soil and 35 percent Woodward soil. The two soils occur as areas so intricately mixed or small that mapping them separately is not practical.

Typically, the Quinlan soil has a yellowish red, calcareous loam surface layer about 7 inches thick. The subsoil is red, friable, calcareous loam about 6 inches thick. Red, weakly consolidated sandstone is at a depth of about 13 inches.

Typically, the Woodward soil has a reddish brown, calcareous loam surface layer about 7 inches thick. The subsoil is friable, calcareous loam about 20 inches thick. The upper part is reddish brown and has a few lime concretions, and the lower part is yellowish red and has a few soft masses of lime. Light red, weakly consolidated sandstone is at a depth of about 27 inches.

Included with these soils in mapping are small areas of Carey soils, Rock outcrop, and very steep breaks. The deep Carey soils are in the less sloping areas. The Rock outcrop is in the steeper areas. The breaks are the nearly vertical sides of ravines. Included areas make up about 25 percent of the map unit.

Permeability is moderately rapid in the Quinlan soil and moderate in the Woodward soil. Available water capacity is very low in the Quinlan soil and low in the Woodward soil. Runoff is rapid on both soils. Natural fertility is low in the Quinlan soil and medium in the Woodward soil. Root penetration is restricted by the sandstone at a depth of about 13 inches in the Quinlan soil and about 27 inches in the Woodward soil. Both soils are mildly alkaline or moderately alkaline throughout.

Nearly all of the acreage is used as range. These soils generally are unsuited to cultivated crops because of a severe hazard of erosion. They are best suited to range. Continued overgrazing reduces the vigor and retards the growth of the taller grasses and increases the extent of the shorter, less productive grasses and of weeds and brush. Control of the undesirable plants that compete with the native grasses is needed. Proper stocking rates, timely deferment of grazing, and a uniform distribution of grazing help to keep the range in good condition.

The Woodward soil is moderately well suited to dwellings. Because the slope is a limitation, some land shaping commonly is needed. The depth to bedrock also is a limitation, especially on sites for dwellings with basements. The bedrock generally is soft, however, and can be easily excavated. The Quinlan soil is poorly suited to dwellings because it is shallow over bedrock. The Woodward soil and the deep included soils are better sites.

These soils generally are unsuited to septic tank absorption fields and sewage lagoons because of the depth to bedrock. The deep included soils are better sites.

The capability subclass is VIe.

Rc—Roxbury silt loam, channeled. This deep, nearly level, well drained soil is on narrow flood plains dissected by meandering intermittent streams. It is frequently flooded for very brief periods. Individual areas are more than 150 feet wide and are 1 mile to more than 4 miles long.

Typically, the surface soil is grayish brown, calcareous silt loam about 21 inches thick. The subsoil is dark grayish brown, friable, calcareous silty clay loam about 15 inches thick. The substratum to a depth of about 60 inches is brown, calcareous silty clay loam. In some areas, the surface layer is less than 10 inches thick and the subsoil and substratum are redder. In other areas the soil is stratified with sandy layers.

Included with this soil in mapping are small areas of Penden soils on side slopes. These soils make up about 10 percent of the map unit. Their surface layer is thinner than that of the Roxbury soil.

Permeability is moderate in the Roxbury soil, and available water capacity is high. Runoff is slow. Natural fertility is high. The surface soil and subsoil are mildly alkaline or moderately alkaline. The shrink-swell potential is moderate in the subsoil.

Most of the acreage is used as range, but a few small areas are cultivated. This soil is poorly suited to cultivated crops. The flooding is the main hazard. Also, operating farm machinery is difficult along the meandering stream channels.

This soil is well suited to range. It receives extra moisture as runoff from adjacent upland soils and as floodwater. Overgrazing reduces the extent of the protective plant cover and causes deterioration of the plant community. Under these conditions, the more desirable grasses are replaced by less productive mid and short grasses and by weeds. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition.

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

The capability subclass is Vw.

Rf—Roxbury silt loam, occasionally flooded. This deep, nearly level, well drained soil is on flood plains. It is occasionally flooded for very brief periods. Individual areas are irregular in shape and range from about 25 to several hundred acres in size.

Typically, the surface soil is grayish brown, calcareous silt loam about 7 inches thick. The subsurface layer also is grayish brown, calcareous silt loam. It is about 14 inches thick. The subsoil is dark grayish brown, friable, calcareous silty clay loam about 15 inches thick. The substratum to a depth of about 60 inches is brown, calcareous silty clay loam. In some areas the subsoil is reddish brown loam.

Included with this soil in mapping are small areas of Kingsdown soils, which make up about 10 percent of the map unit. These soils are more sandy than the Roxbury soil. Also, they are slightly higher on the landscape.

Permeability is moderate in the Roxbury soil, and available water capacity is high. Runoff is slow. Natural fertility is high. Tilth is good. The surface soil and subsoil are mildly alkaline or moderately alkaline. The shrink-swell potential is moderate in the subsoil.

Most of the acreage is used for cultivated crops. This soil is well suited to wheat, sorghum, and alfalfa. Crop yields are reduced in some years because of the flooding, but in other years they can be increased by the extra moisture. Minimizing tillage and leaving crop residue on the surface conserve moisture, increase the infiltration rate, and improve tilth.

This soil is well suited to range. Control of unwanted vegetation and the distribution of grazing are the main concerns of management. Proper stocking rates, rotation grazing, and a uniform distribution of grazing help to control the unwanted vegetation and keep the more desirable grasses in good condition. Well distributed salting facilities help to obtain a uniform distribution of grazing.

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

The capability subclass is IIw.

Sa—Satanta loam, 0 to 2 percent slopes. This deep, nearly level, well drained soil is on uplands. Individual areas are irregular in shape and range from 40 to 200 acres in size.

Typically, the surface layer is grayish brown loam about 7 inches thick. The subsurface layer is brown loam about 4 inches thick. The subsoil is brown, friable clay loam about 21 inches thick. The substratum to a depth of about 60 inches is pale brown, calcareous clay loam. In some areas the subsoil is fine sandy loam.

Included with this soil in mapping are small areas of Harney and Uly soils, which make up about 15 percent of the map unit. Harney soils are lower on the landscape than the Satanta soil. Also, their subsoil is more clayey. Uly soils are in positions on the landscape similar to those of the Satanta soil. They are more silty than the Satanta soil.

Permeability is moderate in the Satanta soil, and available water capacity is high. Runoff is slow. Natural fertility is high. Tilth is good. The surface layer is slightly acid or neutral. The shrink-swell potential is moderate in the subsoil.

Nearly all of the acreage is used for cultivated crops. This soil is well suited to wheat and sorghum. Controlling soil blowing and conserving moisture are the main concerns of management. Stripcropping and leaving crop residue on the surface help to control soil blowing. Minimum tillage and summer fallowing conserve moisture.

This soil is moderately well suited to dwellings and sewage lagoons and is well suited to septic tank absorption fields. The shrink-swell potential is a limitation on sites for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse material, however, help to prevent the structural damage caused by shrinking and swelling. Seepage is a limitation on sites for sewage lagoons. It can be controlled, however, by sealing the lagoon.

The capability subclass is IIc.

Sh—Shellabarger loam, 2 to 5 percent slopes. This deep, gently sloping, well drained soil is on uplands. Individual areas are irregular in shape and range from 30 to several hundred acres in size.

Typically, the surface layer is dark grayish brown loam about 11 inches thick. The subsoil is reddish brown, friable sandy clay loam about 18 inches thick. The substratum to a depth of about 60 inches is reddish brown. The upper part is coarse sandy loam, and the lower part is sand. In some areas shale bedrock is at a depth of 40 to 60 inches.

Included with this soil in mapping are small areas of Albion soils on knolls. These soils are more sandy than the Shellabarger soil. They make up about 10 percent of the map unit.

Permeability and available water capacity are moderate in the Shellabarger soil. Runoff is medium. Natural fertility also is medium. The surface layer is slightly acid.

Most of the acreage supports native grasses. This soil is well suited to range. Overgrazing, however, retards the growth and reduces the vigor of the grasses and increases the runoff rate. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition.

This soil is moderately well suited to wheat and grain sorghum. If cultivated crops are grown, erosion is a hazard. Terraces, contour farming, and minimum tillage help to control erosion and conserve moisture.

This soil is well suited to dwellings and septic tank absorption fields. In some areas, however, the effluent from septic tank systems may pollute the ground water. The soil is moderately well suited to sewage lagoons. Seepage and slope are limitations. Sealing the lagoon helps to control seepage. Some land shaping commonly is needed.

The capability subclass is IIIe.

Tv—Tivoli fine sand, hilly. This deep, excessively drained soil is on uplands. Individual areas range from 30 to several hundred acres in size.

Typically, the surface layer is brown fine sand about 6 inches thick. The substratum to a depth of about 60 inches is yellow fine sand. In some areas the soil has a subsoil of loamy fine sand.

Permeability is rapid, and available water capacity is very low. Runoff is very slow. Natural fertility is low. The surface layer is neutral.

Nearly all of the acreage is used as range. Because of a hazard of soil blowing and the very low available water capacity, this soil generally is unsuited to cultivated crops. It is best suited to range. The major concerns in managing the range are soil blowing and the very low available water capacity. Overgrazing reduces the extent of the protective plant cover and causes deterioration of the plant community. Under these conditions, the more desirable grasses are replaced by less productive grasses. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition and prevent excessive soil blowing.

Mainly because of the slope, this soil generally is unsuitable as a site for dwellings and sewage disposal systems. It readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of shallow ground water.

The capability subclass is VIIe.

Ua—Uly silt loam, 0 to 1 percent slopes. This deep, nearly level, well drained soil is on uplands. Individual areas are irregular in shape and range from 80 to several hundred acres in size.

Typically, the surface layer is grayish brown silt loam about 8 inches thick. The subsoil is friable silty clay loam about 18 inches thick. The upper part is dark grayish brown, and the lower part is brown and calcareous. The substratum to a depth of about 60 inches is pale brown, calcareous silt loam. In some areas the surface layer is calcareous. In other areas the subsoil is clay loam.

Included with this soil in mapping are small areas of Harney and Kingsdown soils, which make up about 10 percent of the map unit. Harney soils are in positions on the landscape similar to those of the Uly soil. Their subsoil is more clayey than that of the Uly soil. Kingsdown soils are more sandy throughout than the Uly soil. They are on knobs and ridges.

Permeability is moderate in the Uly soil, and available water capacity is high. Runoff is slow. Natural fertility is high. Tilth is good. The surface layer is neutral or mildly alkaline.

Most of the acreage is used for cultivated crops. This soil is well suited to wheat and sorghum. Conserving moisture and controlling soil blowing are the main concerns of management. Summer fallowing conserves moisture. Minimum tillage and stripcropping help to control soil blowing.

This soil is well suited to dwellings and septic tank absorption fields and is moderately well suited to sewage lagoons. Seepage is a limitation on sites for sewage lagoons. It can be controlled, however, by sealing the lagoon.

The capability subclass is IIc.

Ub—Uly silt loam, 1 to 3 percent slopes. This deep, gently sloping, well drained soil is on side slopes and other convex slopes in the uplands. Individual areas are irregular in shape and range from 40 to several hundred acres in size.

Typically, the surface layer is grayish brown silt loam about 7 inches thick. The subsoil is friable silty clay loam about 18 inches thick. The upper part is dark grayish brown, and the lower part is brown and calcareous. The substratum to a depth of about 60 inches is pale brown, calcareous silt loam. In some areas the surface layer is calcareous. In other areas the subsoil is clay loam.

Included with this soil in mapping are small areas of Harney soils, which make up about 10 percent of the map unit. These soils are in concave areas. Their subsoil is more clayey than that of the Uly soil.

Permeability is moderate in the Uly soil, and available water capacity is high. Runoff is medium. Natural fertility is high. Tilth is good. The surface layer is neutral or mildly alkaline.

Most of the acreage is used for cultivated crops. This soil is well suited to wheat and sorghum. Controlling erosion and soil blowing and conserving moisture are the main concerns of management. Terraces and contour farming help to control erosion. Leaving crop residue on the surface and minimizing tillage conserve moisture and help to control soil blowing.

This soil is well suited to dwellings and septic tank absorption fields and is moderately well suited to sewage lagoons. Slope and seepage are limitations on sites for sewage lagoons. Some land shaping commonly is needed. Sealing the lagoon helps to control seepage.

The capability subclass is IIe.

Uc—Uly silt loam, 3 to 6 percent slopes. This deep, moderately sloping, well drained soil is on upland side slopes. Individual areas are irregular in shape and range from 20 to 160 acres in size.

Typically, the surface layer is grayish brown silt loam about 7 inches thick. The subsoil is friable silty clay loam about 11 inches thick. The upper part is dark grayish brown, and the lower part is brown and calcareous. The substratum to a depth of about 60 inches is pale brown, calcareous silt loam. In some areas the surface layer is calcareous. In other areas the subsoil is clay loam.

Included with this soil in mapping are small areas of Harney soils, which make up about 10 percent of the map unit. These soils are in slightly concave areas. Their subsoil is more clayey than that of the Uly soil.

Permeability is moderate in the Uly soil, and available water capacity is high. Runoff is medium. Natural fertility is high. Tilth is good. The surface layer is neutral or mildly alkaline.

Most of the acreage is used for cultivated crops, but some areas are used as range. This soil is suited to wheat and sorghum. Measures that control erosion and conserve moisture are the main management needs. Examples are terracing, farming on the contour, and returning crop residue to the soil.

This soil is well suited to range. Overgrazing, however, reduces the vigor and retards the growth of the tall, palatable grasses. Under these conditions, the shorter, less productive grasses are established. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition.

This soil is well suited to dwellings and septic tank absorption fields and is moderately well suited to sewage lagoons. Seepage and slope are limitations on sites for sewage lagoons. Sealing the lagoon helps to control seepage. If the less sloping areas are selected as sites for the lagoons, less leveling and banking will be needed during construction.

The capability subclass is IIIe.

Wa—Waldeck fine sandy loam. This deep, nearly level, somewhat poorly drained soil is on flood plains. It is occasionally flooded for brief periods. Individual areas are irregular in shape and range from 20 to several hundred acres in size.

Typically, the surface soil is grayish brown, calcareous fine sandy loam about 14 inches thick. The next 18 inches is brown, mottled, very friable, calcareous fine sandy loam. The upper part of the substratum is light brownish gray, mottled, calcareous fine sandy loam. The lower part to a depth of about 60 inches is very pale brown sand.

Included with this soil in mapping are small areas of Lesho, Likes, and Lincoln soils, which make up about 15 percent of the map unit. Lesho soils are on the lower parts of the flood plains. Their subsoil is more clayey than that of the Waldeck soil. Likes and Lincoln soils are sandy. Likes soils are on slightly convex slopes above the flood plains, and Lincoln soils are on the flood plains.

Permeability is moderately rapid in the Waldeck soil, and available water capacity is moderate. Runoff is slow. A seasonal high water table is at a depth of 2 to 4 feet. Natural fertility is medium. Tilth is good. The soil is mildly alkaline or moderately alkaline throughout.

Most of the acreage is used as range, but some areas are used for cultivated crops. This soil is moderately well suited to wheat, sorghum, and alfalfa. The flooding and the seasonal high water table are concerns of management, but the crops commonly benefit from the additional moisture. Soil blowing is a hazard during dry periods. Leaving crop residue on the surface and minimizing tillage help to control soil blowing and conserve moisture.

This soil is well suited to range. The seasonal high water table has a beneficial effect on the production of native grasses. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition.

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

The capability subclass is IIIw.

Wo—Woodward loam, 1 to 3 percent slopes. This moderately deep, gently sloping, well drained soil is on uplands. Individual areas are irregular in shape and range from 50 to several hundred acres in size.

Typically, the surface layer is reddish brown, calcareous loam about 9 inches thick. The subsoil is friable, calcareous loam about 23 inches thick. The upper part is reddish brown, and the lower part is reddish yellow. Weakly consolidated sandstone is at a depth of about 32 inches. In some areas the surface layer is fine sandy loam. In a few areas the depth to sandstone is less than 20 inches.

Included with this soil in mapping are small areas of the deep Carey and Penden soils, which make up about 10 percent of the map unit. Carey soils are on the lower parts of the landscape. Penden soils are in positions on the landscape similar to those of the Woodward soil.

Permeability is moderate in the Woodward soil, and available water capacity is low. Runoff is medium. Natural fertility also is medium. The soil is mildly alkaline or moderately alkaline throughout.

Most of the acreage is used for cultivated crops. Only a few areas are used as range. This soil is well suited to wheat and sorghum. Measures that help to control erosion and conserve moisture are the main management needs. Examples are terracing, establishing grassed waterways, farming on the contour, minimizing tillage, and returning crop residue to the soil.

This soil is moderately well suited to dwellings. The depth to bedrock is a limitation on sites for dwellings with basements. The bedrock generally is soft, however, and can be easily excavated. The soil generally is unsuitable as a site for septic tank absorption fields and sewage lagoons because of the depth to bedrock. The deep included soils are better sites.

The capability subclass is IIe.

Wr—Woodward-Quinlan loams, 3 to 6 percent slopes. These moderately sloping, well drained soils are on uplands. The moderately deep Woodward soil is on side slopes, and the shallow Quinlan soil is on convex ridges. Individual areas are irregular in shape and range from 25 to several hundred acres in size. They are about 55 percent Woodward soil and 35 percent Quinlan soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Woodward soil has a reddish brown, calcareous loam surface layer about 9 inches thick. The subsoil is friable, calcareous loam about 21 inches thick. The upper part is reddish brown, and the lower part is reddish yellow. Weakly consolidated sandstone is at a depth of about 30 inches. In some areas the surface layer is fine sandy loam.

Typically, the Quinlan soil has a reddish brown, calcareous loam surface layer about 7 inches thick. The subsoil is reddish brown, friable, calcareous loam about 8 inches thick. Weakly consolidated sandstone is at a depth of about 15 inches.

Included with these soils in mapping are small areas of the deep Carey and Penden soils, which make up about 10 percent of the map unit. These included soils generally are in the less sloping areas.

Permeability is moderate in the Woodward soil and moderately rapid in the Quinlan soil. Available water capacity is low in the Woodward soil and very low in the Quinlan soil. Runoff is medium on both soils. Natural fertility is medium in the Woodward soil and low in the Quinlan soil. Both soils are mildly alkaline or moderately alkaline throughout.

Most of the acreage is used for cultivated crops. The rest is used as range. These soils are moderately well suited to wheat and sorghum. If cultivated crops are grown, erosion is a hazard. Also, the medium or low fertility is a limitation. Terraces, grassed waterways, contour farming, minimum tillage, and stubble mulching help to control erosion and conserve moisture. Applications of fertilizer are needed to increase the content of available plant nutrients.

These soils are well suited to range. Overgrazing, however, retards the growth and reduces the vigor of the grasses and increases the runoff rate. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition. Range seeding is needed to restore the productivity of abandoned cropland.

These soils are moderately well suited to dwellings. The depth to bedrock is a limitation, especially on sites for dwellings with basements. The bedrock generally is soft, however, and can be easily excavated. The soils generally are unsuitable as sites for septic tank absorption fields and sewage lagoons because of the depth to bedrock. The deep included soils in the less sloping areas are better sites.

The capability subclass is IIIe.

Yh—Yahola loam. This deep, nearly level, well drained soil is on flood plains. It is occasionally flooded for very brief periods. Individual areas are irregular in shape and range from about 10 to 50 acres in size.

Typically, the surface layer is brown loam about 8 inches thick. The substratum to a depth of about 60 inches is reddish yellow, calcareous fine sandy loam.

Included with this soil in mapping are small areas of Lincoln soils in similar positions on the flood plains. These soils make up about 10 percent of the map unit. They are more sandy throughout than the Yahola soil.

Permeability is moderately rapid in the Yahola soil, and available water capacity is moderate. Runoff is slow. Natural fertility is medium. The surface layer is moderately alkaline.

Most areas are used as range, but some small areas are used for cultivated crops. This soil is moderately well suited to alfalfa, sorghum, and wheat. The flooding is a hazard, but the crops commonly benefit from the additional moisture. Soil blowing is a hazard during dry periods. Minimizing tillage and leaving crop residue on the surface conserve moisture and help to control soil blowing.

This soil is well suited to range. Overgrazing, however, reduces the vigor and retards the growth of the tall, palatable grasses. Under these conditions, the shorter, less productive grasses are established. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition. Well distributed salting facilities help to obtain a uniform distribution of grazing.

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

The capability subclass is IIw.

Ze—Zenda loam. This deep, nearly level, somewhat poorly drained soil is on flood plains. It is occasionally flooded for very brief periods. Individual areas are irregular in shape and range from 20 to 160 acres in size.

Typically, the surface layer is dark gray, calcareous loam about 14 inches thick. The substratum to a depth of about 60 inches is brown and light brownish gray, mottled, calcareous clay loam. In some areas it is fine sandy loam.

Permeability is moderate, and available water capacity is high. Runoff is slow. A seasonal high water table is at a depth of 3 to 4 feet. Natural fertility is high. Tilth is good. The surface layer is mildly alkaline or moderately alkaline.

Most of the acreage is used for cultivated crops. The rest is used as range. This soil is well suited to wheat, sorghum, and alfalfa. The flooding is a hazard, but the crops commonly benefit from the additional water. Measures that help to control soil blowing and conserve moisture are needed during dry periods. Leaving crop residue on the surface is an example.

This soil is well suited to range. The seasonal high water table has a beneficial effect on the production of native grasses. Overgrazing reduces the vigor and retards the growth of the tall, palatable grasses. Under these conditions, the shorter, less productive grasses are established. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition.

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

The capability subclass is IIw.

prime farmland

Prime farmland is one of several kinds of important farmland 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 and built-up land or water areas. It either is used for food or fiber or is available for those 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 268,700 acres in Clark County, or about 43 percent of the total acreage, meets the requirements for prime farmland. This land occurs as scattered areas throughout the county. The main crops grown on this land are wheat, grain sorghum, and alfalfa. The soils that are considered prime farmland generally have a slope of less than 7 percent and are deep. The surface layer is loam, silt loam, or clay loam.

The map units in Clark County that are considered prime farmland 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."

The map units that meet the requirements for prime farmland are:

Bp	Bippus clay loam, 0 to 2 percent slopes
Bu	Bippus clay loam, 2 to 5 percent slopes
Cr	Carey silt loam, 0 to 1 percent slopes
Cs	Carey silt loam, 1 to 3 percent slopes
Cy	Carey silt loam, 3 to 6 percent slopes
Ha	Harney silt loam, 0 to 1 percent slopes
Hb	Harney silt loam, 1 to 3 percent slopes
Lb	Lesho clay loam
Ms	Missler silty clay loam, 0 to 2 percent slopes
Pa	Penden clay loam, 0 to 1 percent slopes
Pb	Penden clay loam, 1 to 3 percent slopes
Pc	Penden clay loam, 3 to 7 percent slopes
Pf	Penden clay loam, 2 to 7 percent slopes, eroded
Rf	Roxbury silt loam, occasionally flooded
Sa	Satanta loam, 0 to 2 percent slopes
Sh	Shellabarger loam, 2 to 5 percent slopes
Ua	Uly silt loam, 0 to 1 percent slopes
Ub	Uly silt loam, 1 to 3 percent slopes
Uc	Uly silt loam, 3 to 6 percent slopes
Wo	Woodward loam, 1 to 3 percent slopes
Yh	Yahola loam
Ze	Zenda loam

use and management of the soils

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

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

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

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

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

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

crops

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

General management needed for crops is suggested in this section. The crops 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 are listed for the arable soils.

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 34 percent of the acreage in Clark County is used for cultivated crops or is summer fallowed. During the period 1968 to 1978, wheat was grown on about 50 percent of the cropland, sorghum on 10 percent, and alfalfa, barley, rye, and corn on 2 percent (*3*). The rest of the cropland was summer fallowed. Sorghum was grown as either a grain or forage crop.

The acreage used for alfalfa increased during the period 1968 to 1978 (fig. 19). That used for other crops remained constant. The acreage that was summer fallowed increased by 3 percent.

The main concerns in managing the soils in the county for crops are water erosion, soil blowing, fertility, and tilth.

Water erosion is the major hazard on about 50 percent of the cropland in the county. If the surface layer is lost through erosion, productivity is reduced because most of the available plant nutrients and organic matter, which has positive effects on soil structure and tilth, water infiltration, and available water capacity, also are lost. Preparing a good seedbed and tilling are difficult in the more clayey spots that remain after the original friable surface layer has eroded away.

In many areas soil erosion on farmland results in the pollution of streams by sediment, nutrients, and pesticides. Controlling erosion minimizes this pollution and thus helps to maintain the quality of the water.

Measures that control erosion provide a protective cover of crops or crop residue, reduce the runoff rate, and increase the rate of water infiltration. A cropping system that keeps a plant cover on the surface for extended periods helps to control erosion and conserves moisture (fig. 20). Minimum tillage, terraces (fig. 21), diversions, contour farming, and a cropping system that includes close-growing crops as well as row crops reduce the runoff rate and help to control erosion. In the areas in Clark County used for sorghum, minimum tillage is helping to control erosion on an increasing acreage. It is effective on most of the soils. Terraces and diversions

Figure 19.—Alfalfa in an area of Waldeck fine sandy loam. Alfalfa hay supplements native forage during the winter.

reduce the length of slopes and thus also reduce the runoff rate and the susceptibility to erosion. They are most effective on deep, well drained soils that have uniform, regular slopes. Most of the soils in the county have those characteristics.

Measures that maintain or improve fertility and tilth are needed on all of the soils used for crops. These include applications of fertilizer and additions of organic material.

Applications of nitrate and phosphate fertilizer are effective on most of the arable soils in the county. On all soils the kinds and amounts of fertilizer to be applied should be based on the results of soil tests, on the needs of the crop, and on the expected level of yields. The Cooperative Extension Service can help to determine the kinds and amounts needed.

Organic matter affects fertility and tilth because it provides nitrogen, increases the rate of water intake, helps to prevent surface crusting, and helps to control erosion. Most of the soils in the county that are used for crops have a surface layer of silt loam or loam. A surface crust forms during periods of intense rainfall. The crusted surface is hard when dry and is nearly impervious to water. Because of the hard surface, the runoff rate increases. Regularly adding organic material improves soil structure and helps to prevent surface crusting. Leaving crop residue on the surface also helps to prevent crusting.

Soil blowing is a hazard on the more sandy soils in the county, such as Pratt and Kingsdown soils. It can be controlled by a protective cover of plants or mulch, by tillage methods that roughen the surface, or by windbreaks.

Further information about measures that help to control erosion and soil blowing on each kind of soil is available at local offices of 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.

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

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

land capability classification

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

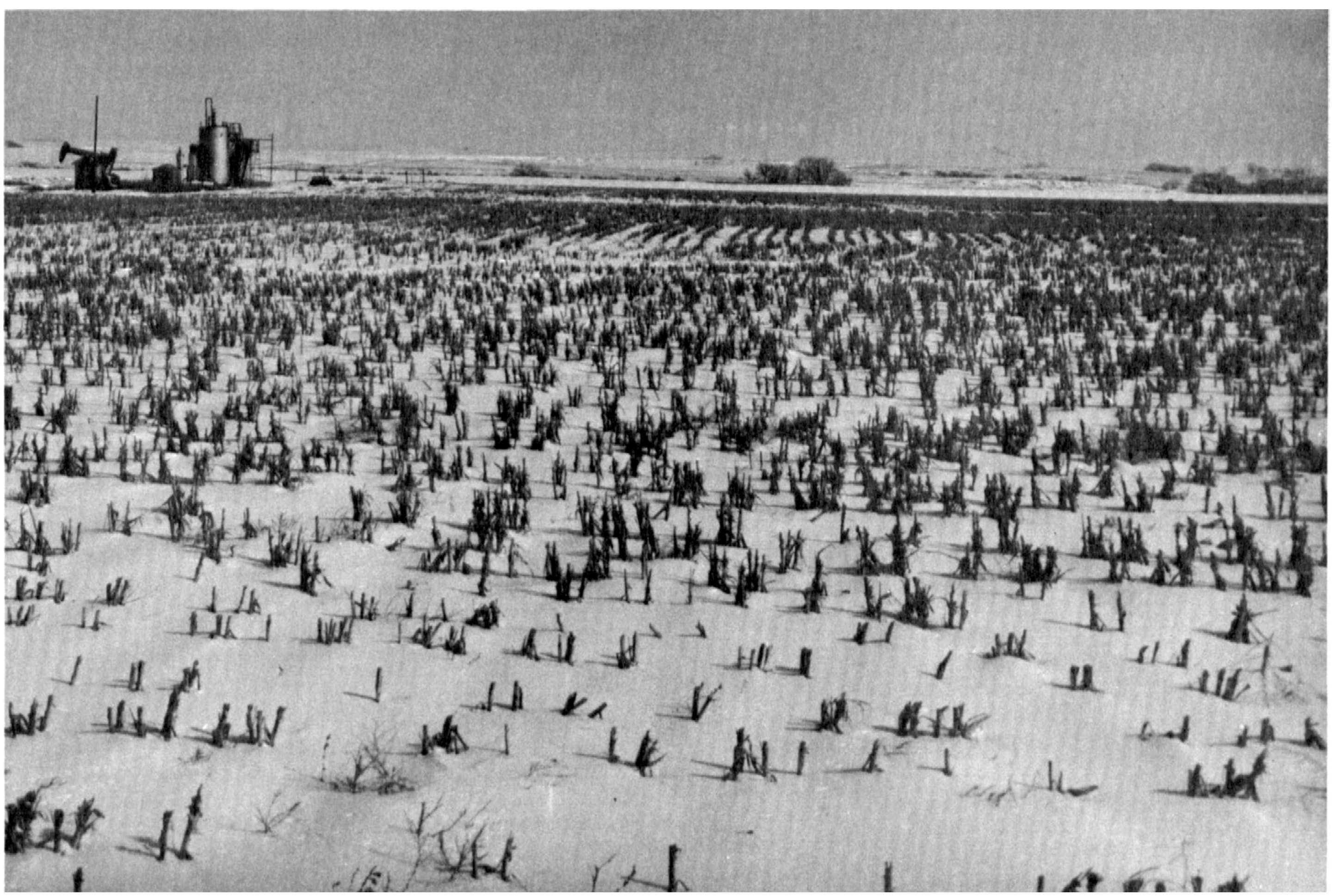


Figure 20.—Stubble from grain sorghum. Because of the stubble, the snow is evenly distributed and is on the field until it melts and soaks into the soil.

Figure 21.—Terraces in an area of Woodward loam, 1 to 3 percent slopes.

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.

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

rangeland

Robert K. Glover, resource conservationist, Soil Conservation Service, helped prepare this section.

About 63 percent of the acreage in Clark County is rangeland. More than 65 percent of the total value of local farm products is from the sale of livestock, principally cattle. Cow-calf and stocker ranches are about equal in extent. About two-thirds of the ranches are larger than 6,500 acres. The 27 largest ranches average 9,659 acres.

On most of the ranches, the forage produced on rangeland is supplemented by crop residue and small grain. In winter the native forage is supplemented by hay, protein supplements, and wheat.

The potential native vegetation is strongly affected by the soils in the county. The texture of the surface layer and of the underlying layers affects the kind of vegetation. A high content of lime at the surface, salinity, and a seasonal high water table within a depth of 5 feet affect the kind and amount of forage species.

The silty Carey, Harney, Missler, and Uly soils support mostly mid grasses. Sand bluestem is common on Pratt and other sandy soils, whereas big bluestem is more common on the loamy, calcareous Campus and Penden soils. The most productive rangeland occurs as areas of subirrigated soils on flood plains and terraces where a seasonal high water table provides additional moisture. Examples are Lesho, Waldeck (fig. 22), and Zenda soils. Krier soils, although subirrigated, are saline. The vegetation produced is tolerant of salinity. An example is alkali sacaton. The potential production is lowest on shallow soils in which the available water capacity is low. Examples are Canlon, Owens, and Quinlan soils. On Roxbury, Yahola, and other alluvial soils, runoff from the adjacent uplands provides additional moisture.

Figure 22.—Subirrigated range site in good condition. The soil is Waldeck fine sandy loam.

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 nearly all of the soils in the survey area, the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the average percentage of each species. Only those soils that are used as or are suited to rangeland are listed. 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 prevailing 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 percentage of air-dry moisture.

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

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, 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. The main management needs on the rangeland in Clark County are proper stocking rates, timely deferment of grazing, and a uniform distribution of grazing.

Woodland

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

The wooded areas in Clark County are along the Cimarron River and the other major streams. A few scattered trees and shrubs are in protected wet areas along the canyons or breaks.

The areas along streams support mainly eastern cottonwood, black willow, hackberry, and American plum. Tamarisk is common in the valley of the Cimarron River. Also, scattered eastern cottonwood, black willow, and Siberian elm are on the flood plain, and thickets of Chickasaw plum are in some of the sandy areas. The wet areas along canyons or breaks support clumps of Chickasaw plum and scattered eastern cottonwood and hackberry.

The trees can be used for firewood, wildlife habitat elements, and other miscellaneous purposes, but they are too scattered to be of commercial value.

windbreaks and environmental plantings

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

Landowners have planted trees at various times on most of the ranch headquarters and farmsteads in Clark County. Siberian elm is the most common tree, especially in the older windbreaks. Examples of other trees and shrubs planted in farmstead and feedlot windbreaks are eastern redcedar, lilac, Russian mulberry, Austrian pine, tamarisk, and Russian-olive. Tree planting around the ranch headquarters and farmsteads is a continual need because old trees deteriorate and die, because storms, insects, or diseases destroy some trees, and because new windbreaks are needed in areas where farming or ranching is expanding.

Field windbreaks or shelterbelts are numerous in Clark County, especially in the southern part (fig. 23). These

Figure 23.—A windbreak in an area of Kingsdown fine sandy loam, 0 to 2 percent slopes.

shelterbelts vary widely in size, row arrangement, and species. Some are made up of as many as 17 rows of trees and shrubs. The commonly grown species include eastern redcedar, Siberian elm, eastern cottonwood, honeylocust, osageorange, hackberry, black locust, Russian mulberry, green ash, western soapberry, Kentucky coffeetree, tamarisk, American elm, black walnut, ponderosa pine, American plum, Russian-olive, eastern redbud, northern catalpa, and bur oak.

In order for windbreaks and environmental plantings to fulfill their intended purpose, the soils on the site should be suited to the species selected for planting. Selecting suitable species helps to ensure survival and a maximum growth rate. The growth rate is greatly affected by the permeability, available water capacity, and fertility of the soil.

An inadequate moisture supply limits tree survival in many areas of the county. As a result, the main management needs are proper site preparation prior to planting and control of weeds and other competing plants after planting. Drip irrigation or any other method of supplemental watering also helps to overcome the moisture deficiency.

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

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.

Clark County has several areas of scenic, geologic, and historic interest. The farm ponds, the Cimarron River, and Bluff Creek provide opportunities for water sports. Clark State Fishing Lake is open to the public for picnicking and fishing. The Big Basin and St. Jacob's Well, northwest of Ashland, also are scenic areas open to the public. The potential for further recreational development in the county is fair.

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

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

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

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

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

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

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

wildlife habitat

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

The primary game species in Clark County are ringneck pheasant, bobwhite quail, mourning dove, white-tailed deer, mule deer (fig. 24), and several species of waterfowl. The Rio Grande Turkey is well established along the Cimarron River (fig. 25). It is hunted during the open season.

Nongame species are numerous because the habitat types are diverse. Cropland, woodland, and grassland are interspersed throughout the county. Each of these provides habitat for a particular group of species.

Furbearers are sparse to common along the Cimarron River and the other major streams in the county (fig. 26). They are trapped on a limited basis.

Stock water ponds, streams, and the Clark State Fishing Lake provide good to excellent fishing. The species commonly caught are largemouth bass, bluegill, carp, channel catfish, and bullhead catfish.

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

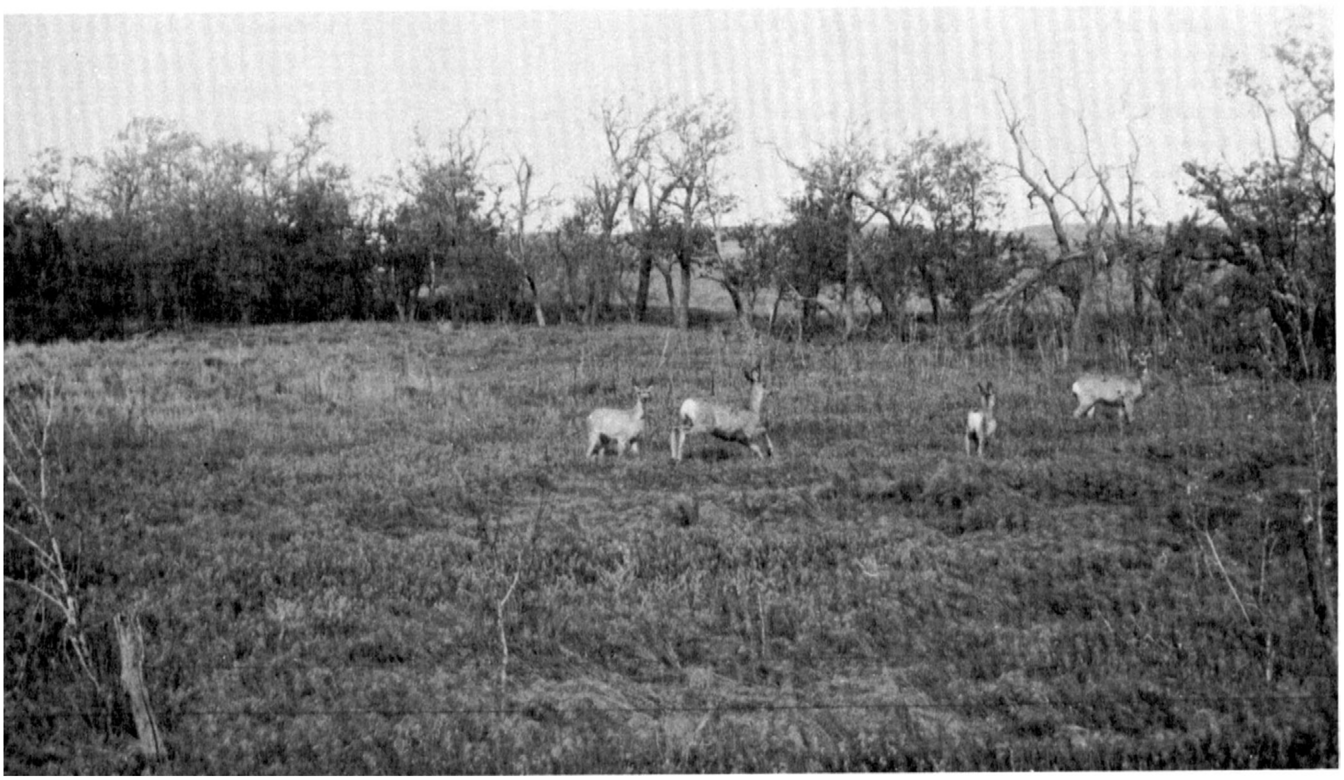


Figure 24.—An area of Roxbury silt loam, channeled, used as habitat for deer.

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, grain sorghum, oats, and barley.

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, sweetclover, 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

Figure 25.—Good cover for turkeys provided by trees on Kingsdown fine sandy loam, 0 to 2 percent slopes. The larger trees are used for roosting.

plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, grama grasses, switchgrass, indiangrass, goldenrod, wheatgrass, ragweed, 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 plum, dogwood, buckbrush, prairie rose, and sumac.

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, indigobush, saltgrass, cordgrass, rushes, sedges, and reeds.

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

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

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

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 blackbird, muskrat, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include jackrabbit, mule deer, prairie dogs, hawks, killdeer, and meadowlarks.

Technical assistance in planning wildlife areas and in determining vegetation suitable for planting is available at local offices of the Soil Conservation Service. Additional information and assistance can be obtained from 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 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

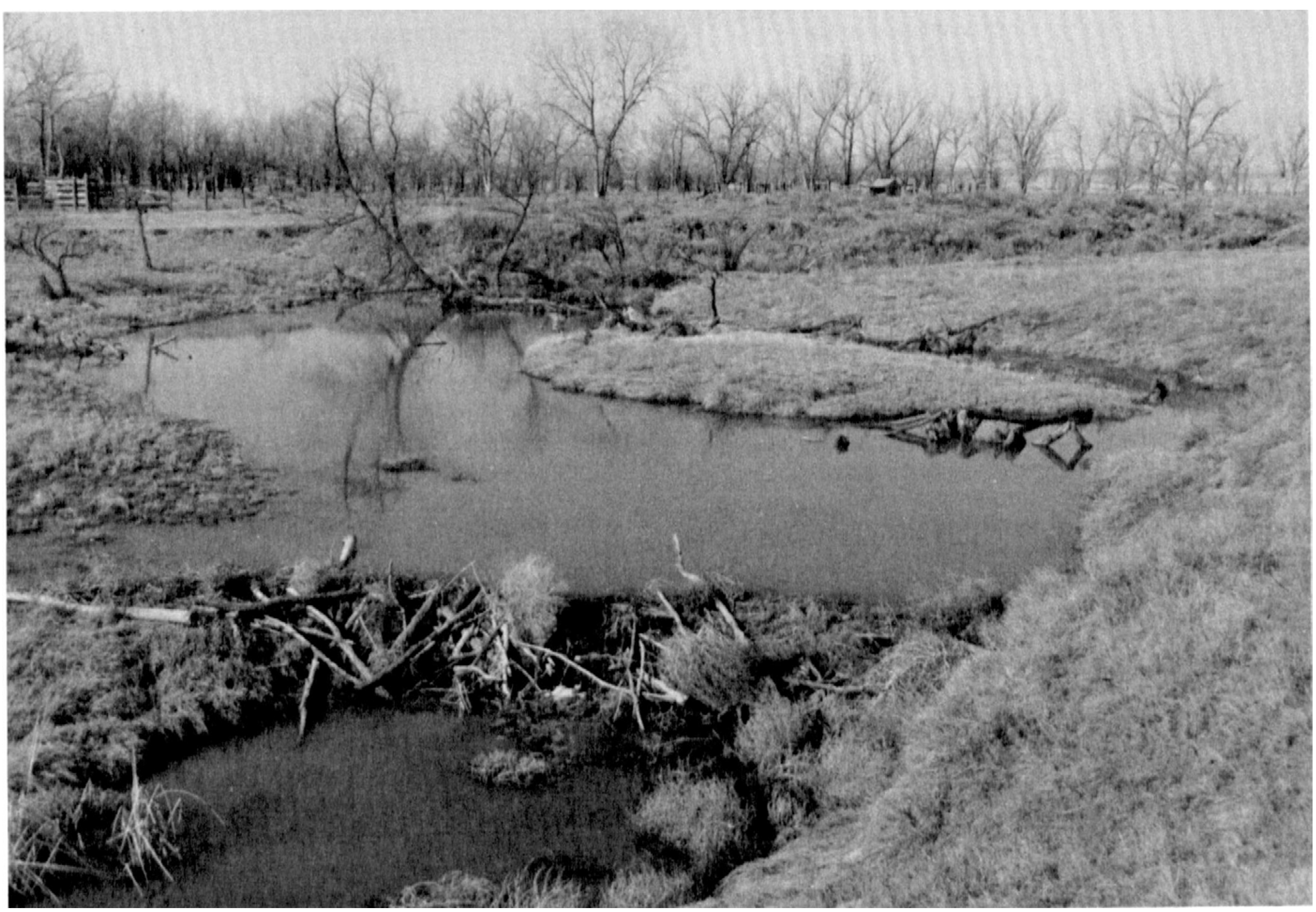


Figure 26.—A beaver dam along Antelope Creek.

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 filter the effluent effectively. 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, 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 for 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, SP-SM.

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

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

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

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry 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 earthmoving 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 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.

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 (*5*). 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 Haplustolls (*Hapl*, meaning minimal horizonation, plus *Ustolls*, the suborder of the Mollisols that have an ustic moisture regime).

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

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

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

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* (*4*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*5*). 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."

Albion series

The Albion series consists of somewhat excessively drained soils that are moderately deep over gravelly sand. These soils are on uplands. They formed in loamy old alluvium over sand and gravel. Permeability is moderately rapid in the solum and rapid in the substratum. Slope ranges from 6 to 12 percent.

Albion soils commonly are adjacent to Campus, Canlon, Owens, Penden, and Shellabarger soils. Campus and Canlon soils are less than 40 inches deep over bedrock. They are on the higher parts of the landscape. Owens soils have a clayey subsoil. They are on the lower parts of the landscape. Penden and Shellabarger soils are in positions on the landscape similar to those of the Albion soils. Their subsoil contains more clay than that of the Albion soils.

Typical pedon of Albion sandy loam, in an area of Albion-Shellabarger sandy loams, 6 to 12 percent slopes, 1,485 feet east and 990 feet south of the northwest corner of sec. 25, T. 30 S., R. 21 W.

A—0 to 8 inches; brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) moist; weak fine granular structure; slightly hard, friable; common fine roots; few pebbles; slightly acid; gradual smooth boundary.

Bt—8 to 15 inches; brown (7.5YR 5/2) sandy loam, dark brown (7.5YR 3/2) moist; moderate medium subangular blocky structure; slightly hard, friable; common fine roots; slightly acid; gradual smooth boundary.

BC—15 to 22 inches; brown (7.5YR 5/4) coarse sandy loam, brown (7.5YR 4/4) moist; weak fine subangular blocky structure; slightly hard, friable; few fine roots; neutral; diffuse smooth boundary.

2C—22 to 60 inches; reddish yellow (7.5YR 6/6) gravelly sand, strong brown (7.5YR 5/6) moist; single grained; loose; neutral.

The thickness of the solum, or the depth to sandy material, ranges from 20 to 40 inches. The thickness of the mollic epipedon is 10 to 20 inches. The content of gravel ranges from 0 to 15 percent in the solum.

The A horizon has hue of 7.5YR or 10YR, value of 4 or 5 (3 moist), and chroma of 2 or 3. The Bt horizon has hue of 7.5YR or 10YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 6. The 2C horizon has hue of 7.5YR or 10YR, value of 5 or 6 (4 or 5 moist), and chroma of 3 to 6. It is sand or gravelly sand.

Bippus series

The Bippus series consists of deep, well drained, moderately permeable soils on colluvial and alluvial fans and foot slopes. These soils formed in calcareous sediments. Slope ranges from 0 to 5 percent.

Bippus soils are similar to Roxbury soils and commonly are adjacent to Missler, Owens, and Penden soils. Roxbury soils are on flood plains. Their subsoil contains less sand than that of the Bippus soils. Missler soils are on uplands. Their subsoil contains more clay than that of the Bippus soils. Owens soils are clayey. They are steeper than the Bippus soils. Penden soils generally are steeper than the Bippus soils. Also, their mollic epipedon is thinner.

Typical pedon of Bippus clay loam, 0 to 2 percent slopes, 1,320 feet west and 1,320 feet south of the northeast corner of sec. 30, T. 32 S., R. 22 W.

A—0 to 23 inches; dark grayish brown (10YR 4/2) clay loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; hard, friable; many fine roots; slight effervescence; moderately alkaline; gradual smooth boundary.

Bw1—23 to 30 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; weak medium and fine subangular blocky structure; hard, friable; few fine roots; few wormcasts; few films of carbonates on faces of peds; slight effervescence; moderately alkaline; gradual smooth boundary.

Bw2—30 to 60 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; weak medium subangular blocky structure; hard, friable; slight effervescence; moderately alkaline.

The solum is more than 60 inches thick. The mollic epipedon is 20 to 40 inches thick. The depth to lime is less than 15 inches. Reaction is mildly alkaline or moderately alkaline throughout the profile. The texture is loam or clay loam throughout the profile.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 2 or 3. The B horizon has hue of 10YR or 7.5YR, value of 4 or 5 (3 or 4 moist), and chroma of 2 to 4.

Campus series

The Campus series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in loamy, calcareous residuum of caliche. Slope ranges from 5 to 15 percent.

Campus soils are similar to Penden soils and commonly are adjacent to those soils and to Canlon and Owens soils. Canlon and Owens soils are 10 to 20 inches deep over bedrock. They are on the steeper slopes below the Campus soils. Penden soils are deep. Their positions on the landscape are similar to those of the Campus soils.

Typical pedon of Campus loam, in an area of Campus-Canlon loams, 5 to 15 percent slopes, 2,310 feet north and 1,920 feet east of the southwest corner of sec. 13, T. 32 S., R. 25 W.

A—0 to 8 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, friable; many fine and medium roots; few wormcasts; slight effervescence; moderately alkaline; clear smooth boundary.

Bw—8 to 15 inches; light brownish gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) moist; weak medium subangular blocky structure; hard, friable; few wormcasts; about 5 percent fine caliche fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

Ck—15 to 28 inches; light yellowish brown (10YR 6/4) clay loam, yellowish brown (10YR 5/4) moist; weak fine subangular blocky structure; hard, friable; about 15 percent caliche fragments and many soft masses of lime; violent effervescence; moderately alkaline; gradual smooth boundary.

R—28 inches; white (10YR 8/2) caliche.

The thickness of the solum ranges from 13 to 20 inches. The depth to caliche ranges from 20 to 40 inches.

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

Canlon series

The Canlon series consists of shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in material weathered from caliche. Slope ranges from 5 to 30 percent.

Canlon soils commonly are adjacent to Campus, Owens, and Penden soils. Campus soils are 20 to 40 inches deep over bedrock. They are in the less sloping areas. Owens soils are clayey. They are on the lower slopes. Penden soils are more than 40 inches deep over bedrock. They are on the higher parts of the landscape.

Typical pedon of Canlon loam, in an area of Campus-Canlon loams, 5 to 15 percent slopes, 1,500 feet west and 1,110 feet south of the northeast corner of sec. 3, T. 31 S., R. 23 W.

A—0 to 5 inches; grayish brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) moist; moderate medium granular structure; hard, friable; many fine and medium roots; few fine caliche fragments; strong effervescence; moderately alkaline; clear smooth boundary.

AC—5 to 9 inches; light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; moderate medium granular structure; slightly hard, friable; many fine roots; about 10 percent 1/4- to 3/4-inch caliche fragments; violent effervescence; moderately alkaline; clear smooth boundary.

C—9 to 13 inches; very pale brown (10YR 8/3) loam, very pale brown (10YR 7/3) moist; massive; hard, friable; few fine roots; about 10 percent 1- to 3-inch caliche fragments; violent effervescence; moderately alkaline; abrupt wavy boundary.

R—13 inches; white (10YR 8/1), hard caliche.

The thickness of the solum ranges from 6 to 12 inches. The depth to caliche ranges from 10 to 20 inches.

The A horizon has hue of 10YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 or 3. The C horizon has hue of 10YR, value of 6 to 8 (5 to 7 moist), and chroma of 3 or 4.

Carey series

The Carey series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in sediments weathered from silty and sandy red beds. Slope ranges from 0 to 6 percent.

Carey soils are similar to Uly soils and commonly are adjacent to Harney, Penden, and Woodward soils. Uly soils do not have an argillic horizon. Their positions on the landscape are similar to those of the Carey soils. Harney soils generally are higher on the landscape than the Carey soils. Also, their subsoil contains more clay. Penden soils generally are on the steeper slopes. Their subsoil contains more sand than that of the Carey soils. The moderately deep Woodward soils are higher on the landscape than the Carey soils.

Typical pedon of Carey silt loam, 0 to 1 percent slopes, 990 feet west and 660 feet north of the southeast corner of sec. 24, T. 33 S., R. 22 W.

Ap—0 to 7 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak medium granular structure; hard, friable; few fine roots; neutral; clear smooth boundary.

AB—7 to 11 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; hard, friable; few fine roots; mildly alkaline; clear smooth boundary.

Bt1—11 to 18 inches; dark brown (7.5YR 4/2) loam, dark brown (7.5YR 3/2) moist; weak medium and fine subangular blocky structure; hard, friable; few fine roots; few wormcasts; mildly alkaline; gradual smooth boundary.

Bt2—18 to 24 inches; light brown (7.5YR 6/4) loam, dark brown (7.5YR 4/4) moist; weak fine subangular blocky structure; hard, friable; few wormcasts; slight effervescence; moderately alkaline; gradual smooth boundary.

C—24 to 60 inches; light reddish brown (5YR 6/4) loam, reddish brown (5YR 4/4) moist; massive; slightly hard, friable; few fine lime concretions; strong effervescence; moderately alkaline.

The depth to lime ranges from 11 to 30 inches. The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 (2 or 3 moist), and chroma of 2 or 3. It is dominantly silt loam but in some pedons is loam. It is neutral or mildly alkaline. The Bt horizon has hue of 7.5YR or 5YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 4. It is loam or silty clay loam. It ranges from neutral to moderately alkaline.

Harney series

The Harney series consists of deep, well drained, moderately slowly permeable soils on uplands. These soils formed in loess. Slope ranges from 0 to 3 percent.

Harney soils are similar to Missler soils and commonly are adjacent to Penden and Uly soils. Missler soils do not have an argillic horizon. They are on the lower parts of the landscape. Penden soils also are on the lower parts of the landscape. They are calcareous throughout. Uly soils do not have an argillic horizon. They are nearly level to moderately sloping and are in areas above or below the Harney soils.

Typical pedon of Harney silt loam, 0 to 1 percent slopes, 1,320 feet south and 990 feet west of the northeast corner of sec. 7, T. 31 S., R. 24 W.

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

AB—7 to 12 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; hard, friable; few fine roots; neutral; gradual smooth boundary.

Bt1—12 to 19 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; hard, firm; few fine roots; mildly alkaline; gradual smooth boundary.

Bt2—19 to 25 inches; grayish brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; strong medium blocky structure; hard, firm; moderately alkaline; gradual smooth boundary.

BCk—25 to 30 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; moderate medium subangular blocky structure; hard, friable; few fine threads and coatings of lime on faces of peds; strong effervescence; moderately alkaline; gradual smooth boundary.

Ck—30 to 40 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; weak medium subangular structure; slightly hard, friable; fine threads and coatings of lime on faces of peds; strong effervescence; moderately alkaline; gradual smooth boundary.

C—40 to 60 inches; very pale brown (10YR 7/3) silt loam, pale brown (10YR 6/3) moist; massive; slightly hard, friable; slight effervescence; moderately alkaline.

The thickness of the solum ranges from 26 to 45 inches. The depth to lime ranges from 18 to 26 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 2 or 3. It is medium acid to neutral. The part of the Bt horizon below the mollic epipedon has hue of 10YR, value of 5 or 6 (4 or 5 moist), and chroma of 2 or 3. This horizon ranges from neutral to moderately alkaline. It is silty clay loam or silty clay. The content of clay in this horizon is 35 to 42 percent. The C horizon has hue of 10YR, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4.

Kingsdown series

The Kingsdown series consists of deep, well drained, moderately rapidly permeable soils on uplands. These soils formed in loamy eolian material. Slope ranges from 0 to 5 percent.

Kingsdown soils are similar to Pratt, Satanta, and Shellabarger soils and commonly are adjacent to Penden, Pratt, and Uly soils. Pratt, Satanta, and Shellabarger soils have an argillic horizon. Pratt soils are undulating to rolling, Satanta soils generally are in the less sloping areas, and Shellabarger soils are on the steeper slopes. Penden and Uly soils are lower on the landscape than the Kingsdown soils. Also, their subsoil contains more clay.

Typical pedon of Kingsdown fine sandy loam, 0 to 2 percent slopes, 2,490 feet north and 750 feet east of the southwest corner of sec. 27, T. 34 S., R. 24 W.

A—0 to 10 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; slightly hard, very friable; common fine roots; slight effervescence at a depth of 8 inches; mildly alkaline; gradual smooth boundary.

Bw—10 to 22 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) moist; weak medium subangular blocky structure; slightly hard, very friable; common fine roots; slight effervescence; moderately alkaline; gradual smooth boundary.

C—22 to 60 inches; pale brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) moist; massive; soft, very friable; few fine roots; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 12 to 30 inches. The mollic epipedon is 7 to 15 inches thick. The depth to lime is 7 to 10 inches.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 2 or 3. It is dominantly fine sandy loam but in some pedons is loamy fine sand. It is neutral or mildly alkaline. The B horizon has hue of 10YR or 7.5YR, value of 4 to 6 (3 or 4 moist), and chroma of 3 or 4. It is mildly alkaline or moderately alkaline. The C horizon has hue of 10YR or 7.5YR, value of 5 or 6 (4 or 5 moist), and chroma of 3 or 4.

Krier series

The Krier series consists of deep, somewhat poorly drained, rapidly permeable soils on flood plains and terraces. These soils formed in loamy sediments over sandy alluvium. Slope is 0 to 1 percent.

Krier soils commonly are adjacent to Lincoln, Pratt, and Tivoli soils. The adjacent soils are better drained than the Krier soils and are higher on the landscape. Also, their surface layer is more sandy.

Typical pedon of Krier loam, 300 feet south and 20 feet east of the center of sec. 34, T. 34 S., R. 23 W.

A—0 to 3 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; hard, friable; common fine roots; slight effervescence; moderately alkaline; clear smooth boundary.

C1—3 to 6 inches; grayish brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) moist; a few very thin dark grayish brown strata; few fine distinct dark brown (7.5YR 4/4) mottles; weak medium subangular blocky structure; hard, friable; common fine roots; strong effervescence; moderately alkaline; slightly saline; clear smooth boundary.

C2—6 to 9 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; a few fine grayish brown strata; few fine distinct dark brown (7.5YR 4/4) mottles; weak medium subangular blocky structure; hard, friable; common fine roots; strong effervescence; moderately alkaline; moderately saline; clear smooth boundary.

C3—9 to 13 inches; light brownish gray (10YR 6/2) loam, grayish brown (10YR 5/2) moist; a few fine grayish brown strata; common fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; hard, friable; few fine roots; strong effervescence; moderately alkaline; moderately saline; gradual wavy boundary.

2C4—13 to 60 inches; pale brown (10YR 6/3) sand, brown (10YR 5/3) moist; many coarse distinct strong brown (7.5YR 5/6) mottles; single grained; loose; strong effervescence; moderately alkaline.

The depth to lime ranges from 0 to 6 inches. The upper part of the profile is loam, fine sandy loam, sandy loam, or clay loam. Fine sand, sand, or coarse sand is at a depth of 10 to 20 inches.

The A horizon has hue of 10YR, value of 4 or 5 (3 or 4 moist), and chroma of 1 or 2. It is mildly alkaline or moderately alkaline. The C horizon has hue of 10YR or 2.5Y, value of 4 to 7 (3 to 5 moist), and chroma of 1 or 2. It is moderately alkaline or strongly alkaline and is slightly saline or moderately saline. The 2C horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 to 6 moist), and chroma of 3 or 4.

Lesho series

The Lesho series consists of somewhat poorly drained, moderately slowly permeable soils on flood plains and terraces. These soils formed in loamy alluvium 20 to 40 inches deep over sand. Slope is 0 to 1 percent.

Lesho soils are similar to Zenda soils and commonly are adjacent to Lincoln and Waldeck soils. Lincoln soils are near stream channels. Their subsoil is more sandy than that of the Lesho soils. Waldeck and Zenda soils are more than 40 inches over sandy alluvium. They are on flood plains.

Typical pedon of Lesho clay loam, 2,160 feet east and 840 feet south of the northwest corner of sec. 11, T. 32 S., R. 21 W.

A—0 to 10 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; hard, friable; many fine roots; slight effervescence; moderately alkaline; clear smooth boundary.

C—10 to 17 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; moderate medium granular structure; hard, friable; common fine roots; slight effervescence; moderately alkaline; clear smooth boundary.

Ab—17 to 26 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; few fine faint yellowish brown (10YR 5/4) mottles; moderate medium granular structure; hard, friable; common fine roots; slight effervescence; moderately alkaline; gradual wavy boundary.

2C—26 to 60 inches; pale brown (10YR 6/3) sand, brown (10YR 5/3) moist; single grained; loose; strong effervescence; moderately alkaline.

The solum and the mollic epipedon are 10 to 20 inches thick. The depth to lime is 0 to 6 inches. The soils are mildly alkaline or moderately alkaline throughout. In some areas they are saline.

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

Likes series

The Likes series consists of deep, excessively drained, rapidly permeable soils on uplands and foot slopes. These soils formed in sandy sediments. Slope ranges from 1 to 8 percent.

Likes soils are similar to Lincoln and Tivoli soils and commonly are adjacent to Campus, Canlon, Lincoln, Quinlan, and Waldeck soils. Lincoln soils are stratified and are on flood plains. Tivoli soils are noncalcareous. They are on the steeper slopes. The loamy Campus and Canlon soils are on the steeper slopes above the Likes soils. Quinlan soils are 10 to 20 inches deep over sandstone. They generally are on the steeper side slopes. Waldeck soils have a loamy subsoil. They are on flood plains.

Typical pedon of Likes loamy sand, undulating, 1,170 feet east and 90 feet north of the southwest corner of sec. 1, T. 35 S., R. 22 W.

A—0 to 10 inches; brown (10YR 5/3) loamy sand, dark brown (10YR 4/3) moist; moderate medium granular structure; soft, very friable; common fine roots; mildly alkaline; gradual smooth boundary.

C1—10 to 26 inches; brown (7.5YR 5/4) loamy sand, dark brown (7.5YR 4/4) moist; single grained; loose; few fine roots; slight effervescence; moderately alkaline; gradual smooth boundary.

C2—26 to 60 inches; reddish yellow (7.5YR 6/6) loamy sand, strong brown (7.5YR 5/6) moist; single grained; loose; slight effervescence; moderately alkaline.

The depth to lime ranges from 10 to 24 inches. The soils are mildly alkaline or moderately alkaline throughout. The content of gravel is 0 to 5 percent throughout the profile.

The A horizon has hue of 10YR, value of 5 or 6 (4 or 5 moist), and chroma of 2 or 3. It is fine sand, loamy fine sand, or loamy sand. The C horizon has hue of 7.5YR or 10YR, value of 5 to 7 (4 to 6 moist), and chroma of 3 to 6. It is loamy fine sand, loamy sand, or sand.

Lincoln series

The Lincoln series consists of deep, somewhat excessively drained, rapidly permeable soils on flood plains. These soils formed in sandy alluvium. Slope ranges from 0 to 2 percent.

Lincoln soils are similar to Likes and Tivoli soils and commonly are adjacent to those soils and to Krier and Pratt soils. Likes, Pratt, and Tivoli soils are not stratified and are on uplands. The somewhat poorly drained Krier soils are slightly lower on the landscape than the Lincoln soils.

Typical pedon of Lincoln loamy fine sand, 2,160 feet north and 90 feet west of the southeast corner of sec. 19, T. 34 S., R. 23 W.

A—0 to 13 inches; brown (10YR 5/3) loamy fine sand, dark brown (10YR 4/3) moist; weak medium granular structure; soft, very friable; common fine roots; slight effervescence; moderately alkaline; clear smooth boundary.

C—13 to 60 inches; very pale brown (10YR 7/4) fine sand, light yellowish brown (10YR 6/4) moist; single grained; loose; few fine roots; thin strata of darker fine sandy loam and clay loam; slight effervescence; moderately alkaline.

The A horizon has hue of 10YR, value of 5 to 7 (3 to 5 moist), and chroma of 2 or 3. It is dominantly loamy fine sand but in some pedons is sand. It is mildly alkaline or moderately alkaline. The C horizon has hue of 7.5YR or 10YR, value of 6 or 7 (5 or 6 moist), and chroma of 3 or 4. It commonly has strata of fine sandy loam to clay loam less than 1 inch thick.

Missler series

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

Missler soils are similar to Harney and Uly soils and commonly are adjacent to Carey and Penden soils. Harney soils have an argillic horizon. Their positions on the landscape are similar to those of the Missler soils. Uly soils are higher on the landscape than the Missler soils. Also, their subsoil contains less clay. Carey soils have an argillic horizon and are redder than the Missler soils. Also, they are higher on the landscape. Penden soils generally are more sloping than the Missler soils and are higher or lower on the landscape. Also, they have a less clayey subsoil.

Typical pedon of Missler silty clay loam, 0 to 2 percent slopes, 1,320 feet north and 900 feet east of the southwest corner of sec. 26, T. 32 S., R. 23 W.

Ap—0 to 10 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, friable; few fine roots; few wormcasts; mildly alkaline; gradual smooth boundary.

Bw—10 to 24 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; weak medium subangular blocky structure; hard, firm; few fine roots; slight effervescence; moderately alkaline; gradual smooth boundary.

C—24 to 60 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; weak fine subangular blocky structure; hard, firm; few fine soft accumulations of lime; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 20 to 30 inches. The mollic epipedon is 7 to 15 inches thick. The depth to lime ranges from 7 to 20 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. The B horizon has hue of 10YR, value of 5 or 6 (4 or 5 moist), and chroma of 2 or 3. It is silty clay loam or silty clay.

Ness series

The Ness series consists of deep, poorly drained, very slowly permeable soils on uplands. These soils formed in clayey and silty sediments. Slope is 0 to 1 percent.

Ness soils commonly are adjacent to Harney soils on the higher parts of the landscape. Harney soils have an argillic horizon.

Typical pedon of Ness silty clay, 2,310 feet south and 510 feet west of the northeast corner of sec. 9, T. 31 S., R. 25 W.

A1—0 to 11 inches; gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) moist; moderate medium granular structure; very hard, very firm; common fine roots; mildly alkaline; clear smooth boundary.

A2—11 to 36 inches; gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) moist; weak fine blocky structure; extremely hard, very firm; few fine roots; mildly alkaline; gradual smooth boundary.

C—36 to 60 inches; light gray (10YR 7/2) silty clay loam, grayish brown (10YR 5/2) moist; massive; hard, friable; slight effervescence; moderately alkaline.

The thickness of the solum ranges from 20 to 40 inches. The depth to lime ranges from 24 to 40 inches.

The A horizon has hue of 10YR and value of 4 or 5 (2 or 3 moist). It has chroma of 1 in the upper 10 inches and chroma of 1 or 2 in the lower part. It is dominantly silty clay but in some pedons is clay. It is neutral or mildly alkaline. The C horizon has hue of 10YR, value of 5 to 7 (4 or 5 moist), and chroma of 2. It is silty clay loam or silt loam.

Owens series

The Owens series consists of shallow, well drained, very slowly permeable soils on uplands. These soils formed in residuum of clayey shale. Slope ranges from 6 to 25 percent.

Owens soils commonly are adjacent to Campus, Canlon, Quinlan, and Woodward soils. The loamy Campus and Canlon soils are on the higher parts of the landscape. Quinlan and Woodward soils have a loamy subsoil. They are on the lower parts of the landscape.

Typical pedon of Owens silty clay, 6 to 25 percent slopes, 2,580 feet west and 1,500 feet south of the northeast corner of sec. 30, T. 31 S., R. 22 W.

A—0 to 6 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; weak fine and medium subangular blocky structure; very hard, very firm; many fine roots; slight effervescence; moderately alkaline; many small sandstone and ironstone fragments on the surface; gradual smooth boundary.

Bk—6 to 17 inches; light yellowish brown (2.5Y 6/4) silty clay, light olive brown (2.5Y 5/4) moist; moderate medium blocky structure; extremely hard, very firm; few fine roots; few soft accumulations of lime; strong effervescence; moderately alkaline; gradual smooth boundary.

Cr—17 inches; light brownish gray (2.5Y 6/2) clayey shale.

The thickness of the solum, or the depth to shale, ranges from 10 to 20 inches. Fragments of limestone, ironstone, or sandstone less than 10 inches in diameter cover 0 to 5 percent of the surface. The solum has hue of 10YR or 2.5Y, value of 5 or 6 (4 or 5 moist), and chroma of 2 to 4.

The A horizon is dominantly silty clay, but the range includes clay loam and clay. In some pedons the B horizon is mottled.

Penden series

The Penden series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in calcareous old alluvium. Slope ranges from 0 to 15 percent.

Penden soils are similar to Campus and Uly soils and commonly are adjacent to Campus, Canlon, Harney, Kingsdown, and Missler soils. Campus soils are 20 to 40 inches deep over caliche. Uly soils contain less sand in the subsoil than the Penden soils. Canlon soils are less than 20 inches deep over caliche. They are on the steeper slopes. Harney soils have an argillic horizon. They are on the higher, less sloping parts of the landscape. Kingsdown soils are on convex ridgetops. Their subsoil is more sandy than that of the Penden soils. The nearly level Missler soils are on broad uplands. Their subsoil contains more clay than that of the Penden soils.

Typical pedon of Penden clay loam, 1 to 3 percent slopes, 900 feet east and 30 feet south of the northwest corner of sec. 29, T. 33 S., R. 24 W.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; hard, friable; many fine roots; slight effervescence; mildly alkaline; gradual smooth boundary.

A—9 to 16 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; hard, friable; few fine roots; many wormcasts; strong effervescence; moderately alkaline; gradual smooth boundary.

Bk—16 to 28 inches; pale brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; weak medium subangular blocky structure; hard, friable; many soft accumulations and concretions of lime; violent effervescence; moderately alkaline; gradual smooth boundary.

C—28 to 60 inches; very pale brown (10YR 7/4) clay loam, pale brown (10YR 6/3) moist; weak medium subangular blocky structure; hard, friable; few fine lime concretions; violent effervescence; moderately alkaline.

The thickness of the solum ranges from 20 to 36 inches. The A horizon has hue of 10YR, value of 4 or 5 (3 moist), and chroma of 2 or 3. It is dominantly clay loam but in some pedons is loam or silty clay loam. It is mildly alkaline or moderately alkaline. The B 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 clay loam, loam, or silty clay loam. The C horizon has hue of 7.5YR or 10YR, value of 6 to 8 (5 to 7 moist), and chroma of 3 or 4. It is clay loam or loam.

Penden clay loam, 2 to 7 percent slopes, eroded, lacks a mollic epipedon, which is definitive for the series. This difference, however, does not significantly affect the use or behavior of the soil.

Pratt series

The Pratt series consists of deep, well drained, rapidly permeable soils on uplands. These soils formed in sandy eolian deposits. Slope ranges from 1 to 15 percent.

Pratt soils are similar to Kingsdown and Tivoli soils and commonly are adjacent to those soils. Kingsdown soils are more clayey than the Pratt soils. They are nearly level and undulating. Tivoli soils do not have an argillic horizon. They are on the steeper slopes or ridges.

Typical pedon of Pratt loamy fine sand, undulating, 1,980 feet west and 420 feet south of the northeast corner of sec. 14, T. 34 S., R. 22 W.

A—0 to 11 inches; brown (10YR 5/3) loamy fine sand, dark brown (10YR 4/3) moist; weak medium granular structure; soft, very friable; many fine roots; neutral; clear smooth boundary.

Bt—11 to 30 inches; light brown (7.5YR 6/4) loamy fine sand, brown (7.5YR 5/4) moist; weak coarse subangular blocky structure; slightly hard, very friable; few fine roots; horizontal bands of darker, clay coated sand; neutral; gradual smooth boundary.

C—30 to 60 inches; light brown (7.5YR 6/4) loamy fine sand, brown (7.5YR 5/4) moist; single grained; loose; neutral.

The solum is 24 to 36 inches thick. It is medium acid to neutral.

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

Quinlan series

The Quinlan series consists of shallow, well drained, moderately rapidly permeable soils on uplands. These soils formed in material weathered from soft, calcareous, fine grained sandstone. Slope ranges from 3 to 15 percent.

Quinlan soils are similar to Woodward soils and commonly are adjacent to Carey, Owens, Penden, and Woodward soils. Woodward soils are more than 20 inches deep over bedrock. They are on side slopes below the Quinlan soils. Carey soils are more than 40 inches deep over bedrock. They are on the lower parts of the landscape. Owens soils are clayey. They are on the higher parts of the landscape. Penden soils are more than 40 inches deep over bedrock. Their positions on the landscape are similar to those of the Quinlan soils.

Typical pedon of Quinlan loam, in an area of Quinlan-Woodward loams, 6 to 15 percent slopes, 1,830 feet east and 45 feet north of the southwest corner of sec. 8, T. 34 S., R. 21 W.

A—0 to 7 inches; yellowish red (5YR 5/6) loam, yellowish red (5YR 4/6) moist; weak medium granular structure; slightly hard, friable; many fine roots; slight effervescence; moderately alkaline; gradual wavy boundary.

Bw—7 to 13 inches; red (2.5YR 5/6) loam, red (2.5YR 4/6) moist; weak medium subangular blocky structure; slightly hard, friable; many fine roots; strong effervescence; moderately alkaline; gradual wavy boundary.

Cr—13 inches; red (2.5YR 5/6), weakly consolidated, calcareous sandstone.

The thickness of the solum, or the depth to weakly consolidated sandstone, ranges from 10 to 20 inches. The soils are mildly alkaline or moderately alkaline throughout.

The A and B horizons have hue of 5YR or 2.5YR, value of 4 to 6 (3 to 5 moist), and chroma of 3 to 6. The A horizon is dominantly loam but in some pedons is fine sandy loam.

Roxbury series

The Roxbury series consists of deep, well drained, moderately permeable soils on flood plains. These soils formed in calcareous, silty alluvium. Slope ranges from 0 to 2 percent.

Roxbury soils are similar to Bippus and Yahola soils and commonly are adjacent to Kingsdown and Missler soils. Bippus soils are on colluvial and alluvial fans. Their subsoil contains more sand than that of the Roxbury soils. Yahola and Kingsdown soils are more sandy than the Roxbury soils. Also, Yahola soils have a redder subsoil, and Kingsdown soils are higher on the landscape and are nearly level and undulating. Missler soils have a mollic epipedon that is less than 20 inches thick. They are on uplands.

Typical pedon of Roxbury silt loam, occasionally flooded, 660 feet north and 1,980 feet east of the southwest corner of sec. 19, T. 30 S., R. 24 W.

Ap—0 to 7 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; common fine roots; slight effervescence; mildly alkaline; gradual smooth boundary.

A—7 to 21 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; few fine roots; slight effervescence; mildly alkaline; gradual smooth boundary.

Bw—21 to 36 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; hard, friable; few fine roots; few threads of lime; numerous wormcasts; slight effervescence; mildly alkaline; gradual smooth boundary.

C—36 to 60 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; massive; hard, friable; few threads of lime; strong effervescence; moderately alkaline.

The mollic epipedon is more than 20 inches thick. The depth to lime is less than 15 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 silty clay loam and loam. The B horizon has hue of 10YR, value of 4 to 6 (2 to 4 moist), and chroma of 2. It is silty clay loam or silt loam.

Satanta series

The Satanta series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in loamy eolian material. Slope ranges from 0 to 2 percent.

The Satanta soils in this survey area are slightly more moist than is defined as the range for the Satanta series. This difference, however, does not significantly affect the use or behavior of the soils.

Satanta soils are similar to Kingsdown soils and commonly are adjacent to Kingsdown and Harney soils. Kingsdown soils are more sandy than the Satanta soils. They are on knobs. Harney soils are lower on the landscape than the Satanta soils. Also, their subsoil contains more clay.

Typical pedon of Satanta loam, 0 to 2 percent slopes, 1,500 feet east and 1,500 feet south of the northwest corner of sec. 29, T. 30 S., R. 25 W.

Ap—0 to 7 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; hard, friable; few fine roots; slightly acid; gradual smooth boundary.

A—7 to 11 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; weak medium granular structure; hard, friable; few fine roots; neutral; gradual smooth boundary.

Bt—11 to 32 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; moderate fine and medium subangular blocky structure; hard, friable; few fine roots; few wormcasts; mildly alkaline; gradual smooth boundary.

Ck—32 to 38 inches; pale brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; moderate medium subangular blocky structure; hard, friable; slight effervescence; few small lime concretions; mildly alkaline; gradual smooth boundary.

C—38 to 60 inches; pale brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; massive; slightly hard, very friable; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 28 to 40 inches. The thickness of mollic epipedon ranges from 10 to 20 inches. The depth to lime ranges from 20 to 36 inches.

The A horizon has hue of 10YR, value of 4 or 5 (3 moist), and chroma of 2 or 3. It is dominantly loam, but the range includes clay loam and fine sandy loam. The Bt and C horizons are clay loam or loam. The Bt horizon has hue of 10YR, value of 4 or 5 (3 or 4 moist), and chroma of 2 or 3. The C horizon has hue of 10YR, value of 5 or 6 (4 or 5 moist), and chroma of 2 to 4. It is mildly alkaline or moderately alkaline.

Shellabarger series

The Shellabarger series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in old alluvium. Slope ranges from 2 to 12 percent.

Shellabarger soils are similar to Kingsdown soils and commonly are adjacent to Albion, Campus, Canlon, Owens, and Penden soils. Kingsdown and Albion soils contain less clay in the subsoil than the Shellabarger soils. Also, Albion soils are shallower to a sandy substratum. They are on convex ridgetops. Campus and Canlon soils are calcareous throughout. They are on the higher, steeper slopes. Owens soils have a clayey subsoil. They are on the lower parts of the landscape. Penden soils are calcareous. Their positions on the landscape are similar to those of the Shellabarger soils.

Typical pedon of Shellabarger sandy loam, in an area of Albion-Shellabarger sandy loams, 6 to 12 percent slopes, about 1,590 feet south and 1,590 feet west of the northeast corner of sec. 24, T. 30 S., R. 21 W.

A—0 to 10 inches; reddish brown (5YR 4/3) sandy loam, dark reddish brown (5YR 3/3) moist; weak medium granular structure; slightly hard, friable; many fine roots; slightly acid; clear smooth boundary.

Bt1—10 to 15 inches; reddish brown (5YR 4/3) sandy clay loam, dark reddish brown (5YR 3/3) moist; weak medium subangular blocky structure; hard, friable; common fine roots; neutral; clear smooth boundary.

Bt2—15 to 36 inches; reddish brown (5YR 5/4) sandy clay loam, reddish brown (5YR 4/4) moist; weak medium subangular blocky structure; hard, friable; few fine roots; mildly alkaline; clear smooth boundary.

C—36 to 60 inches; reddish yellow (7.5YR 6/6) sandy loam, strong brown (7.5YR 5/6) moist; weak fine subangular blocky structure; soft, very friable; mildly alkaline.

The thickness of the solum ranges from 30 to 50 inches. The mollic epipedon is 10 to 20 inches thick.

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

Tivoli series

The Tivoli series consists of deep, excessively drained, rapidly permeable soils on uplands. These soils formed in sandy eolian deposits. Slope ranges from 10 to 30 percent.

Tivoli soils are similar to Likes, Lincoln, and Pratt soils and commonly are adjacent to Pratt soils. Likes soils are calcareous. They are in the less sloping areas. Lincoln soils formed in sandy alluvium on flood plains. Pratt soils have an argillic horizon. They are on the lower slopes.

Typical pedon of Tivoli fine sand, hilly, 1,320 feet east and 1,830 feet north of the southwest corner of sec. 18, T. 34 S., R. 23 W.

A—0 to 6 inches; brown (10YR 5/3) fine sand, brown (10YR 4/3) moist; single grained; loose, very friable; common fine roots; neutral; clear smooth boundary.

C—6 to 60 inches; yellow (10YR 7/6) fine sand, yellowish brown (10YR 5/6) moist; single grained; loose; few fine roots; mildly alkaline.

The soils are slightly acid to mildly alkaline throughout. The A horizon has hue of 10YR, value of 5 or 6 (4 or 5 moist), and chroma of 2 to 4. It is fine sand or loamy fine sand. The C horizon has hue of 7.5YR or 10YR, value of 5 to 7 (4 to 6 moist), and chroma of 3 to 6.

Uly series

The Uly series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in loess. Slope ranges from 0 to 6 percent.

Uly soils are similar to Carey, Missler, and Penden soils and commonly are adjacent to Harney soils. Carey soils are redder than the Uly soils. Missler and Harney soils contain more clay in the subsoil than the Uly soils. Also, Harney soils generally are higher on the landscape and are nearly level and gently sloping. Penden soils contain more sand in the subsoil than the Uly soils. They are on the steeper slopes.

Typical pedon of Uly silt loam, 3 to 6 percent slopes (fig. 27), 330 feet west and 270 feet north of the southeast corner of sec. 7, T. 30 S., R. 22 W.

A—0 to 7 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, friable; many fine roots; neutral; gradual smooth boundary.

Bw—7 to 14 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; hard, friable; common fine roots; mildly alkaline; gradual smooth boundary.

BC—14 to 18 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; weak fine subangular blocky structure; hard, friable; few fine roots; slight effervescence; moderately alkaline; gradual smooth boundary.

C—18 to 60 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; massive; slightly hard, friable; films and threads of lime; violent effervescence; moderately alkaline.

The mollic epipedon is 7 to 20 inches thick. The solum is 12 to 30 inches thick. The depth to lime ranges from 8 to 20 inches.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 2. It is neutral or mildly alkaline. The B horizon has hue of 10YR, value of 4 to 6 (3 to 5 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 or 7.5YR, value of 5 to 8 (5 or 6 moist), and chroma of 2 to 4.

Waldeck series

The Waldeck series consists of deep, somewhat poorly drained, moderately rapidly permeable soils on flood plains. These soils formed in alluvium. Slope is 0 to 1 percent.

Waldeck soils are similar to Yahola and Zenda soils and commonly are adjacent to Lesho, Likes, and Lincoln soils. The well drained Yahola soils do not have a mollic epipedon. Zenda soils contain more clay in the subsoil than the Waldeck soils. Lesho soils are 20 to 40 inches deep over sandy alluvium. They are on the slightly lower flood plains. Likes and Lincoln soils are sandy throughout. Likes soils are on foot slopes, and Lincoln soils are on the slightly higher flood plains.

Typical pedon of Waldeck fine sandy loam, 2,210 feet north and 1,320 feet east of the southwest corner of sec. 33, T. 34 S., R. 24 W.

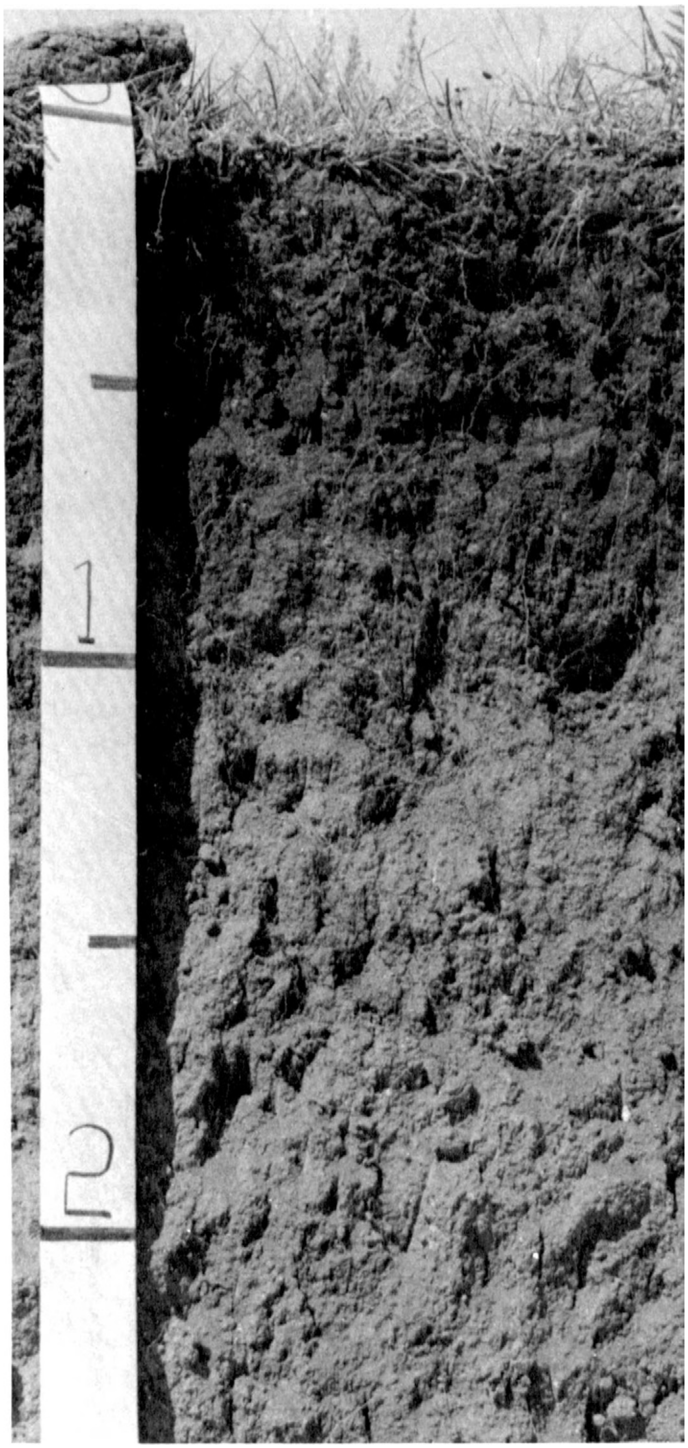


Figure 27.—Profile of Uly silt loam, 3 to 6 percent slopes. The surface layer has many roots. Depth is marked in feet.

A—0 to 14 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, very friable; many fine roots; slight effervescence; mildly alkaline; gradual smooth boundary.

AC—14 to 32 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) moist; common fine distinct strong brown (7.5YR 5/6) mottles below a depth of 20 inches; moderate fine granular structure; slightly hard, very friable; common fine roots; slight effervescence; mildly alkaline; gradual smooth boundary.

C1—32 to 45 inches; light brownish gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; few fine distinct brown (7.5YR 5/4) mottles; massive; slightly hard, friable; few fine roots; slight effervescence; mildly alkaline; gradual smooth boundary.

2C2—45 to 60 inches; very pale brown (10YR 7/4) sand, light yellowish brown (10YR 6/4) moist; single grained; loose; moderately alkaline.

The thickness of the mollic epipedon ranges from 10 to 20 inches. The depth to lime ranges from 0 to 12 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 2 or 3. It is fine sandy loam or loam. The C horizon has hue of 7.5YR or 10YR, value of 5 or 6 (4 or 5 moist), and chroma of 2 to 4. It is sandy loam or fine sandy loam. The 2C horizon is fine sand or sand.

Woodward series

The Woodward series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from soft, calcareous, fine grained sandstone. Slope ranges from 1 to 15 percent.

Woodward soils are similar to Quinlan soils and commonly are adjacent to Carey, Penden, and Quinlan soils. Quinlan soils are less than 20 inches deep over bedrock. They are on the crest of ridges. Carey and Penden soils are more than 40 inches deep over bedrock. Carey soils are on the lower parts of the landscape, and Penden soils are in positions on the landscape similar to those of the Woodward soils.

Typical pedon of Woodward loam, in an area of Woodward-Quinlan loams, 3 to 6 percent slopes, 2,490 feet east and 2,490 feet north of the southwest corner of sec. 31, T. 33 S., R. 22 W.

Ap—0 to 9 inches; reddish brown (5YR 5/4) loam, dark reddish brown (5YR 3/4) moist; weak medium granular structure; slightly hard, friable; few fine roots; slight effervescence; mildly alkaline; gradual smooth boundary.

Bw—9 to 20 inches; reddish brown (5YR 5/4) loam, reddish brown (5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, friable; few fine roots; few wormcasts; few lime concretions; strong effervescence; moderately alkaline; gradual smooth boundary.

BC—20 to 30 inches; reddish yellow (5YR 6/6) loam, yellowish red (5YR 4/6) moist; weak medium subangular blocky structure; slightly hard, friable; few threads and soft masses of lime; strong effervescence; moderately alkaline; gradual smooth boundary.

Cr—30 inches; light red (2.5YR 6/6), weakly consolidated, calcareous sandstone.

The thickness of the solum, or the depth to sandstone, ranges from 20 to 40 inches. The A horizon has hue of 7.5YR or 5YR, value of 4 to 6 (3 or 4 moist), and chroma of 3 or 4. It is dominantly loam, but the range includes silt loam. The B horizon has hue of 7.5YR or 5YR, value of 5 or 6 (4 or 5 moist), and chroma of 3 to 6.

Yahola series

The Yahola series consists of deep, well drained, moderately rapidly permeable soils on flood plains. These soils formed in calcareous, loamy alluvium. Slope is 0 to 1 percent.

Yahola soils are similar to Roxbury and Waldeck soils and commonly are adjacent to Lincoln and Missler soils. Roxbury and Waldeck soils have a mollic epipedon. Roxbury soils are on the higher flood plains, and the somewhat poorly drained Waldeck soils are on the lower flood plains. Lincoln soils are sandy. They are in positions on the flood plains similar to those of the Yahola soils. Missler soils are on uplands. Their subsoil is more clayey than that of the Yahola soils.

Typical pedon of Yahola loam, 330 feet west and 45 feet north of the southeast corner of sec. 13, T. 33 S., R. 23 W.

A—0 to 8 inches; brown (7.5YR 5/2) loam, dark brown (7.5YR 4/4) moist; moderate medium granular structure; slightly hard, friable; common fine roots; slight effervescence; moderately alkaline; clear smooth boundary.

C1—8 to 21 inches; reddish yellow (7.5YR 6/6) fine sandy loam, strong brown (7.5YR 5/6) moist; massive; slightly hard, very friable; common fine roots; slight effervescence; moderately alkaline; gradual smooth boundary.

C2—21 to 60 inches; reddish yellow (7.5YR 6/6) fine sandy loam, strong brown (7.5YR 5/6) moist; massive; thin strata of loamy fine sand; slightly hard, very friable; few fine roots; slight effervescence; moderately alkaline.

The A horizon has hue of 7.5YR or 5YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 6. It is dominantly loam, but the range includes fine sandy loam. In some pedons the C horizon has strata of loam and clay loam.

Zenda series

The Zenda series consists of deep, somewhat poorly drained, moderately permeable soils on flood plains. These soils formed in loamy alluvium. Slope is 0 to 1 percent.

Zenda soils are similar to Lesho and Waldeck soils and commonly are adjacent to Lincoln and Waldeck soils. Lesho soils are 20 to 40 inches deep over sandy alluvium. They are on the lower flood plains. The subsoil of Waldeck soils is more sandy than that of the Zenda soils. Lincoln soils are sandy. They are adjacent to stream channels.

Typical pedon of Zenda loam, 2,640 feet east and 330 feet north of the southwest corner of sec. 4, T. 34 S., R. 24 W.

A—0 to 14 inches; dark gray (10YR 4/1) loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; hard, friable; many fine roots; slight effervescence; moderately alkaline; clear smooth boundary.

C1—14 to 36 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; few fine faint brown (7.5YR 5/4) mottles; moderate medium subangular blocky structure; very hard, firm; few fine roots; few thin strata of sandy loam in the lower part; strong effervescence; moderately alkaline; gradual smooth boundary.

C2—36 to 60 inches; light brownish gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) moist; few fine distinct brown (7.5YR 5/4) mottles; massive; very hard, firm; violent effervescence; moderately alkaline.

The solum is 10 to 18 inches thick. The mollic epipedon is 10 to 20 inches thick.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 to 3. It is dominantly loam but in some pedons is clay loam or sandy 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 to 4. It commonly has strata of sandy loam or loamy sand.

formation of the soils

Soil forms through processes that act on deposited or accumulated geologic material. As a result of these processes, it is constantly changing. The characteristics of the soil at any given point are determined by the interaction among five factors of soil formation—the physical and mineral composition of the parent material, the climate, 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. Each of these factors affects the formation of every soil, and each modifies the effects of the other four. The effects of the individual factors vary from place to place.

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 soil 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 weathered rock or partly weathered material in which soils form. It affects the texture, structure, color, natural fertility, and other properties of the soil. The soils in Clark County formed in alluvium, eolian sand, loess, and residuum of sandstone, shale, or caliche.

Alluvium is material that is transported by water. The old alluvial sediments of the Pleistocene Series and the Upper Pliocene Series were deposited by widely shifting streams that originated in the Rocky Mountains. They are loamy or sandy, and some sediments of the Pliocene Series have beds of caliche. Soils that formed in old alluvium are on uplands. Examples are Albion, Penden, and Shellabarger soils. Recent alluvial sediments are on flood plains along the major streams in the county. Krier, Lesho, Lincoln, Roxbury, Waldeck, Yahola, and Zenda soils formed in this material.

Eolian sand is sandy material transported by wind. In Clark County it is deposited on undulating to hilly sandhills. Pratt and Tivoli soils formed in this sandy material.

Loess is silty, wind deposited material, some of which has been carried hundreds of miles from its source. Peorian Loess of the Wisconsin Glaciation covers some of the uplands in the northern part of the county. It was deposited during the Pleistocene epoch. The silty Harney and Uly soils formed in this material.

The loamy Quinlan and Woodward soils formed in residuum of calcareous, fine grained sandstone. This reddish bedrock is of the Upper Permian System. The clayey Owens soils formed in residuum of the Kiowa Shale of the Cretaceous System. Canlon soils formed in material weathered from caliche.

climate

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

The continental climate of Clark County is characterized by intermittent dry and moist periods. These periods 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 Satanta soils is an indication of this excess moisture. Because of the downward movement of water, some of the basic nutrients, and even clay particles, have been leached from the upper horizons of some soils.

plant and animal life

Plants generally affect the content of plant nutrients and of organic matter in the soil and the color of the surface layer. Bacteria and fungi help to decompose the plants, thus releasing more nutrients. Earthworms, cicadas, and burrowing animals help to keep the soil open and porous.

Prairie grasses have had a significant effect on soil formation in Clark County. As a result of the grasses, the upper part of a typical soil in the county is dark and is high in content of organic matter. In many areas the next part 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 soil formation through its effect on runoff, drainage, and other factors related to the movement of water, including geologic and accelerated erosion. The amount of water that enters the soil depends partly on relief.

Runoff is more rapid on the steeper soils than on less sloping soils. As a result, less water enters the steeper soils and more soil material is lost through erosion. The profile of the nearly level and gently sloping Harney soils generally is more strongly expressed than that of the steeper soils, such as Quinlan soils. In most nearly level or depressional areas, the amount of available moisture is increased by runoff from the higher lying areas. Because of this additional water, the upper layers of the soil tend to be thick. Most of the nearly level soils that formed in alluvium receive new sediments during periods of flooding.

time

The length of time needed for soil formation depends mainly on the other factors of soil formation. As water moves downward through the soil, soluble matter and fine particles are leached gradually from the surface layer and are deposited in the subsoil. The extent of leaching depends not only on the amount of water that has penetrated the surface but also on the amount of time that has elapsed.

Some of the soils in the county are young. Yahola soils, which formed in recent alluvium, are an example. They show very little evidence of horizon differentiation other than a slight darkening of the surface layer. The older soils have well defined horizons. Harney soils are an example. They have been exposed to soil-forming processes for a much longer period than the Yahola soils.

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glossary

ABC soil. A soil having an A, a B, and a C horizon.

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

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

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

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

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

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

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

Badland. Steep or very steep, commonly nonstony, barren land dissected by many intermittent drainage channels. Badland is most common in semiarid and arid regions where streams are entrenched in soft geologic material. Local relief generally ranges from 25 to 500 feet. Runoff potential is very high, and geologic erosion is active.

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.

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-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.

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.

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.

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.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

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.

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.

Excess salt (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

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.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

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

Foot slope. The inclined surface at the base of a hill.

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 uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

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.

E horizon.—The mineral horizon below an O or A horizon and above a B horizon. The E horizon is characterized by a loss of some combination of silicate clay, iron, and aluminum and by a remaining concentration of sand and silt particles of quartz or other resistant minerals.

B horizon.—The mineral horizon below an A, E, or O 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 angular or subangular blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A, E, and B horizons are generally called the solum. 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, E, 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, an Arabic numeral, commonly a 2, precedes the letter C.

R layer.—Hard bedrock beneath the soil. The bedrock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

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.

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.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

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

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

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.

Ponding. Standing water on soils in closed depressions. The water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability or an impermeable layer near the surface, the soil may not adequately filter effluent from a waste disposal system.

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

Red beds. Red sandstone, shale, or siltstone of the Upper Permian System.

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.

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.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

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 substratum. 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.

Slow intake (in tables). The slow movement of water into the soil.

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.

Sodicity. The degree to which a soil is affected by exchangeable sodium. Sodicity is expressed as a sodium absorption ratio (SAR) of a saturation extract, or the ratio of Na to Ca!! + Mg!!. The degrees of sodicity are—

	SAR
Slight	less than 13:1
Moderate	13-30:1
Strong	more than 30:1

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, E, 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 (A, E, AB, or EB) 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, E, AB, and EB horizons. Includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that 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.

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

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Most data recorded in the period 1951-76 at Ashland, Kansas; average snowfall recorded in the period 1898-1948]

Month	Temperature					Precipitation				
				2 years in 10 will have--			2 years in 10 will have--			
	Average daily maximum	Average daily minimum	Average daily	Maximum temperature higher than--	Minimum temperature lower than--	Average	Less than--	More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	In	In	In		In
January----	46.8	17.3	32.1	74	-11	0.34	0.00	0.52	1	2.7
February---	52.4	21.8	37.1	85	2	.57	.15	.78	1	4.2
March------	59.0	28.2	43.6	90	7	1.50	.12	2.44	3	3.0
April------	71.3	40.3	55.8	95	19	1.52	.42	2.27	3	.5
May--------	80.0	51.2	65.6	101	31	3.27	1.08	5.00	5	.0
June-------	89.7	61.0	75.4	107	43	3.34	.88	5.29	6	.0
July-------	94.0	66.2	80.6	108	52	2.58	1.23	3.58	5	.0
August-----	94.2	64.4	79.3	108	50	2.63	.98	3.79	4	.0
September--	84.3	55.0	69.7	102	35	2.64	.63	3.80	4	.0
October----	74.5	42.1	58.3	96	24	1.49	.30	2.55	3	.1
November---	58.9	28.8	43.9	82	7	.97	.02	1.87	2	1.0
December---	49.4	20.7	35.1	75	-3	.58	.01	1.14	2	3.1
Year-----	71.3	41.4	56.4	109	-12	21.43	16.76	26.71	39	14.6

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1931-60 at Ashland, 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 10	April 22	May 7
2 years in 10 later than--	April 5	April 17	May 2
5 years in 10 later than--	March 27	April 7	April 22
First freezing temperature in fall:			
1 year in 10 earlier than--	October 25	October 19	October 8
2 years in 10 earlier than--	October 29	October 24	October 12
5 years in 10 earlier than--	November 8	November 2	October 22

TABLE 3.--GROWING SEASON

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

Probability	Daily minimum temperature		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	207	191	159
8 years in 10	213	197	167
5 years in 10	226	209	183
2 years in 10	238	221	199
1 year in 10	245	227	207

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

Map symbol	Soil name	Acres	Percent
Ab	Albion-Shellabarger sandy loams, 6 to 12 percent slopes	16,250	2.6
Bd	Badland-Woodward complex	1,780	0.3
Bp	Bippus clay loam, 0 to 2 percent slopes	10,250	1.6
Bu	Bippus clay loam, 2 to 5 percent slopes	4,140	0.7
Cc	Campus-Canlon loams, 5 to 15 percent slopes	55,150	8.8
Ch	Canlon-Rock outcrop complex, 5 to 30 percent slopes	2,385	0.4
Cr	Carey silt loam, 0 to 1 percent slopes	17,120	2.7
Cs	Carey silt loam, 1 to 3 percent slopes	15,950	2.5
Cy	Carey silt loam, 3 to 6 percent slopes	5,810	0.9
Ha	Harney silt loam, 0 to 1 percent slopes	53,850	8.6
Hb	Harney silt loam, 1 to 3 percent slopes	35,525	5.6
Ka	Kingsdown fine sandy loam, 0 to 2 percent slopes	22,375	3.6
Kb	Kingsdown fine sandy loam, 2 to 5 percent slopes	8,160	1.3
Kr	Krier loam	5,270	0.8
Lb	Lesho clay loam	804	0.1
Le	Lesho clay loam, saline	4,310	0.7
Lf	Likes loamy sand, undulating	12,050	1.9
Lh	Likes-Quinlan complex, 3 to 15 percent slopes	6,200	1.0
Ln	Lincoln loamy fine sand	17,950	2.9
Lr	Lincoln-Krier complex	7,200	1.1
Ms	Missler silty clay loam, 0 to 2 percent slopes	16,450	2.6
Ns	Ness silty clay	3,050	0.5
Os	Owens silty clay, 6 to 25 percent slopes	29,425	4.7
Pa	Penden clay loam, 0 to 1 percent slopes	3,440	0.5
Pb	Penden clay loam, 1 to 3 percent slopes	19,350	3.1
Pc	Penden clay loam, 3 to 7 percent slopes	18,350	2.9
Pf	Penden clay loam, 2 to 7 percent slopes, eroded	3,650	0.6
Pg	Penden clay loam, 7 to 15 percent slopes	47,725	7.5
Pr	Pratt loamy fine sand, undulating	3,900	0.6
Pt	Pratt-Tivoli loamy fine sands, rolling	29,500	4.7
Qw	Quinlan-Woodward loams, 6 to 15 percent slopes	40,000	6.4
Rc	Roxbury silt loam, channeled	9,500	1.5
Rf	Roxbury silt loam, occasionally flooded	8,450	1.3
Sa	Satanta loam, 0 to 2 percent slopes	4,650	0.7
Sh	Shellabarger loam, 2 to 5 percent slopes	6,000	1.0
Tv	Tivoli fine sand, hilly	13,625	2.2
Ua	Uly silt loam, 0 to 1 percent slopes	10,725	1.7
Ub	Uly silt loam; 1 to 3 percent slopes	7,475	1.2
Uc	Uly silt loam, 3 to 6 percent slopes	13,200	2.1
Wa	Waldeck fine sandy loam	4,950	0.8
Wo	Woodward loam, 1 to 3 percent slopes	10,620	1.7
Wr	Woodward-Quinlan loams, 3 to 6 percent slopes	19,350	3.1
Yh	Yahola loam	1,500	0.2
Ze	Zenda loam	1,450	0.2
	Water	896	0.1
	Total	629,760	100.0

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Only arable soils are listed. 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	Grain sorghum	Winter wheat	Alfalfa hay
	Bu	Bu	Ton
Bp: Bippus	42	30	2.5
Bu: Bippus	38	27	2.5
Cr: Carey	45	32	2.5
Cs: Carey	40	30	2.5
Cy: Carey	36	26	2.0
Ha: Harney	44	33	2.0
Hb: Harney	40	30	2.0
Ka: Kingsdown	44	28	3.0
Kb: Kingsdown	40	25	2.5
Lb: Lesho	36	23	3.5
Le: Lesho	30	18	2.0
Ln: Lincoln	28	20	---
Ms: Missler	44	29	2.5
Pa: Penden	42	30	2.5
Pb: Penden	38	28	2.5
Pc: Penden	34	24	2.0
Pf: Penden	30	20	---
Pr: Pratt	40	23	2.0
Rf: Roxbury	46	34	3.5
Sa: Satanta	48	30	2.5
Sh: Shellabarger	42	26	2.5
Ua: Uly	45	32	2.5

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Grain sorghum	Winter wheat	Alfalfa hay
	Bu	Bu	Ton
Ub-Uly	40	30	2.5
Uc-Uly	35	27	2.0
Wa-Waldeck	44	24	3.5
Wo-Woodward	36	29	2.0
Wr-Woodward-Quinlan	30	23	---
Yh-Yahola	44	24	3.5
Ze-Zenda	42	26	4.0

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES

[Only the soils that support rangeland vegetation suitable for grazing are listed]

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Ab*:					
Albion	Sandy	Favorable	4,000	Sand bluestem	30
		Normal	3,000	Little bluestem	25
		Unfavorable	2,000	Indiangrass	10
				Switchgrass	10
				Sand lovegrass	5
Shellabarger	Sandy	Favorable	4,500	Sand bluestem	25
		Normal	3,200	Little bluestem	20
		Unfavorable	2,000	Indiangrass	10
				Switchgrass	10
				Big bluestem	10
				Sand lovegrass	5
Bd*:					
Badland.					
Woodward	Loamy Upland	Favorable	4,000	Little bluestem	20
		Normal	2,800	Big bluestem	20
		Unfavorable	2,000	Switchgrass	10
				Indiangrass	10
				Sideoats grama	10
				Blue grama	10
Bp, Bu	Loamy Terrace	Favorable	4,500	Big bluestem	25
Bippus		Normal	3,000	Switchgrass	10
		Unfavorable	2,000	Sideoats grama	10
				Western wheatgrass	10
				Little bluestem	10
				Vine-mesquite	5
				Indiangrass	5
Cc*:					
Campus	Limy Upland	Favorable	3,000	Little bluestem	30
		Normal	2,000	Big bluestem	20
		Unfavorable	1,000	Sideoats grama	20
				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
Ch*:					
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
Rock outcrop.					

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Cr, Cs, Cy: Carey	Loamy Upland	Favorable	4,000	Big bluestem	25
		Normal	2,800	Little bluestem	20
		Unfavorable	1,600	Sideoats grama	15
				Blue grama	10
				Western wheatgrass	5
				Indiangrass	5
Ha, Hb: Harney	Loamy Upland	Favorable	3,500	Big bluestem	20
		Normal	2,500	Little bluestem	15
		Unfavorable	1,000	Blue grama	15
				Sideoats grama	10
				Buffalograss	10
				Western wheatgrass	10
				Western ragweed	5
Ka, Kb: Kingsdown	Sandy	Favorable	4,000	Sand bluestem	20
		Normal	3,000	Little bluestem	20
		Unfavorable	2,000	Indiangrass	10
				Switchgrass	10
				Big bluestem	10
				Sand lovegrass	5
				Sand dropseed	5
				Blue grama	5
Kr: Krier	Saline Subirrigated	Favorable	6,500	Alkali sacaton	25
		Normal	5,500	Switchgrass	20
		Unfavorable	4,000	Alkali cordgrass	10
				Inland saltgrass	10
				Tall dropseed	10
				Western wheatgrass	5
Lb: Lesho	Subirrigated	Favorable	9,000	Sand bluestem	15
		Normal	8,000	Indiangrass	15
		Unfavorable	7,000	Eastern gamagrass	15
				Switchgrass	10
				Prairie cordgrass	10
				Little bluestem	5
				Tall dropseed	5
				Western wheatgrass	5
				Sedge	5
Le: Lesho	Saline Subirrigated	Favorable	6,500	Alkali sacaton	25
		Normal	5,500	Switchgrass	20
		Unfavorable	4,000	Inland saltgrass	10
				Tall dropseed	10
				Indiangrass	5
				Alkali cordgrass	5
				Western wheatgrass	5
Lf: Likes	Sands	Favorable	3,500	Little bluestem	20
		Normal	2,500	Sand bluestem	20
		Unfavorable	1,300	Sideoats grama	10
				Indiangrass	10
				Sand lovegrass	10
				Switchgrass	5
				Sand sagebrush	5
				Blue grama	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: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Lh*:					
Likes	Sands	Favorable	3,500	Little bluestem	20
		Normal	2,500	Sand bluestem	20
		Unfavorable	1,300	Sideoats grama	10
				Indiangrass	10
				Sand lovegrass	10
				Switchgrass	5
				Sand sagebrush	5
				Blue grama	5
Quinlan	Shallow Prairie	Favorable	2,500	Little bluestem	30
		Normal	1,800	Sand bluestem	15
		Unfavorable	1,300	Sideoats grama	10
				Blue grama	10
				Indiangrass	5
				Scribner panicum	5
				Prairie-clover	5
				Dotted gayfeather	5
Ln: Lincoln	Sandy Lowland	Favorable	4,000	Switchgrass	30
		Normal	3,000	Sand bluestem	15
		Unfavorable	2,000	Indiangrass	15
				Little bluestem	5
				Texas bluegrass	5
				Beaked panicum	5
				Purpletop	5
				Maximilian sunflower	5
Lr*:					
Lincoln	Sandy Lowland	Favorable	4,000	Switchgrass	30
		Normal	3,000	Sand bluestem	15
		Unfavorable	2,000	Indiangrass	15
				Little bluestem	5
				Texas bluegrass	5
				Beaked panicum	5
				Purpletop	5
				Maximilian sunflower	5
Krier	Saline Subirrigated	Favorable	6,500	Alkali sacaton	25
		Normal	5,500	Switchgrass	20
		Unfavorable	4,000	Alkali cordgrass	10
				Inland saltgrass	10
				Tall dropseed	10
				Western wheatgrass	5
Ms: Missler	Loamy Upland	Favorable	4,000	Big bluestem	20
		Normal	2,500	Blue grama	15
		Unfavorable	1,000	Little bluestem	15
				Western wheatgrass	10
				Sideoats grama	10
				Buffalograss	10
				Sand dropseed	5
				Slimflower scurfpea	5
Os: Owens	Blue Shale	Favorable	3,500	Big bluestem	20
		Normal	2,500	Little bluestem	15
		Unfavorable	1,500	Sideoats grama	15
				Blue grama	10
				Silver bluestem	5
				Buffalograss	5
				Leadplant	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: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Pa, Pb, Pc, Pf, Pg- Penden	Limy Upland	Favorable	3,000	Big bluestem	25
		Normal	2,000	Little bluestem	25
		Unfavorable	1,000	Sideoats grama	20
				Switchgrass	5
				Indiangrass	5
				Western wheatgrass	5
				Leadplant	5
Pr: Pratt	Sands	Favorable	4,500	Sand bluestem	25
		Normal	3,000	Little bluestem	20
		Unfavorable	2,000	Indiangrass	10
				Sand lovegrass	10
				Switchgrass	5
				Blue grama	5
				Sand dropseed	5
Pt*:					
Pratt	Sands	Favorable	4,500	Sand bluestem	25
		Normal	3,000	Little bluestem	20
		Unfavorable	2,000	Indiangrass	10
				Sand lovegrass	10
				Switchgrass	5
				Blue grama	5
				Sand dropseed	5
Tivoli	Sands	Favorable	2,000	Little bluestem	25
		Normal	1,400	Sand bluestem	20
		Unfavorable	1,000	Big sandreed	10
				Texas bluegrass	10
				Sand lovegrass	5
				Scribner panicum	5
				Sand dropseed	5
				Sand sagebrush	5
Qw*:					
Quinlan	Shallow Prairie	Favorable	2,500	Little bluestem	30
		Normal	1,800	Sand bluestem	15
		Unfavorable	1,300	Indiangrass	5
				Scribner panicum	5
				Sideoats grama	5
				Prairie-clover	5
				Dotted gayfeather	5
Woodward	Loamy Upland	Favorable	4,000	Little bluestem	20
		Normal	2,800	Big bluestem	20
		Unfavorable	2,000	Switchgrass	10
				Indiangrass	10
				Sideoats grama	10
				Blue grama	10
Rc, Rf: Roxbury	Loamy Lowland	Favorable	5,000	Big bluestem	30
		Normal	4,000	Western wheatgrass	15
		Unfavorable	3,000	Little bluestem	10
				Sideoats grama	10
				Switchgrass	10
				Indiangrass	5
Sa: Satanta	Loamy Upland	Favorable	3,000	Blue grama	15
		Normal	2,000	Little bluestem	15
		Unfavorable	1,000	Big bluestem	15
				Western wheatgrass	10
				Sideoats grama	10
				Switchgrass	5
				Sand dropseed	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Sh: Shellabarger	Sandy	Favorable	4,500	Sand bluestem	25
		Normal	3,200	Little bluestem	20
		Unfavorable	2,000	Indiangrass	10
				Switchgrass	10
				Big bluestem	10
				Sand lovegrass	5
Tv: Tivoli	Choppy Sand	Favorable	2,000	Little bluestem	25
		Normal	1,400	Sand bluestem	20
		Unfavorable	1,000	Big sandreed	10
				Texas bluegrass	10
				Sand lovegrass	5
				Scribner panicum	5
				Sand dropseed	5
				Sand sagebrush	5
Ua, Ub, Uc: Uly	Loamy Upland	Favorable	3,500	Big bluestem	30
		Normal	2,500	Little bluestem	25
		Unfavorable	1,500	Sideoats grama	10
				Blue grama	10
				Western wheatgrass	10
Wa: Waldeck	Subirrigated	Favorable	9,000	Big bluestem	25
		Normal	8,000	Indiangrass	15
		Unfavorable	7,000	Switchgrass	10
				Eastern gamagrass	10
				Prairie cordgrass	10
				Little bluestem	5
				Sedge	5
Wo: Woodward	Loamy Upland	Favorable	4,000	Little bluestem	20
		Normal	2,800	Big bluestem	20
		Unfavorable	2,000	Switchgrass	10
				Indiangrass	10
				Sideoats grama	10
				Blue grama	10
Wr*:					
Woodward	Loamy Upland	Favorable	4,000	Little bluestem	20
		Normal	2,800	Big bluestem	20
		Unfavorable	2,000	Switchgrass	10
				Indiangrass	10
				Sideoats grama	10
				Blue grama	10
Quinlan	Shallow Prairie	Favorable	2,500	Little bluestem	30
		Normal	1,800	Sand bluestem	15
		Unfavorable	1,300	Indiangrass	5
				Scribner panicum	5
				Sideoats grama	5
				Prairie-clover	5
				Dotted gayfeather	5
Yh: Yahola	Sandy Terrace	Favorable	6,000	Sand bluestem	25
		Normal	4,500	Indiangrass	15
		Unfavorable	3,000	Switchgrass	15
				Little bluestem	10
				Eastern gamagrass	5
				Tall dropseed	5
Ze: Zenda	Subirrigated	Favorable	9,000	Big bluestem	25
		Normal	8,000	Indiangrass	15
		Unfavorable	7,000	Switchgrass	10
				Eastern gamagrass	10
				Prairie cordgrass	10
				Little bluestem	5
				Sedge	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
Ab*:					
Albion	Lilac, fragrant sumac, Siberian peashrub.	Russian-olive, Rocky Mountain juniper, Russian mulberry.	Eastern redcedar, bur oak, Austrian pine, honeylocust, green ash.	Siberian elm	---
Shellabarger	Lilac, American plum.	Common chokecherry, Rocky Mountain juniper.	Eastern redcedar, ponderosa pine, Austrian pine, honeylocust, Scotch pine, green ash, hackberry.	Siberian elm	---
Bd*:					
Badland.					
Woodward	Siberian peashrub, Tatarian honeysuckle, fragrant sumac, silver buffaloberry.	Russian-olive, green ash, eastern redcedar, ponderosa pine, Rocky Mountain juniper.	Honeylocust, Siberian elm.	---	---
Bp, Bu Bippus	Lilac, Amur honeysuckle, fragrant sumac, common chokecherry.	Russian-olive, eastern redcedar, Rocky Mountain juniper.	Green ash, osageorange, honeylocust, ponderosa pine.	Siberian elm	---
Cc*:					
Campus	Fragrant sumac, silver buffaloberry, Tatarian honeysuckle, Siberian peashrub.	Rocky Mountain juniper, eastern redcedar, Russian-olive.	Siberian elm, ponderosa pine, honeylocust, green ash.	---	---
Canlon.					
Ch*:					
Canlon.					
Rock outcrop.					
Cr, Cs, Cy Carey	Lilac, Amur honeysuckle, fragrant sumac.	Russian-olive, common chokecherry, Russian mulberry.	Green ash, honeylocust, bur oak, eastern redcedar, ponderosa pine.	Siberian elm	---
Ha, Hb Harney	Amur honeysuckle, lilac, fragrant sumac.	Russian mulberry	Eastern redcedar, bur oak, honeylocust, Russian-olive, Austrian pine, green ash, hackberry.	Siberian elm	---
Ka, Kb Kingsdown	American plum, common chokecherry, lilac, Amur honeysuckle.	Rocky Mountain juniper, Russian mulberry.	Eastern redcedar, honeylocust, hackberry, ponderosa pine, green ash.	Siberian elm	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of-- <8	8-15	16-25	26-35	>35
Kr-----------------Krier	Silver buffaloberry, lilac, Tatarian honeysuckle.	Eastern redcedar, Rocky Mountain juniper, Russian-olive, Siberian peashrub.	Golden willow, Siberian elm, green ash.	---	Eastern cottonwood.
Lb-----------------Lesho	American plum-----	Amur honeysuckle, lilac.	Eastern redcedar, ponderosa pine, Russian-olive, green ash, Russian mulberry, Austrian pine.	Honeylocust, hackberry.	Eastern cottonwood.
Le-----------------Lesho	Silver buffaloberry, Tatarian honeysuckle, lilac.	Eastern redcedar, Rocky Mountain juniper, Siberian peashrub, Russian-olive.	Green ash, golden willow, Siberian elm.	---	Eastern cottonwood.
Lf-----------------Likes	---	Eastern redcedar, Rocky Mountain juniper.	Ponderosa pine----	---	---
Lh*:					
Likes-------------	---	Eastern redcedar, Rocky Mountain juniper.	Ponderosa pine----	---	---
Quinlan.					
Ln-----------------Lincoln	Siberian peashrub	Tatarian honeysuckle, silver buffaloberry.	Green ash, hackberry, eastern redcedar, Rocky Mountain juniper.	Honeylocust, Siberian elm.	Eastern cottonwood.
Lr*:					
Lincoln-----------	Siberian peashrub	Tatarian honeysuckle, silver buffaloberry.	Eastern redcedar, green ash, hackberry, Rocky Mountain juniper.	Honeylocust, Siberian elm.	Eastern cottonwood.
Krier-------------	Silver buffaloberry, lilac, Tatarian honeysuckle.	Eastern redcedar, Rocky Mountain juniper, Russian-olive, Siberian peashrub.	Golden willow, Siberian elm, green ash.	---	Eastern cottonwood.
Ms-----------------Missler	Lilac, fragrant sumac, Amur honeysuckle.	Russian-olive, common chokecherry.	Eastern redcedar, honeylocust, ponderosa pine, green ash, common hackberry, bur oak.	Siberian elm------	---
Ns. Ness					
Os. Owens					
Pa, Pb, Pc, Pf, Pg-----------------Penden	Fragrant sumac, silver buffaloberry, Siberian peashrub, Tatarian honeysuckle.	Eastern redcedar, Russian-olive, Rocky Mountain juniper, bur oak.	Siberian elm, honeylocust, ponderosa pine, green ash.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Pr: Pratt	Lilac, American plum, common chokecherry, Amur honeysuckle.	Eastern redcedar, Rocky Mountain juniper, Russian mulberry.	Ponderosa pine, Austrian pine, hackberry, green ash.	Siberian elm	---
Pt*:					
Pratt	---	Eastern redcedar, Rocky Mountain juniper.	Ponderosa pine, Austrian pine.	---	---
Tivoli	---	Eastern redcedar, Rocky Mountain juniper.	Ponderosa pine	---	---
Qw*:					
Quinlan.					
Woodward	Siberian peashrub, Tatarian honeysuckle, fragrant sumac, silver buffaloberry.	Russian-olive, green ash, eastern redcedar, ponderosa pine, Rocky Mountain juniper.	Honeylocust, Siberian elm.	---	---
Rc, Rf: Roxbury	---	Tatarian honeysuckle, Siberian peashrub, silver buffaloberry.	Eastern redcedar, Russian-olive, ponderosa pine, green ash, Russian mulberry.	Siberian elm, hackberry, honeylocust.	Eastern cottonwood.
Sa: Satanta	Fragrant sumac, lilac, Amur honeysuckle.	Russian-olive, common chokecherry.	Eastern redcedar, honeylocust, ponderosa pine, green ash, hackberry, bur oak.	Siberian elm	---
Sh: Shellabarger	Lilac, American plum.	Common chokecherry, Rocky Mountain juniper.	Eastern redcedar, ponderosa pine, Austrian pine, honeylocust, Scotch pine, green ash, hackberry.	Siberian elm	---
Tv: Tivoli	---	Eastern redcedar, Rocky Mountain juniper.	Ponderosa pine	---	---
Ua, Ub, Uc: Uly	Amur honeysuckle, lilac.	Common chokecherry, Russian mulberry.	Eastern redcedar, green ash, Russian-olive, honeylocust, Austrian pine, hackberry, bur oak.	Siberian elm	---
Wa: Waldeck	---	Siberian peashrub, silver buffaloberry, Tatarian honeysuckle.	Eastern redcedar, Russian mulberry, ponderosa pine, green ash, Russian-olive.	Hackberry, Siberian elm, honeylocust.	Eastern cottonwood.
Wo: Woodward	Siberian peashrub, Tatarian honeysuckle, fragrant sumac, silver buffaloberry.	Russian-olive, green ash, eastern redcedar, ponderosa pine, Rocky Mountain juniper.	Honeylocust, Siberian elm.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Wr*:					
Woodward	Siberian peashrub, Tatarian honeysuckle, fragrant sumac, silver buffaloberry.	Russian-olive, green ash, eastern redcedar, ponderosa pine, Rocky Mountain juniper.	---	---	---
Quinlan.					
Yh: Yahola	Siberian peashrub	Tatarian honeysuckle, silver buffaloberry.	Russian-olive, green ash, hackberry, eastern redcedar, ponderosa pine, Rocky Mountain juniper.	Honeylocust, Siberian elm.	Eastern cottonwood.
Ze: Zenda	---	Silver buffaloberry, Tatarian honeysuckle, Siberian peashrub.	Eastern redcedar, green ash, ponderosa pine, Russian-olive, Russian mulberry.	Hackberry, Siberian elm, honeylocust.	Eastern cottonwood.

* 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
Ab*:				
Albion	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Shellabarger	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Bd*:				
Badland.				
Woodward	Severe: slope.	Severe: slope.	Severe: slope.	Severe: erodes easily.
Bp Bippus	Slight	Slight	Slight	Slight.
Bu Bippus	Slight	Slight	Moderate: slope.	Slight.
Cc*:				
Campus	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Canlon	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock, small stones.	Slight.
Ch*:				
Canlon	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock, small stones.	Moderate: slope.
Rock outcrop.				
Cr Carey	Slight	Slight	Slight	Slight.
Cs, Cy Carey	Slight	Slight	Moderate: slope.	Slight.
Ha Harney	Slight	Slight	Slight	Slight.
Hb Harney	Slight	Slight	Moderate: slope.	Slight.
Ka Kingsdown	Slight	Slight	Slight	Slight.
Kb Kingsdown	Slight	Slight	Moderate: slope.	Slight.
Kr Krier	Severe: flooding, wetness.	Moderate: wetness, excess salt.	Severe: wetness.	Moderate: wetness.
Lb Lesho	Severe: flooding.	Moderate: wetness.	Moderate: wetness, flooding.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Le: Lesho	Severe: flooding.	Moderate: wetness, excess salt.	Moderate: wetness, excess salt.	Slight.
Lf: Likes	Slight	Slight	Moderate: slope.	Slight.
Lh*:				
Likes	Slight	Slight	Moderate: slope.	Slight.
Quinlan	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Slight.
Ln: Lincoln	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.
Lr*:				
Lincoln	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.
Krier	Severe: flooding, wetness.	Moderate: wetness, excess salt.	Severe: wetness.	Moderate: wetness.
Ms: Missler	Slight	Slight	Slight	Slight.
Ns: Ness	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
Os: Owens	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, too clayey, depth to rock.	Moderate: too clayey.
Pa: Penden	Slight	Slight	Slight	Slight.
Pb, Pc, Pf: Penden	Slight	Slight	Moderate: slope.	Slight.
Pg: Penden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Pr: Pratt	Slight	Slight	Moderate: slope.	Slight.
Pt*:				
Pratt	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Tivoli	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Qw*:				
Quinlan	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Slight.
Woodward	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: erodes easily.
Rc: Roxbury	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Rf: Roxbury	Severe: flooding.	Slight	Moderate: flooding.	Slight.
Sa: Satanta	Moderate: dusty.	Moderate: dusty.	Moderate: dusty.	Moderate: dusty.
Sh: Shellabarger	Slight	Slight	Moderate: slope.	Slight.
Tv: Tivoli	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy.
Ua: Uly	Slight	Slight	Slight	Slight.
Ub, Uc: Uly	Slight	Slight	Moderate: slope.	Slight.
Wa: Waldeck	Severe: flooding.	Moderate: wetness.	Moderate: wetness, flooding.	Slight.
Wo: Woodward	Slight	Slight	Moderate: slope, depth to rock.	Severe: erodes easily.
Wr*:				
Woodward	Slight	Slight	Moderate: slope, depth to rock.	Severe: erodes easily.
Quinlan	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight.
Yh: Yahola	Severe: flooding.	Slight	Moderate: flooding.	Slight.
Ze: Zenda	Severe: flooding.	Moderate: wetness.	Moderate: wetness, flooding.	Slight.

* 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
Ab*:									
Albion	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Very poor	Fair.
Shellabarger	Poor	Fair	Good	Good	Very poor.	Very poor.	Fair	Very poor	Good.
Bd*:									
Badland.									
Woodward	Poor	Fair	Good	Fair	Very poor.	Very poor.	Fair	Very poor	Fair.
Bp Bippus	Good	Good	Good	Good	Very poor.	Very poor.	Good	Very poor	Good.
Bu Bippus	Fair	Good	Good	Good	Very poor.	Very poor.	Good	Very poor	Good.
Cc*:									
Campus	Poor	Fair	Good	Poor	Very poor.	Very poor.	Fair	Very poor	Fair.
Canlon	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Very poor	Poor.
Ch*:									
Canlon	Very poor	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Very poor	Poor.
Rock outcrop.									
Cr, Cs Carey	Good	Good	Good	Good	Very poor.	Very poor.	Good	Very poor	Good.
Cy Carey	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Very poor	Fair.
Ha Harney	Good	Good	Good	Good	Poor	Fair	Good	Poor	Good.
Hb Harney	Good	Good	Good	Good	Poor	Fair	Good	Poor	Good.
Ka, Kb Kingsdown	Good	Good	Good	Good	Poor	Very poor.	Good	Very poor	Good.
Kr Krier	Poor	Poor	Fair	Poor	Good	Good	Poor	Good	Poor.
Lb Lesho	Fair	Fair	Good	Good	Fair	Fair	Fair	Fair	Good.
Le Lesho	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair.
Lf Likes	Poor	Fair	Good	Good	Very poor.	Very poor.	Fair	Very poor	Good.
Lh*:									
Likes	Poor	Fair	Good	Good	Very poor.	Very poor.	Fair	Very poor	Good.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT POTENTIALS--Continued

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
Lh*:									
Quinlan	Poor	Poor	Fair	Poor	Very poor.	Very poor.	Fair	Very poor	Poor.
Ln Lincoln	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Very poor	Fair.
Lr*:									
Lincoln	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Very poor	Fair.
Krier	Poor	Poor	Fair	Poor	Good	Good	Poor	Good	Poor.
Ms Missler	Good	Good	Good	Good	Poor	Very poor.	Good	Very poor	Good.
Ns Ness	Poor	Poor	Poor	Poor	Fair	Good	Poor	Good	Poor.
Os Owens	Poor	Fair	Fair	Poor	Very poor.	Very poor.	Fair	Very poor	Poor.
Pa, Pb Penden	Good	Good	Fair	Fair	Very poor.	Poor	Fair	Very poor	Fair.
Pc, Pf Penden	Fair	Good	Fair	Poor	Very poor.	Poor	Fair	Very poor	Fair.
Pg Penden	Poor	Fair	Fair	Poor	Very poor.	Poor	Fair	Very poor	Fair.
Pr Pratt	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Very poor	Fair.
Pt*:									
Pratt	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Very poor	Fair.
Tivoli	Poor	Poor	Fair	Poor	Very poor.	Very poor.	Poor	Very poor	Poor.
Qw*:									
Quinlan	Poor	Poor	Fair	Poor	Very poor.	Very poor.	Fair	Very poor	Poor.
Woodward	Fair	Good	Good	Fair	Very poor.	Very poor.	Good	Very poor	Fair.
Rc Roxbury	Fair	Fair	Fair	Fair	Poor	Fair	Fair	Poor	Fair.
Rf Roxbury	Good	Good	Good	Fair	Poor	Fair	Good	Poor	Fair.
Sa Satanta	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
Sh Shellabarger	Fair	Good	Good	Good	Poor	Very poor.	Good	Very poor	Good.
Tv Tivoli	Poor	Poor	Fair	Poor	Very poor.	Very poor.	Poor	Very poor	Poor.
Ua, Ub Uly	Good	Good	Good	Good	Very poor.	Very poor.	Good	Very poor	Good.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT POTENTIALS--Continued

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
Uc: Uly	Fair	Good	Good	Fair	Very poor.	Very poor.	Fair	Very poor	Good.
Wa: Waldeck	Fair	Good	Good	Good	Fair	Fair	Good	Fair	Good.
Wo: Woodward	Fair	Good	Good	Fair	Poor	Very poor.	Good	Very poor	Fair.
Wr*:									
Woodward	Fair	Good	Good	Fair	Poor	Very poor.	Good	Very poor	Fair.
Quinlan	Poor	Poor	Fair	Poor	Poor	Very poor.	Fair	Very poor	Poor.
Yh: Yahola	Good	Good	Good	Good	Poor	Very poor.	Good	Very poor	Good.
Ze: Zenda	Fair	Good	Good	Good	Fair	Fair	Good	Fair	Good.

* 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
Ab*:					
Albion	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
Shellabarger	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
Bd*:					
Badland.					
Woodward	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Bp Bippus	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.
Bu Bippus	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.
Cc*:					
Campus	Severe: depth to rock.	Moderate: slope, depth to rock.	Severe: depth to rock.	Severe: slope.	Moderate: depth to rock, low strength, slope.
Canlon	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.
Ch*:					
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.
Rock outcrop.					
Cr, Cs Carey	Slight	Slight	Slight	Slight	Moderate: low strength.
Cy Carey	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength.
Ha, Hb Harney	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Ka, Kb Kingsdown	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
Kr Krier	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding.
Lb Lesho	Severe: cutbanks cave, wetness.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Severe: low strength, flooding.
Le Lesho	Severe: cutbanks cave, wetness.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Severe: low strength.
Lf Likes	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Lh*:					
Likes	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
Quinlan	Severe: depth to rock.	Moderate: depth to rock, slope.	Severe: depth to rock.	Severe: slope.	Moderate: slope, depth to rock.
Ln Lincoln	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
Lr*:					
Lincoln	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
Krier	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding.
Ms Missler	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Ns Ness	Severe: cutbanks cave, ponding.	Severe: ponding, shrink-swell.	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: low strength, ponding.
Os Owens	Severe: depth to rock.	Severe: shrink-swell.	Severe: shrink-swell, depth to rock.	Severe: shrink-swell, slope.	Severe: shrink-swell, low strength.
Pa, Pb Penden	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Pc, Pf Penden	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Pg Penden	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.
Pr Pratt	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
Pt*:					
Pratt	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
Tivoli	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
Qw*:					
Quinlan	Severe: depth to rock.	Moderate: depth to rock, slope.	Severe: depth to rock.	Severe: slope.	Moderate: slope, depth to rock.
Woodward	Moderate: depth to rock, slope.	Moderate: slope.	Moderate: depth to rock, slope.	Severe: slope.	Moderate: slope, low strength.
Rc, Rf Roxbury	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.
Sa Satanta	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Sh: Shellabarger	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
Tv: Tivoli	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Ua, Ub: Uly	Slight	Slight	Slight	Slight	Severe: low strength.
Uc: Uly	Slight	Slight	Slight	Moderate: slope.	Severe: low strength.
Wa: Waldeck	Severe: cutbanks cave, wetness.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Severe: flooding.
Wo: Woodward	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Slight	Moderate: low strength.
Wr*:					
Woodward	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Moderate: slope.	Moderate: low strength.
Quinlan	Severe: depth to rock.	Moderate: depth to rock.	Severe: depth to rock.	Moderate: depth to rock, slope.	Moderate: depth to rock.
Yh: Yahola	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
Ze: Zenda	Severe: wetness.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Severe: low strength, flooding.

* 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
Ab*:					
Albion	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Shellabarger	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Poor: thin layer.
Bd*:					
Badland.					
Woodward	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: area reclaim, slope, thin layer.
Bp Bippus	Slight	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
Bu Bippus	Slight	Moderate: seepage, slope.	Moderate: too clayey.	Slight	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.	Severe: slope, depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Ch*:					
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.
Rock outcrop.					
Cr Carey	Slight	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
Cs, Cy Carey	Slight	Moderate: slope, seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
Ha Harney	Moderate: percs slowly.	Moderate: seepage.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
Hb Harney	Moderate: percs slowly.	Moderate: seepage, slope.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
Ka, Kb Kingsdown	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: too sandy.
Kr Krier	Severe: flooding, wetness, poor filter.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Poor: seepage, too sandy, wetness.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Lb: Lesho	Severe: flooding, wetness, percs slowly.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Poor: seepage, too sandy.
Le: Lesho	Severe: wetness, percs slowly.	Severe: seepage, flooding, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
Lf: Likes	Severe: poor filter.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: seepage.
Lh*:					
Likes	Severe: poor filter.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: seepage.
Quinlan	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Ln: Lincoln	Severe: flooding, poor filter.	Severe: seepage, flooding.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage.	Poor: seepage, too sandy.
Lr*:					
Lincoln	Severe: flooding, poor filter.	Severe: seepage, flooding.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage.	Poor: seepage, too sandy.
Krier	Severe: flooding, wetness, poor filter.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Poor: seepage, too sandy, wetness.
Ms: Missler	Severe: percs slowly.	Slight	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
Ns: Ness	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: hard to pack, ponding.
Os: Owens	Severe: percs slowly, depth to rock.	Severe: slope, depth to rock.	Severe: too clayey, depth to rock.	Severe: depth to rock.	Poor: too clayey, hard to pack, area reclaim.
Pa: Penden	Moderate: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
Pb, Pc, Pf: Penden	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Pg: Penden	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Pr: Pratt	Severe: poor filter.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: thin layer.
Pt*:					
Pratt	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Poor: thin layer.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Pt*:					
Tivoli	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Qw*:					
Quinlan	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Woodward	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim, thin layer.
Rc, Rf Roxbury	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
Sa Satanta	Slight	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
Sh Shellabarger	Slight	Moderate: seepage, slope.	Slight	Slight	Poor: thin layer.
Tv Tivoli	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
Ua Uly	Slight	Moderate: seepage.	Slight	Slight	Good.
Ub, Uc Uly	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Wa Waldeck	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Fair: wetness, thin layer.
Wo Woodward	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim, thin layer.
Wr*:					
Woodward	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim, thin layer.
Quinlan	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Yh Yahola	Severe: flooding.	Severe: seepage, flooding.	Severe: flooding, seepage.	Severe: flooding, seepage.	Good.
Ze Zenda	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: too clayey, wetness.

* 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
Ab*:				
Albion	Good	Probable	Probable	Poor: small stones, area reclaim.
Shellabarger	Good	Probable	Improbable: too sandy.	Fair: small stones, area reclaim.
Bd*:				
Badland.				
Woodward	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Bp, Bu Bippus	Fair: shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Cc*:				
Campus	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones.
Canlon	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.
Ch*:				
Canlon	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, slope, small stones.
Rock outcrop.				
Cr, Cs, Cy Carey	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
Ha, Hb Harney	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Ka, Kb Kingsdown	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Kr Krier	Fair: wetness.	Probable	Improbable: too sandy.	Poor: thin layer.
Lb Lesho	Fair: wetness.	Probable	Improbable: too sandy.	Fair: too clayey, thin layer.
Le Lesho	Fair: wetness.	Probable	Improbable: too sandy.	Poor: thin layer.
Lf Likes	Good	Probable	Improbable: too sandy.	Fair: too sandy.
Lh*:				
Likes	Good	Probable	Improbable: too sandy.	Fair: too sandy.
Quinlan	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Ln: Lincoln	Good	Probable	Improbable: too sandy.	Fair: too sandy.
Lr*:				
Lincoln	Good	Probable	Improbable: too sandy.	Fair: too sandy.
Krier	Fair: wetness.	Probable	Improbable: too sandy.	Poor: thin layer.
Ms: Missler	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Ns: Ness	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
Os: Owens	Poor: shrink-swell, low strength, area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, too clayey.
Pa, Pb, Pc, Pf: Penden	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Pg: Penden	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
Pr: Pratt	Good	Probable	Improbable: too sandy.	Fair: too sandy.
Pt*:				
Pratt	Good	Probable	Improbable: too sandy.	Fair: too sandy, slope.
Tivoli	Good	Probable	Improbable: too sandy.	Fair: too sandy, slope.
Qw*:				
Quinlan	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.
Woodward	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, thin layer, slope.
Rc, Rf: Roxbury	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Sa: Satanta	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Sh: Shellabarger	Good	Probable	Improbable: too sandy.	Fair: small stones, area reclaim.
Tv: Tivoli	Fair: slope.	Probable	Improbable: too sandy.	Poor: too sandy, slope.
Ua, Ub, Uc: Uly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Wa: Waldeck	Fair: wetness.	Probable	Improbable: too sandy.	Good.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Wo: Woodward	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, thin layer.
Wr*:				
Woodward	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, thin layer.
Quinlan	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.
Yh: Yahola	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Ze: Zenda	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-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
Ab*:						
Albion	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
Shellabarger	Severe: slope.	Severe: thin layer.	Deep to water	Slope	Slope, soil blowing.	Slope.
Bd*:						
Badland.						
Woodward	Severe: slope.	Severe: piping.	Deep to water	Depth to rock, slope, erodes easily.	Slope, depth to rock, erodes easily.	Slope, erodes easily, depth to rock.
Bp Bippus	Moderate: seepage.	Moderate: piping.	Deep to water	Favorable	Favorable	Favorable.
Bu Bippus	Moderate: seepage.	Moderate: piping.	Deep to water	Slope	Favorable	Favorable.
Cc*:						
Campus	Severe: slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	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.
Ch*:						
Canlon	Severe: depth to rock, slope.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Depth to rock, slope.	Slope, depth to rock.
Rock outcrop.						
Cr, Cs Carey	Moderate: seepage.	Severe: piping.	Deep to water	Erodes easily	Erodes easily	Erodes easily.
Cy Carey	Moderate: seepage.	Severe: piping.	Deep to water	Slope, erodes easily.	Erodes easily	Erodes easily.
Ha, Hb Harney	Moderate: seepage.	Moderate: hard to pack.	Deep to water	Favorable	Erodes easily	Erodes easily.
Ka Kingsdown	Severe: seepage.	Severe: seepage, piping.	Deep to water	Soil blowing	Soil blowing	Favorable.
Kb Kingsdown	Severe: seepage.	Severe: seepage, piping.	Deep to water	Soil blowing, slope.	Soil blowing	Favorable.
Kr Krier	Severe: seepage.	Severe: seepage, piping, wetness.	Flooding, cutbanks cave, excess salt.	Wetness, droughty.	Wetness, too sandy.	Wetness, excess salt, droughty.
Lb Lesho	Severe: seepage.	Severe: seepage, piping.	Flooding, cutbanks cave.	Wetness, flooding.	Wetness, too sandy.	Favorable.
Le Lesho	Severe: seepage.	Severe: seepage, piping.	Cutbanks cave, excess salt.	Wetness, excess salt.	Wetness, too sandy.	Excess salt.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
Lf: Likes	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Soil blowing	Droughty.
Lh*:						
Likes	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Soil blowing	Droughty.
Quinlan	Severe: depth to rock, slope.	Severe: piping, thin layer.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
Ln: Lincoln	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
Lr*:						
Lincoln	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
Krier	Severe: seepage.	Severe: seepage, piping, wetness.	Flooding, cutbanks cave, excess salt.	Wetness, droughty, soil blowing.	Wetness, too sandy, soil blowing.	Wetness, excess salt, droughty.
Ms: Missler	Slight	Moderate: hard to pack.	Deep to water	Favorable	Favorable	Favorable.
Ns: Ness	Moderate: seepage.	Severe: piping, hard to pack, ponding.	Ponding, percs slowly.	Ponding, slow intake, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
Os: Owens	Severe: depth to rock.	Moderate: hard to pack.	Deep to water	Slope, droughty, slow intake.	Slope, erodes easily, percs slowly.	Slope, droughty, erodes easily.
Pa, Pb: Penden	Moderate: seepage.	Moderate: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
Pc, Pf: Penden	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Pg: Penden	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Pr: Pratt	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
Pt*:						
Pratt	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
Tivoli	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
Qw*:						
Quinlan	Severe: depth to rock, slope.	Severe: piping, thin layer.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
Woodward	Severe: slope.	Severe: piping.	Deep to water	Depth to rock, slope, erodes easily.	Slope, depth to rock, erodes easily.	Slope, erodes easily, depth to rock.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
Rc, Rf: Roxbury	Moderate: seepage.	Moderate: thin layer, piping.	Deep to water	Flooding	Erodes easily	Erodes easily.
Sa: Satanta	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Favorable	Favorable.
Sh: Shellabarger	Moderate: seepage, slope.	Severe: thin layer.	Deep to water	Slope	Favorable	Favorable.
Tv: Tivoli	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
Ua, Ub: Uly	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
Uc: Uly	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Wa: Waldeck	Severe: seepage.	Severe: piping.	Flooding	Wetness, soil blowing, flooding.	Wetness, soil blowing.	Favorable.
Wo: Woodward	Moderate: seepage, depth to rock.	Severe: piping.	Deep to water	Depth to rock, erodes easily.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Wr*:						
Woodward	Moderate: seepage, depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope, erodes easily.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Quinlan	Severe: depth to rock.	Severe: piping, thin layer.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Yh: Yahola	Severe: seepage.	Severe: piping.	Deep to water	Flooding	Favorable	Favorable.
Ze: Zenda	Moderate: seepage.	Moderate: piping, wetness.	Flooding	Wetness, flooding.	Wetness	Favorable.

* 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. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
Ab*:											
Albion	0-8	Sandy loam	SM, ML	A-2, A-4	0	100	75-100	60-90	25-55	<30	NP-5
	8-15	Sandy loam, loam	SM, ML	A-2, A-4	0	85-100	75-100	45-90	30-55	20-35	NP-10
	15-22	Coarse sandy loam, loamy sand.	SM	A-2, A-1	0	85-100	75-90	40-70	15-30	<30	NP-5
	22-60	Loamy sand, gravelly sand, sand.	SP-SM, GP-GM, SM, GM	A-2, A-1, A-3	0-5	40-100	40-90	30-70	5-30	<30	NP-5
Shellabarger	0-10	Sandy loam	SM, ML	A-4, A-2	0	95-100	95-100	75-100	30-55	<30	NP-5
	10-60	Sandy clay loam, sandy loam, fine sandy loam.	SC	A-4, A-6	0	95-100	85-100	70-90	35-50	25-40	8-20
Bd*:											
Badland.											
Woodward	0-24	Loam	ML, CL, CL-ML	A-4, A-6	0	100	100	90-100	51-95	<31	NP-12
	24	Weathered bedrock	---	---	---	---	---	---	---	---	---
Bp, Bu Bippus	0-23	Clay loam	CL, SC, SM-SC	A-4, A-6	0	100	95-100	85-98	36-80	22-40	7-20
	23-60	Clay loam, loam, sandy clay loam.	SC, CL, SM-SC	A-4, A-6	0	100	95-100	85-98	36-75	22-40	7-20
Cc*:											
Campus	0-8	Loam	CL, CL-ML, ML	A-4, A-6	0	100	95-100	80-100	55-90	20-40	3-20
	8-15	Loam, clay loam	CL, ML	A-6, A-7, A-4	0	100	100	75-95	50-80	33-45	8-20
	15-28	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
	28	Cemented	---	---	---	---	---	---	---	---	---
Canlon	0-13	Loam	CL, SC, CL-ML, SM-SC	A-4, A-6	0	75-100	55-100	50-95	36-85	20-40	4-20
	13	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ch*:											
Canlon	0-13	Loam	CL, SC, CL-ML, SM-SC	A-4, A-6	0	75-100	55-100	50-95	36-85	20-40	4-20
	13	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Rock outcrop.											
Cr, Cs, Cy Carey	0-7	Silt loam	CL, ML, CL-ML	A-4, A-6	0	100	98-100	90-100	51-95	20-32	3-15
	7-60	Silty clay loam, clay loam, loam.	CL, CL-ML	A-4, A-6	0	100	98-100	95-100	60-95	24-40	5-20
Ha, Hb Harney	0-12	Silt loam	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-20
	12-30	Silty clay, silty clay loam.	CL, CH	A-7, A-6	0	100	100	95-100	85-100	35-60	15-35
	30-60	Silty clay loam, silt loam.	CL	A-6	0	100	100	95-100	85-100	30-40	10-20

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Ka, Kb----------- Kingsdown	0-10	Fine sandy loam	SM, SM-SC, ML, CL-ML	A-2, A-4	0	100	95-100	65-100	30-55	<26	NP-7
	10-22	Fine sandy loam, sandy loam.	SM, SM-SC, ML, CL-ML	A-2, A-4	0	100	95-100	65-100	30-55	<26	NP-7
	22-60	Fine sandy loam, loamy fine sand, loam.	SM, SM-SC, ML, CL-ML	A-2, A-4	0	100	95-100	55-100	15-55	<26	NP-7
Kr--------------- Krier	0-3	Loam-------------	CL, CL-ML	A-6, A-4	0	100	100	85-100	65-90	20-40	5-18
	3-13	Loam, clay loam, sandy loam.	CL, CL-ML, SM, SM-SC	A-2, A-4, A-6	0	100	95-100	70-100	20-85	20-40	2-20
	13-60	Sand, fine sand, coarse sand.	SM, SP-SM	A-2, A-3	0	100	95-100	55-75	5-35	---	NP
Lb--------------- Lesho	0-10	Clay loam--------	CL	A-6, A-7-6	0	100	100	95-100	65-85	35-45	15-22
	10-26	Clay loam, loam	CL	A-4, A-6, A-7-6	0	100	100	85-100	65-95	25-45	7-22
	26-60	Sand, coarse sand, fine sand.	SM, SP-SM	A-1, A-2, A-3, A-4	0	100	95-100	30-85	5-45	---	NP
Le--------------- Lesho	0-10	Clay loam--------	CL	A-6, A-7-6	0	100	100	90-100	75-95	35-45	15-22
	10-35	Loam, clay loam, silty clay loam.	CL	A-6, A-7-6	0	100	100	85-100	65-95	30-45	11-22
	35-60	Sand, fine sand, coarse sand.	SM, SP-SM	A-2, A-3	0	100	95-100	55-75	5-35	---	NP
Lf--------------- Likes	0-60	Loamy sand-------	SM, SP-SM, SM-SC	A-2-4	0-2	90-100	90-100	75-95	10-30	<25	NP-6
Lh*:											
Likes-----------	0-8	Loamy sand-------	SM, SP-SM, SM-SC	A-2-4	0-2	90-100	90-100	75-95	10-30	<25	NP-6
	8-60	Sand-------------	SM, SP-SM	A-2-4	0-2	90-100	90-100	70-90	5-30	---	NP
Quinlan---------	0-13	Loam-------------	CL, ML, CL-ML	A-4, A-6	0	100	95-100	90-100	51-97	<37	NP-14
	13-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
Ln--------------- Lincoln	0-13	Loamy fine sand	SM	A-2	0	100	98-100	90-100	15-35	---	NP
	13-60	Stratified fine sand to clay loam.	SM, SP-SM	A-2, A-3	0	100	98-100	82-100	5-35	---	NP
Lr*:											
Lincoln---------	0-8	Loamy fine sand	SM	A-2	0	100	98-100	90-100	15-35	---	NP
	8-60	Stratified fine sand to clay loam.	SM, SP-SM	A-2, A-3	0	100	98-100	82-100	5-35	---	NP
Krier-----------	0-4	Sandy loam-------	SM	A-2, A-4	0	100	95-100	70-100	20-50	<20	NP-4
	4-15	Loam, clay loam, sandy loam.	CL, CL-ML, SM, SM-SC	A-2, A-4, A-6	0	100	95-100	70-100	20-85	20-40	2-20
	15-60	Sand, fine sand, coarse sand.	SM, SP-SM	A-2, A-3	0	100	95-100	55-75	5-35	---	NP
Ms--------------- Missler	0-10	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	75-100	30-55	10-30
	10-60	Silty clay loam, silty clay.	CL, CH	A-6, A-7	0	100	100	95-100	90-100	35-60	20-35
Ns--------------- Ness	0-36	Silty clay-------	CH	A-7-6	0	100	100	95-100	90-100	50-70	30-45
	36-60	Silty clay loam, silt loam.	CL, CH, ML, MH	A-6, A-7-6, A-4	0	100	100	95-100	90-100	30-55	8-30

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Os------ Owens	0-6	Silty clay-------	CL, CH	A-7-6	0-5	95-100	95-100	85-100	75-95	45-60	22-32
	6-17	Clay, clay loam, silty clay.	CL, CH	A-7-6	0-5	95-100	90-100	85-100	75-95	45-60	22-32
	17	Weathered bedrock	---	---	---	---	---	---	---	---	---
Pa, Pb, Pc, Pf, Pg------ Penden	0-16	Clay loam--------	CL	A-6, A-7-6	0	100	100	85-100	65-95	30-45	11-25
	16-28	Clay loam, loam, silty clay loam.	CL	A-6, A-7-6	0	100	100	85-100	60-90	30-45	11-25
	28-60	Clay loam, loam	CL	A-6, A-7-6	0	100	100	75-100	55-75	30-45	11-25
Pr------ Pratt	0-11	Loamy fine sand	SM	A-2	0	100	95-100	70-100	15-35	---	NP
	11-30	Loamy fine sand, loamy sand, fine sandy loam.	SM, SM-SC	A-2, A-4	0	100	95-100	90-100	15-40	<20	NP-6
	30-60	Loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	100	95-100	80-100	5-35	---	NP
Pt*:											
Pratt------	0-8	Loamy fine sand	SM	A-2	0	100	95-100	70-100	15-35	---	NP
	8-30	Loamy fine sand, loamy sand, fine sandy loam.	SM, SM-SC	A-2, A-4	0	100	95-100	90-100	15-40	<20	NP-6
	30-60	Loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	100	95-100	80-100	5-35	---	NP
Tivoli------	0-6	Loamy fine sand	SM	A-2	0	100	95-100	90-100	15-35	---	NP
	6-60	Fine sand, sand	SM, SP-SM	A-2, A-3	0	100	95-100	80-100	5-25	---	NP
Qw*:											
Quinlan------	0-13	Loam-------------	CL, ML, CL-ML	A-4, A-6	0	100	95-100	90-100	51-97	<37	NP-14
	13	Weathered bedrock	---	---	---	---	---	---	---	---	---
Woodward------	0-27	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	100	100	90-100	51-95	<31	NP-12
	27	Weathered bedrock	---	---	---	---	---	---	---	---	---
Rc, Rf------ Roxbury	0-21	Silt loam--------	CL	A-4, A-6	0	100	100	95-100	65-100	25-40	7-20
	21-36	Silt loam, silty clay loam.	CL	A-4, A-6, A-7-6	0	100	100	95-100	80-100	30-50	8-25
	36-60	Silt loam, silty clay loam, loam.	ML, CL	A-4, A-6, A-7-6	0	100	100	95-100	65-100	30-50	7-25
Sa------ Satanta	0-11	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	100	95-100	80-100	55-80	22-36	2-15
	11-60	Loam, clay loam, sandy clay loam.	SC, CL	A-7, A-6	0	100	95-100	75-100	40-75	25-45	11-25
Sh------ Shellabarger	0-11	Loam-------------	CL	A-4, A-6	0	95-100	95-100	80-95	55-75	25-35	7-15
	11-29	Sandy clay loam, sandy loam, fine sandy loam.	SC	A-4, A-6	0	95-100	85-100	70-90	35-50	25-40	8-20
	29-60	Coarse sandy loam, fine sandy loam, sand.	SC, SM, SP-SM, SM-SC	A-2, A-4	0	80-100	70-100	50-80	10-40	<30	NP-10
Tv------ Tivoli	0-6	Fine sand--------	SM, SP-SM	A-2, A-3	0	100	95-100	80-100	5-25	---	NP
	6-60	Fine sand, sand	SM, SP-SM	A-2, A-3	0	100	95-100	80-100	5-25	---	NP
Ua, Ub, Uc------ Uly	0-7	Silt loam--------	ML, CL	A-4, A-6	0	100	100	100	95-100	25-40	2-15
	7-18	Silt loam, silty clay loam.	ML, CL	A-4, A-6	0	100	100	100	95-100	25-40	3-15
	18-60	Silt loam, very fine sandy loam.	CL, ML	A-4, A-6	0	100	100	100	95-100	25-40	3-15

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

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	
Wa----------------Waldeck	0-14	Fine sandy loam	SM, SM-SC, ML, CL-ML	A-2, A-4	0	100	95-100	75-100	25-55	<25	NP-5
	14-45	Fine sandy loam, sandy loam.	SM, SM-SC	A-2, A-4	0	100	95-100	70-100	30-50	<25	NP-5
	45-60	Fine sand, sand	SM, SP, SP-SM	A-1, A-2, A-3	0	90-100	80-100	40-60	1-35	---	NP
Wo----------------Woodward	0-30	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	100	100	90-100	51-95	<31	NP-12
	30	Weathered bedrock	---	---	---	---	---	---	---	---	---
Wr*:											
Woodward---------	0-27	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	100	100	90-100	51-95	<31	NP-12
	27	Weathered bedrock	---	---	---	---	---	---	---	---	---
Quinlan----------	0-13	Loam-------------	CL, ML, CL-ML	A-4, A-6	0	100	95-100	90-100	51-97	<37	NP-14
	13	Weathered bedrock	---	---	---	---	---	---	---	---	---
Yh----------------Yahola	0-8	Loam-------------	ML, CL-ML	A-4	0	100	100	95-100	65-85	22-29	2-7
	8-21	Fine sandy loam, loam, very fine sandy loam.	SM, ML, CL-ML, SM-SC	A-4	0	100	95-100	90-100	36-85	<26	NP-7
	21-60	Stratified clay loam to loamy fine sand.	SM, ML, CL-ML, SM-SC	A-2, A-4	0	100	95-100	90-100	15-85	<26	NP-7
Ze----------------Zenda	0-14	Loam-------------	CL-ML, CL	A-4, A-6	0	100	95-100	85-100	55-80	25-40	5-20
	14-60	Loam, clay loam, sandy clay loam.	CL	A-6	0	100	95-100	85-100	55-80	25-40	10-25

* 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		Wind erodi- bility group	Organic matter
									K	T		
	In	Pct	G/cm^3	In/hr	In/in	pH	Mmhos/cm					Pct
Ab*:												
Albion----------	0-8	7-15	1.35-1.50	2.0-6.0	0.13-0.20	5.6-6.5	<2	Low--------	0.20	3	3	1-2
	8-15	10-18	1.45-1.60	2.0-6.0	0.12-0.18	6.1-7.8	<2	Low--------	0.20			
	15-22	4-15	1.45-1.60	2.0-6.0	0.09-0.12	6.1-8.4	<2	Low--------	0.20			
	22-60	2-10	1.50-1.65	6.0-20	0.03-0.10	6.1-8.4	<2	Low--------	0.15			
Shellabarger----	0-10	8-16	1.35-1.50	0.6-2.0	0.13-0.21	5.1-6.5	<2	Low--------	0.20	5	3	1-2
	10-60	18-27	1.45-1.60	0.6-2.0	0.16-0.18	6.1-7.8	<2	Low--------	0.28			
Bd*:												
Badland.												
Woodward--------	0-24	10-18	1.30-1.60	0.6-2.0	0.13-0.20	6.6-8.4	<2	Low--------	0.32	4	4L	---
	24	---	---	---	---	---	---	-----------	----			
Bp, Bu----------- Bippus	0-23	15-35	---	0.6-2.0	0.14-0.20	7.4-8.4	<2	Moderate	0.28	5	4L	1-3
	23-60	20-35	---	0.6-2.0	0.14-0.20	7.9-8.4	<2	Moderate	0.28			
Cc*:												
Campus----------	0-8	15-27	1.25-1.35	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low--------	0.28	4	4L	1-2
	8-15	18-35	1.30-1.40	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.28			
	15-28	18-35	1.40-1.60	0.6-2.0	0.15-0.19	7.9-8.4	<2	Low--------	0.28			
	28	---	---	---	---	---	---	-----------	----			
Canlon----------	0-13	12-27	1.35-1.50	0.6-2.0	0.12-0.16	7.4-8.4	<2	Low--------	0.32	2	4L	---
	13	---	---	---	---	---	---	-----------	----			
Ch*:												
Canlon----------	0-13	12-27	1.35-1.50	0.6-2.0	0.12-0.16	7.4-8.4	<2	Low--------	0.32	2	4L	---
	13	---	---	---	---	---	---	-----------	----			
Rock outcrop.												
Cr, Cs, Cy------- Carey	0-7	10-25	---	0.6-2.0	0.15-0.20	6.6-7.8	<2	Low--------	0.32	5	6	1-3
	7-60	20-35	---	0.6-2.0	0.15-0.20	6.6-8.4	<2	Low--------	0.43			
Ha, Hb----------- Harney	0-12	22-27	1.30-1.40	0.6-2.0	0.22-0.24	5.6-7.8	<2	Low--------	0.32	5	6	2-4
	12-30	35-42	1.35-1.50	0.2-0.6	0.12-0.19	6.1-8.4	<2	Moderate	0.43			
	30-60	24-35	1.20-1.35	0.6-2.0	0.18-0.22	7.9-8.4	<2	Low--------	0.43			
Ka, Kb----------- Kingsdown	0-10	8-18	1.40-1.50	2.0-6.0	0.15-0.18	6.6-8.4	<2	Low--------	0.20	5	3	1-2
	10-22	8-18	1.45-1.55	2.0-6.0	0.14-0.17	7.4-8.4	<2	Low--------	0.20			
	22-60	5-18	1.45-1.55	2.0-6.0	0.10-0.17	7.4-8.4	<2	Low--------	0.20			
Kr--------------- Krier	0-3	12-27	1.30-1.40	2.0-6.0	0.20-0.22	7.4-9.0	2-8	Low--------	0.32	3	4L	---
	3-13	10-32	1.40-1.50	2.0-6.0	0.13-0.18	7.9-9.0	4-16	Low--------	0.32			
	13-60	1-5	1.45-1.55	6.0-20	0.03-0.07	7.4-9.0	2-8	Low--------	0.15			
Lb--------------- Lesho	0-10	28-35	1.30-1.40	0.2-0.6	0.17-0.19	7.4-8.4	<4	Moderate	0.28	4	4L	1-3
	10-26	18-35	1.35-1.45	0.2-0.6	0.16-0.19	7.4-8.4	<4	Moderate	0.28			
	26-60	1-8	1.45-1.55	>2.0	0.02-0.10	7.4-9.0	<4	Low--------	0.15			
Le--------------- Lesho	0-10	28-35	1.30-1.40	0.2-0.6	0.17-0.19	7.4-9.0	2-8	Moderate	0.28	4	4L	1-2
	10-35	22-35	1.35-1.45	0.2-0.6	0.15-0.19	7.9-9.0	4-16	Moderate	0.28			
	35-60	1-5	1.45-1.55	6.0-20	0.03-0.07	7.4-9.0	2-8	Low--------	0.15			
Lf--------------- Likes	0-60	5-15	1.40-1.70	6.0-20	0.04-0.10	7.4-8.4	<2	Very low	0.17	5	2	<.5
Lh*:												
Likes-----------	0-60	5-15	1.40-1.70	6.0-20	0.04-0.10	7.4-8.4	<2	Very low	0.17	5	2	<.5
Quinlan---------	0-13	15-27	1.30-1.55	0.6-2.0	0.13-0.24	7.4-8.4	<2	Low--------	0.32	2	4L	<1
	13-60	---	---	---	---	---	---	-----------	----			

See footnote at end of table.

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

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
Ln-----------------	0-13	5-15	1.35-1.50	6.0-20	0.06-0.11	7.4-8.4	<2	Low--------	0.17	5	2	<.5
Lincoln	13-60	5-15	1.30-1.60	6.0-20	0.02-0.08	7.9-8.4	<2	Low--------	0.17			
Lr*:												
Lincoln----------	0-8	5-15	1.35-1.50	6.0-20	0.06-0.11	7.4-8.4	<2	Low--------	0.17	5	2	<.5
	8-60	5-15	1.30-1.60	6.0-20	0.02-0.08	7.9-8.4	<2	Low--------	0.17			
Krier------------	0-4	6-12	1.35-1.45	2.0-6.0	0.13-0.17	7.4-9.0	2-8	Low--------	0.24	3	3	---
	4-15	10-32	1.40-1.50	2.0-6.0	0.13-0.18	7.9-9.0	4-16	Low--------	0.32			
	15-60	1-5	1.45-1.55	6.0-20	0.03-0.07	7.4-9.0	2-8	Low--------	0.15			
Ms-----------------	0-10	30-40	1.25-1.35	0.2-0.6	0.18-0.23	6.6-8.4	<2	Moderate	0.32	5	7	1-3
Missler	10-60	35-45	1.30-1.40	0.2-0.6	0.12-0.20	7.4-8.4	<2	Moderate	0.32			
Ns-----------------	0-36	40-60	1.30-1.45	<0.06	0.11-0.14	6.6-8.4	<2	High-------	0.28	5	4	1-3
Ness	36-60	20-40	1.35-1.45	0.06-2.0	0.10-0.20	7.4-8.4	<2	Moderate	0.28			
Os-----------------	0-6	35-60	---	<0.06	0.13-0.17	7.9-8.4	<2	High-------	0.37	2	4L	<2
Owens	6-17	35-60	---	<0.06	0.13-0.17	7.9-8.4	<2	High-------	0.37			
	17	---	---	---	---	---	---	-----------	---			
Pa, Pb, Pc, Pf, Pg----------------- Penden	0-16	28-35	1.30-1.45	0.6-2.0	0.17-0.22	7.4-8.4	<2	Moderate	0.28	5	4L	1-4
	16-28	24-35	1.35-1.50	0.6-2.0	0.15-0.19	7.9-8.4	<2	Moderate	0.37			
	28-60	24-35	1.30-1.50	0.6-2.0	0.14-0.19	7.9-8.4	<2	Moderate	0.37			
Pr-----------------	0-11	2-8	1.40-1.55	6.0-20	0.10-0.13	5.6-7.3	<2	Low--------	0.17	5	2	.5-1
Pratt	11-30	4-11	1.45-1.55	6.0-20	0.09-0.12	5.6-7.3	<2	Low--------	0.17			
	30-60	1-8	1.45-1.60	6.0-20	0.08-0.12	6.1-7.3	<2	Low--------	0.17			
Pt*:												
Pratt------------	0-8	2-8	1.40-1.55	6.0-20	0.10-0.13	5.6-7.3	<2	Low--------	0.17	5	2	.5-1
	8-30	4-11	1.45-1.55	6.0-20	0.09-0.12	5.6-7.3	<2	Low--------	0.17			
	30-60	1-8	1.45-1.60	6.0-20	0.08-0.12	6.1-7.3	<2	Low--------	0.17			
Tivoli-----------	0-6	5-10	1.35-1.50	6.0-20.0	0.07-0.11	6.1-7.8	<2	Low--------	0.17	5	2	<1
	6-60	1-10	1.50-1.70	6.0-20.0	0.02-0.08	6.1-8.4	<2	Low--------	0.17			
Qw*:												
Quinlan----------	0-13	15-27	1.30-1.55	0.6-2.0	0.13-0.24	7.4-8.4	<2	Low--------	0.32	2	4L	<1
	13	---	---	---	---	---	---	-----------	----			
Woodward---------	0-27	10-18	1.30-1.60	0.6-2.0	0.13-0.20	6.6-8.4	<2	Low--------	0.32	4	4L	---
	27	---	---	---	---	---	---	-----------	----			
Rc, Rf------------	0-21	18-27	1.30-1.45	0.6-2.0	0.22-0.24	6.6-8.4	<2	Low--------	0.32	5	4L	2-4
Roxbury	21-36	18-35	1.35-1.50	0.6-2.0	0.17-0.22	7.4-8.4	<2	Moderate	0.43			
	36-60	18-35	1.35-1.50	0.6-2.0	0.17-0.22	7.4-8.4	<2	Moderate	0.43			
Sa-----------------	0-11	10-25	1.30-1.40	0.6-2.0	0.20-0.22	6.1-7.8	<2	Low--------	0.28	5	6	1-2
Satanta	11-60	18-35	1.35-1.45	0.6-2.0	0.15-0.19	6.6-8.4	<2	Moderate	0.28			
Sh-----------------	0-11	12-22	1.30-1.40	0.6-2.0	0.20-0.22	5.1-6.5	<2	Low--------	0.28	5	6	1-3
Shellabarger	11-29	18-27	1.45-1.60	0.6-2.0	0.16-0.18	6.1-7.8	<2	Low--------	0.28			
	29-60	3-18	1.50-1.65	0.6-2.0	0.05-0.16	6.1-8.4	<2	Low--------	0.28			
Tv-----------------	0-6	1-10	1.35-1.50	6.0-20.0	0.02-0.08	6.1-7.8	<2	Low--------	0.17	5	1	<1
Tivoli	6-60	1-10	1.50-1.70	6.0-20.0	0.02-0.08	6.1-8.4	<2	Low--------	0.17			
Ua, Ub, Uc--------	0-7	17-27	1.20-1.30	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low--------	0.32	5	6	1-3
Uly	7-18	20-32	1.20-1.30	0.6-2.0	0.18-0.22	6.1-8.4	<2	Low--------	0.43			
	18-60	18-27	1.10-1.20	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low--------	0.43			
Wa-----------------	0-14	8-16	1.50-1.60	2.0-6.0	0.14-0.18	7.4=8.4	<2	Low--------	0.20	5	3	1-2
Waldeck	14-45	8-16	1.50-1.60	2.0-6.0	0.12-0.17	7.4-8.4	<2	Low--------	0.20			
	45-60	1-4	1.55-1.65	6.0-20	0.05-0.07	7.4-8.4	<2	Low--------	0.20			
Wo-----------------	0-30	10-18	1.30-1.60	0.6-2>0	0.13-0.20	6.6-8.4	<2	Low--------	0.32	4	4L	---
Woodward	30	---	---	---	---	---	---	-----------	----			

See footnote at end of table.

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

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
									K	T		
	In	Pct	G/cm^3	In/hr	In/in	pH	Mmhos/cm					Pct
Wr*:												
Woodward	0-30	10-18	1.30-1.60	0.6-2.0	0.13-0.20	6.6-8.4	<2	Low	0.32	4	4L	---
	30	---	---	---	---	---	---	---	----			
Quinlan	0-13	15-27	1.30-1.55	0.6-2.0	0.13-0.24	7.4-8.4	<2	Low	0.32	2	4L	<1
	13	---	---	---	---	---	---	---	----			
Yh, Yahola	0-8	10-18	1.30-1.55	2.0-6.0	0.15-0.20	7.4-8.4	<2	Low	0.32	5	3	.5-1
	8-21	5-18	1.40-1.70	2.0-6.0	0.11-0.20	7.9-8.4	<2	Low	0.20			
	21-60	2-30	1.45-1.75	2.0-6.0	0.07-0.20	7.9-8.4	<2	Low	0.20			
Ze, Zenda	0-14	12-32	1.45-1.55	0.6-2.0	0.17-0.22	6.6-8.4	<4	Moderate	0.28	5	6	1-3
	14-60	18-35	1.45-1.60	0.6-2.0	0.15-0.19	7.4-8.4	<4	Moderate	0.28			

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

TABLE 16.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness	Uncoated steel	Concrete
					Ft			In			
Ab*:											
Albion	B	None	---	---	>6.0	---	---	>60	---	Low	Low.
Shellabarger	B	None	---	---	>6.0	---	---	>60	---	Low	Moderate.
Bd*:											
Badland.											
Woodward	B	None	---	---	>6.0	---	---	20-40	Soft	Low	Low.
Bp, Bu Bippus	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low.
Co*:											
Campus	B	None	---	---	>6.0	---	---	20-40	Hard	Low	Low.
Canlon	D	None	---	---	>6.0	---	---	10-20	Hard	Low	Low.
Ch*:											
Canlon	D	None	---	---	>6.0	---	---	10-20	Hard	Low	Low.
Rock outcrop.											
Cr, Cs, Cy Carey	B	None	---	---	>6.0	---	---	>60	---	High	Low.
Ha, Hb Harney	C	None	---	---	>6.0	---	---	>60	---	High	Low.
Ka, Kb Kingsdown	B	None	---	---	>6.0	---	---	>60	---	Low	Low.
Kr Krier	D	Occasional	Very brief	Mar-Jul	1.0-3.0	Apparent	Mar-Jun	>60	---	High	Low.
Lb Lesho	C	Occasional	Very brief	Mar-Jul	2.0-4.0	Apparent	Mar-Jun	>60	---	High	Low.
Le Lesho	C	Rare	---	---	2.0-4.0	Apparent	Mar-Jun	>60	---	High	Low.
Lf Likes	A	None	---	---	>6.0	---	---	>60	---	Low	Low.
Lh*:											
Likes	A	None	---	---	>6.0	---	---	>60	---	Low	Low.
Quinlan	C	None	---	---	>6.0	---	---	10-20	Soft	Moderate	Low.
Ln Lincoln	A	Occasional	Very brief to brief.	Apr-Oct	5.0-8.0	Apparent	Nov-May	>60	---	Low	Low.
Lr*:											
Lincoln	A	Occasional	Very brief to brief.	Apr-Oct	5.0-8.0	Apparent	Nov-May	>60	---	Low	Low.
Krier	D	Occasional	Very brief	Mar-Jul	1.0-3.0	Apparent	Mar-Jun	>60	---	High	Low.
Ms Missler	C	None	---	---	>6.0	---	---	>60	---	High	Low.
Ns Ness	D	None	---	---	+1-1.0	Perched	Mar-Jun	>60	---	High	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hard-ness	Uncoated steel	Concrete
					Ft			In			
Os------------------ Owens	D	None--------	---	---	>6.0	---	---	10-20	Soft	High-----	Low.
Pa, Pb, Pc, Pf, Pg------------------ Penden	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low.
Pr------------------ Pratt	A	None--------	---	---	>6.0	---	---	>60	---	Low------	Moderate.
Pt*:											
Pratt-------------	A	None--------	---	---	>6.0	---	---	>60	---	Low------	Moderate.
Tivoli------------	A	None--------	---	---	>6.0	---	---	>60	---	Low------	Low.
Qw*:											
Quinlan-----------	C	None--------	---	---	>6.0	---	---	10-20	Soft	Moderate	Low.
Woodward----------	B	None--------	---	---	>6.0	---	---	20-40	Soft	Low------	Low.
Rc------------------ Roxbury	B	Frequent----	Very brief	Apr-Sep	>6.0	---	---	>60	---	Low------	Low.
Rf------------------ Roxbury	B	Occasional	Very brief	Apr-Sep	>6.0	---	---	>60	---	Low------	Low.
Sa------------------ Satanta	B	None--------	---	---	>6.0	---	---	>60	---	Low------	Low.
Sh------------------ Shellabarger	B	None--------	---	---	>6.0	---	---	>60	---	Low------	Moderate.
Tv------------------ Tivoli	A	None--------	---	---	>6.0	---	---	>60	---	Low------	Low.
Ua, Ub, Uc-------- Uly	B	None--------	---	---	>6.0	---	---	>60	---	High-----	Low.
Wa------------------ Waldeck	C	Occasional	Brief-----	Mar-Oct	2.0-4.0	Apparent	Oct-Apr	>60	---	Moderate	Low.
Wo------------------ Woodward	B	None--------	---	---	>6.0	---	---	20-40	Soft	Low------	Low.
Wr*:											
Woodward----------	B	None--------	---	---	>6.0	---	---	20-40	Soft	Low------	Low.
Quinlan-----------	C	None--------	---	---	>6.0	---	---	10-20	Soft	Moderate	Low.
Yh------------------ Yahola	B	Occasional	Very brief	Apr-Aug	>6.0	---	---	>60	---	Low------	Low.
Ze------------------ Zenda	C	Occasional	Very brief	Apr-Sep	3.0-4.0	Apparent	Oct-Apr	>60	---	High-----	Low.

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

TABLE 17.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series]

Soil name	Family or higher taxonomic class
Albion	Coarse-loamy, mixed, thermic Udic Argiustolls
Bippus	Fine-loamy, mixed, thermic Cumulic Haplustolls
Campus	Fine-loamy, mixed, mesic Typic Calciustolls
Canlon	Loamy, mixed (calcareous), mesic Lithic Ustorthents
Carey	Fine-silty, mixed, thermic Typic Argiustolls
Harney	Fine, montmorillonitic, mesic Typic Argiustolls
Kingsdown	Coarse-loamy, mixed, thermic Entic Haplustolls
Krier	Sandy, mixed, thermic Aeric Halaquepts
Lesho	Fine-loamy over sandy or sandy-skeletal, mixed, thermic Fluvaquentic Haplustolls
Likes	Mixed, thermic Typic Ustipsamments
Lincoln	Sandy, mixed, thermic Typic Ustifluvents
Missler	Fine, mixed, thermic Typic Haplustolls
Ness	Fine, montmorillonitic, mesic Udic Pellusterts
Owens	Clayey, mixed, thermic, shallow Typic Ustochrepts
Penden	Fine-loamy, mixed, mesic Typic Calciustolls
Pratt	Sandy, mixed, thermic Psammentic Haplustalfs
Quinlan	Loamy, mixed, thermic, shallow Typic Ustochrepts
Roxbury	Fine-silty, mixed, mesic Cumulic Haplustolls
*Satanta	Fine-loamy, mixed, mesic Aridic Argiustolls
Shellabarger	Fine-loamy, mixed, thermic Udic Argiustolls
Tivoli	Mixed, thermic Typic Ustipsamments
Uly	Fine-silty, mixed, mesic Typic Haplustolls
Waldeck	Coarse-loamy, mixed, thermic Fluvaquentic Haplustolls
Woodward	Coarse-silty, mixed, thermic Typic Ustochrepts
Yahola	Coarse-loamy, mixed (calcareous), thermic Typic Ustifluvents
Zenda	Fine-loamy, mixed, thermic Fluvaquentic Haplustolls

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