

SOIL SURVEY OF

Dawes County, Nebraska



United States Department of Agriculture
Soil Conservation Service
In cooperation with
University of Nebraska
Conservation and Survey Division

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in the period 1956-73. Soil names and descriptions were approved in 1973. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1973. This survey was made cooperatively by the Soil Conservation Service and the University of Nebraska Conservation and Survey Division. It is part of the technical assistance furnished to the Upper Niobrara-White Natural Resources District.

Soil maps in this survey may be copied without permission, but any enlargement of these maps could cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas on contrasting soils that could have been shown at a larger mapping scale.

HOW TO USE THIS SOIL SURVEY

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

Locating Soils

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

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

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil and the page where each range site is described, and it shows the windbreak suitability group in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suit-

ability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the capability units, the range sites, and the windbreak suitability groups.

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

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

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

Community planners and others can read about soil properties that affect the choice of sites for dwellings, industrial buildings, and recreation areas in the section "Engineering Uses of the Soils."

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

Scientists and others can read about soil formation and classification in the section "Formation and Classification of Soils."

Newcomers in Dawes County will be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given in the section "Environmental Factors Affecting Soil Use."

Cover: Typical farm in the Kadoka-Keith-Mitchell association. Terraces help to control water erosion, and the windbreaks provide effective protection from the winter winds. An area of the Pine Ridge is in background.

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SOIL SURVEY OF DAWES COUNTY, NEBRASKA

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UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN
COOPERATION WITH THE UNIVERSITY OF NEBRASKA CONSERVATION AND SURVEY DIVISION

DAWES COUNTY is in the northwestern part of Nebraska (fig. 1). Its total area is 888,960 acres, or 1,389 square miles. Chadron, the largest town and county seat, is in the northeastern part of the county. Dawes County is in the Great Plains physiographic province.

In the 1830's fur traders and trappers entered Dawes County, then inhabited by Sioux, Cheyenne, and Arapahoe Indians. The presence of fur-bearing animals along the White River enticed fur traders to the area to trade with the Indians. In 1874 Fort Robinson was established and played an important role in the western settlement. By 1885, a railroad was being built across the Nebraska Panhandle to Wyoming. The town of Chadron was established that year, followed by Crawford in 1886. Dawes County was established in 1886.

Most of the land was settled in the 1880's under provisions of the Homestead Act. Many settlers experienced hardships, and three out of five people left the land. The great drought of the 1890's, resulting in poor crops and poor prices, took its toll. By 1900, foreclosures had taken place, setting the stage for the

development of large ranches. The government instituted a land buying program in the northern part of the county, which brought some recovery. The remaining families settled on this land, and the area has remained stable up to the present.

Population has declined in most parts of the county over the years. Population in the county decreased from 10,128 in 1940 to 9,761 in 1970. In 1970 Chadron had a population of 5,921, Crawford 1,291, and Whitney 82.

The climate of Dawes County is semiarid, and the average annual precipitation is 18.2 inches. Relative humidity is lower in Dawes County than in eastern Nebraska, so that the air feels warmer in winter and cooler in summer.

The White River watershed drains the northern part of the county, and the Niobrara River watershed drains the southern part. The breaks to the White River valley from the south make a rough, steep terrain dissected by deep drainageways. The breaks form a continuous area from the eastern to the western boundary of the county that ranges from about 2 miles to more than 5 miles in width and from 500 to 1,000 feet in height from base to crest. The area, covered with mixed grass and ponderosa pine trees, is known as the Pine Ridge. The rest of the county is gently rolling to hilly. The watershed of the Niobrara River has deeply entrenched drainageways.

The soils of Dawes County formed under grass in a wide variety of materials. The parent materials were shale, siltstone, sandstone, loess, eolian sand, gravel, colluvium, and alluvium. The soils vary widely in characteristics and in their suitability for use. The content of carbonates is high in most of the soils because the parent material commonly contains lime and the semiarid climate has resulted in a minimum of leaching.

¹ EDWARD H. SAUTTER, JACK YOUNG, and DONALD A. YOST, Soil Conservation Service, contributed to the fieldwork.

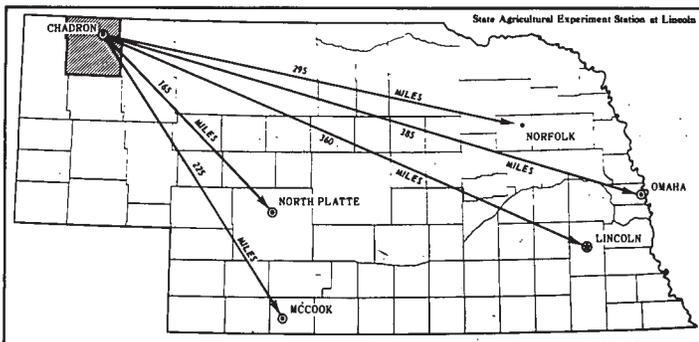


Figure 1.—Location of Dawes County in Nebraska.

Livestock ranching is the main farming enterprise in Dawes County. Most of the ranches produce feeder calves and lambs. Raising winter wheat is the second most important enterprise. About 22 percent of the county is in crops, chiefly winter wheat, alfalfa, and oats. Only about 6 percent of the cropland is irrigated. The rest of the acreage in the county is in native grass that is used for grazing or is cut for hay for winter livestock feed. The Pine Ridge area is grazable woodland that can be used for grazing without impairing the forest value. Some timber in this area is cut for commercial purposes.

State highways connect the larger communities. County roads serve most parts of the county, but only a few cross the Pine Ridge area. Trails from the highways and county roads provide access where needed.

Dawes County provides good hunting for deer, antelope, and turkey. Whitney Reservoir and Box Butte Reservoir offer fishing and boating facilities. Some of the spring-fed, cold-water streams provide trout fishing. The county attracts hunters, fisherman, and tourists. Scenic buttes in the Pine Ridge enhance the beauty of the area. The Nebraska National Forest in the Pine Ridge, the Oglala National Grasslands, Chadron State Park, and Fort Robinson State Park are the principal attractions. Geologic formations exposed in the county also attract many rock and fossil collectors each year.

An earlier soil survey of Dawes County was published by the United States Department of Agriculture in 1915 (7).² This new survey was made to provide up-to-date information on the soils and to take into account advances in soil interpretation, engineering, and soil classification since that time.

How This Survey Was Made

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

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

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other impor-

tant characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Pierre and Rosebud, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects the use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Pierre silty clay, 5 to 30 percent slopes, is one of several phases within the Pierre series.

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

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

Some mapping units are made up of soils of different series, or of different phases within one series. Three such kinds of mapping units are shown on the soil map of Dawes County: soil complexes, soil associations, and undifferentiated soil groups.

A soil complex consists of areas of two or more soils so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, or land types, joined by a hyphen. Rock outcrop-Canyon complex, 30 to 60 percent slopes, is an example.

A soil association is made up of areas of adjacent soils that are large enough to be shown individually on the soil map but that are shown as one unit because the time and effort of delineating them separately cannot be justified. There is a considerable degree of uniformity in pattern and relative extent of the dominant soils, but the soils may differ greatly one from another. The name of an association consists of the names of the dominant soils, or land types, joined by a hyphen. Canyon-Bridget-Rock outcrop association, steep, is an example.

An undifferentiated soil group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. If there

² Italic numbers in parentheses refer to Literature Cited, page 130.

are two or more dominant series represented in the group, the name of the group ordinarily consists of the names of the dominant soils, joined by "and." Valent and Dwyer loamy fine sands, 3 to 17 percent slopes, is an undifferentiated soil group in Dawes County.

In most areas surveyed there are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Loamy alluvial land is a land type in Dawes County.

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

Soil scientists observe how soils behave when used for growing native and cultivated plants, and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this to the slow permeability of the soil or its high water table. They see that streets, road pavements, and foundations for houses are cracked on a particular kind of soil, and they relate this failure to the high shrink-swell potential of the soil. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

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

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

neering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The terms for texture used in the title of the associations apply to the texture of the surface layer. For example, in the title of the Canyon-Alliance-Rosebud association, the words "loamy" and "silty" refer to the texture of the surface layer.

Soil association names and delineations on the general soil map do not fully agree with those of the general soil map in adjacent counties published at other dates. Differences on the maps are the result of improvements in the classifications or refinements in soil series concepts. In addition, more precise maps are needed because the uses of the general soil map have expanded in recent years. The more modern maps meet these needs.

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

Clayey Soils on Uplands and Stream Terraces

Two soil associations are in this group. The soils are nearly level to steep and are well drained.

1. *Pierre-Samsil-Kyle association*

Deep to shallow, very gently sloping to steep, well-drained clayey soils that formed in material weathered from shale; on uplands

This association consists of undulating to hilly uplands that have smooth slopes and broad swalelike drainageways (fig. 2).

This association occupies about 21 percent of the county, or 189,200 acres. Pierre soils make up 35 percent of the association; Samsil soils 33 percent; and Kyle soils 21 percent. Land types make up the remaining 11 percent.

Pierre soils are moderately deep and very gently sloping to steep. They are on smooth side slopes and rounded ridgetops. Their surface layer is silty clay, and their subsoil is calcareous clay. Bedded clay shale is at a depth of 20 to 40 inches.

Samsil soils are shallow and gently sloping to steep. They are on narrow ridgetops and in areas that border intermittent drainageways. Their surface layer and underlying material are calcareous silty clay. Bedded clay shale is at a depth of 10 to 20 inches.

Kyle soils are deep and very gently sloping to gently sloping. They are in swales and on broad ridgetops on uplands. They are also on tablelands. Their surface layer is silty clay, and their subsoil and underlying material are calcareous clay.

Minor in this association are areas of Clayey alluvial land, Shale outcrop, and Slickspots. Clayey alluvial land is on bottom lands along drainageways and is subject to flooding. Shale outcrop consists of very steep areas of exposed soft bedded shale on uplands. Slickspots are mostly on foot slopes and stream terraces with Pierre and Kyle soils.

Most of this association is in native grass and is

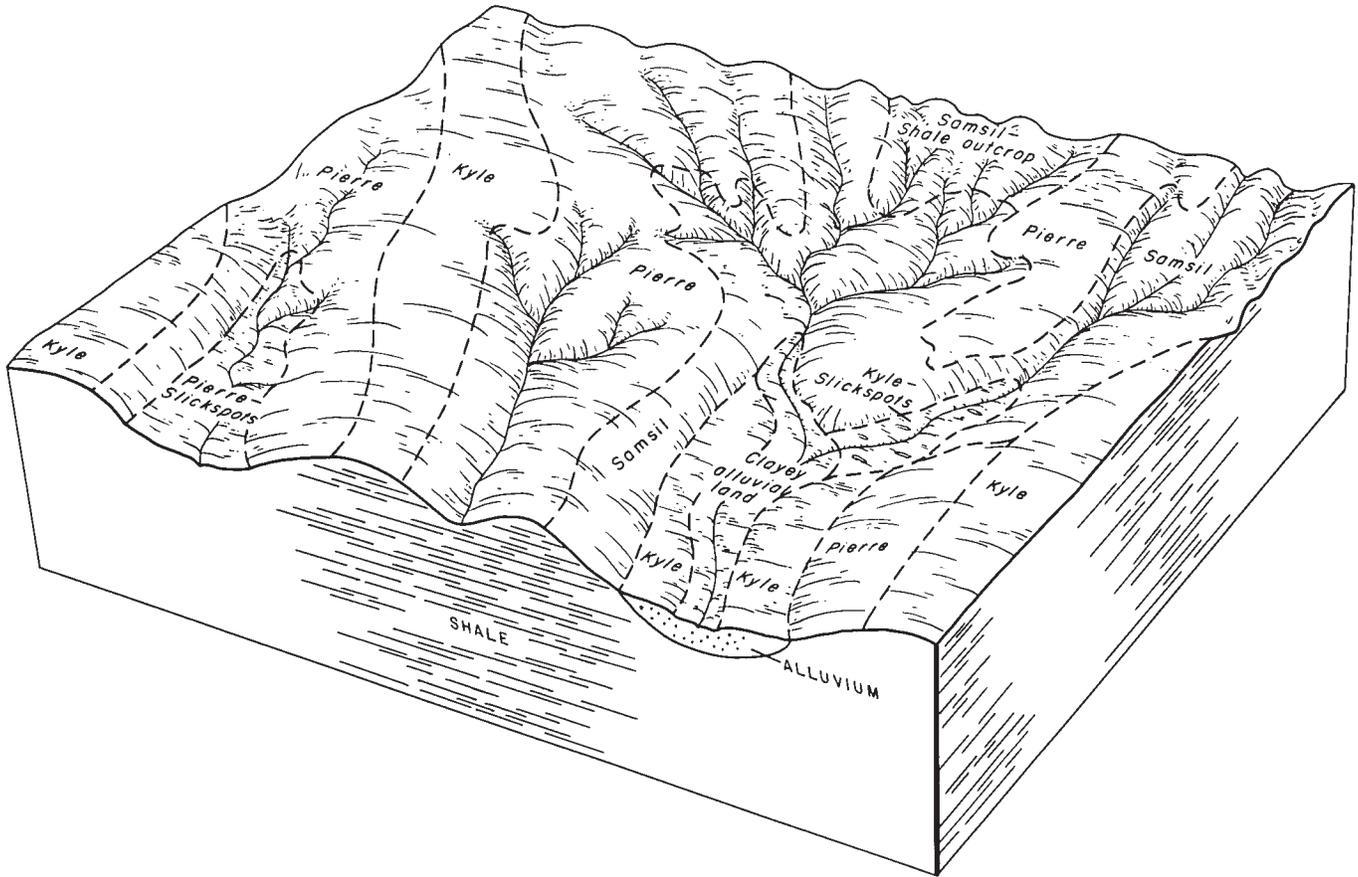


Figure 2.—Typical pattern of soils and underlying material in the Pierre-Samsil-Kyle association.

used for grazing, but a small acreage is cultivated. Wheat, oats, and alfalfa are the principal crops. Ranching, the main enterprise in this association, consists of the production of feeder calves and feeder lambs. Most of the area is government-administered land that ranchers use by permit. Most ranchers grow alfalfa for winter feed. Water spreading is used to increase production.

Low rainfall limits the growth of grasses, and the grazing season is limited by an inadequate supply of water for livestock. Neither the soils, the slopes, nor the water supply are favorable for developing irrigation. Except in areas that are served by water pipelines, water for livestock consists of precipitation caught and stored in stock water ponds. The source of water for pipelines is in the Pine Ridge. Wells yield a very limited quantity of highly mineralized water, some of which is not suitable for domestic use. Water erosion and soil blowing are hazards in cultivated areas. Some areas are also severely affected by salts and alkali.

Very few farm or ranch headquarters are in the association. A few roads cross the area, and unimproved trails extending from these roads provide access where needed. Local markets are available for products of the ranches and farms.

2. Kyle-Buffington association

Deep, nearly level to very gently sloping, well-drained clayey soils; on stream terraces

This association consists of broad, nearly level stream terraces that have deeply entrenched drainage-ways and a few gently undulating hills on drainage divides.

This association occupies about 2 percent of the county, or 14,300 acres. Kyle soils make up 49 percent of this association and Buffington soils 14 percent. Minor soils and land types make up the remaining 37 percent.

Kyle soils are deep and nearly level to very gently sloping. They formed in material weathered from clay shale. Their surface layer is silty clay, and their subsoil and underlying material are calcareous clay.

Buffington soils are deep and nearly level. They formed in clayey alluvium from the surrounding clay shale deposited 1 to 2 feet thick over silty alluvium from silty shale and siltstone. Their surface layer is calcareous silty clay, and their subsoil is calcareous silty clay loam. The underlying material is calcareous light silty clay loam.

Minor in this association are soils in the Bufton, Haverson, and Pierre series and areas of Loamy al-

luvial land. Bufton soils are on stream terraces and the breaks along intermittent drainageways. Pierre soils are on the highest parts of the landscape. Haverson soils are on bottom lands along intermittent drainageways that are flooded at times. Loamy alluvial land is on the lowest parts of the bottom lands and is subject to flooding.

Nearly 50 percent of this association is in cultivated crops, most of which are irrigated. Alfalfa hay is the main irrigated crop. Wheat, oats, or other small grains are commonly grown in the cultivated areas that are not irrigated. Irrigation water comes from canals and ditches that carry water from Whitney Lake. The rest of this association is in native grass and is used mostly for grazing. Diversified farms and ranches are in this association. The main livestock enterprise is the production of feeder calves and feeder lambs. Many farmers and ranchers in this association also have land in association 1.

A lack of seasonal rainfall and the very low permeability of the soils limit production of dryfarmed crops and grasses. The grazing season is limited in some places by an inadequate supply of water for livestock. Some water comes from wells, but most of it is from precipitation caught and stored in stock water ponds. The clayey soils in this association are difficult to farm and difficult to manage for irrigation. Wells generally yield a limited quantity of highly mineralized water. Some areas are severely affected by salts and alkali.

Gravel roads or improved roads are on some section lines. The rest of the association is served by graded dirt roads and trails. Local markets are available for products raised in the association.

Silty Soils on Uplands, Stream Terraces, and Foot Slopes

Two soil associations are in this group. The soils are nearly level to steep and are well drained.

3. Bufton-Orella-Norrest association

Deep to shallow, nearly level to steep, well-drained silty soils that formed in material weathered from shale; on uplands and stream terraces

This association consists of undulating and rolling hills and broad, nearly level stream terraces. It is characterized by deeply entrenched drainageways that are bordered in some places by small areas of Badland.

This association occupies about 7 percent of the county, or 65,500 acres. Bufton soils make up 38 percent of the association; Orella soils 28 percent; and Norrest soils 15 percent. Minor soils and land types make up the remaining 19 percent.

Bufton soils are deep and nearly level to steep. They are on rolling uplands and stream terraces. They formed in weathered silty shale and colluvial-alluvial sediment weathered from shale and siltstone. Their surface layer, subsoil, and underlying material are calcareous heavy silty clay loam.

Orella soils are shallow and gently sloping to steep. They are on breaks to drainageways and on rolling uplands. They formed in material weathered from

silty shale. Their surface layer, transitional layer, and underlying material are calcareous silty clay loam. Silty shale is at a depth of 10 to 20 inches.

Norrest soils are moderately deep and very gently sloping to steep. They are on rolling uplands. They formed in material weathered from silty shale and siltstone. They have a surface layer of silty clay loam. The subsoil is calcareous light silty clay in the upper part and calcareous heavy silty clay loam in the lower part. The underlying material is calcareous silty clay loam. Bedded silty shale is at a depth of 20 to 40 inches.

Minor in this association are soils in the Mitchell, Kyle, and Pierre series and areas of Loamy alluvial land, Shale outcrop, Slickspots, and Badland. Mitchell soils are on rolling uplands and stream terraces. Pierre and Kyle soils, which commonly occur along with areas of Slickspots, are on some of the lower side slopes and stream terraces. Loamy alluvial land is on bottom lands along drainageways and is subject to flooding. Shale outcrop is on broken, very steep upland slopes and is near Orella soils. Slickspots are on foot slopes and on stream terraces. Badland is on breaks to upland drainageways.

Nearly all of this association is in native grass, which is used for grazing or hay. Only a small acreage is cultivated, and wheat, oats, and alfalfa, are the main crops. Where surface water is available, water spreading is used to improve grass and hay production. Ranching, the main enterprise in this association, consists of the production of calves and feeder lambs. Ranchers also cut hay for winter feed.

A lack of seasonal rainfall generally limits the growth of grasses. Except in areas that are served by water pipelines, the grazing season is limited by a shortage of water for livestock. The source of water for pipelines is in the Pine Ridge. Wells yield a limited quantity of highly mineralized water. Water erosion and soil blowing are hazards in cultivated areas. Alkalinity and salinity are concerns in places.

Only a few ranch headquarters are in the association. A few roads cross the area, and unimproved trails extending from these roads provide access where needed. Local markets are available for products of the ranches and farms.

4. Kadoka-Keith-Mitchell association

Deep, nearly level to steep, well-drained silty soils that formed in loess and in material weathered from siltstone; on uplands and foot slopes

This association lies between the Pine Ridge and the White River. It consists mostly of undulating to rolling uplands that are dissected by many spring-fed creeks. The creeks originate mainly in the Pine Ridge and flow toward the White River.

This association occupies about 15 percent of the county, or 134,900 acres. Kadoka variant soils make up 28 percent of the association; Keith soils 23 percent; and Mitchell soils 18 percent (fig. 3). Minor soils and land types make up the remaining 31 percent.

Kadoka variant soils are deep and very gently sloping to strongly sloping. They are on the middle and lower parts of side slopes on uplands. They formed in material weathered from siltstone. Their surface layer

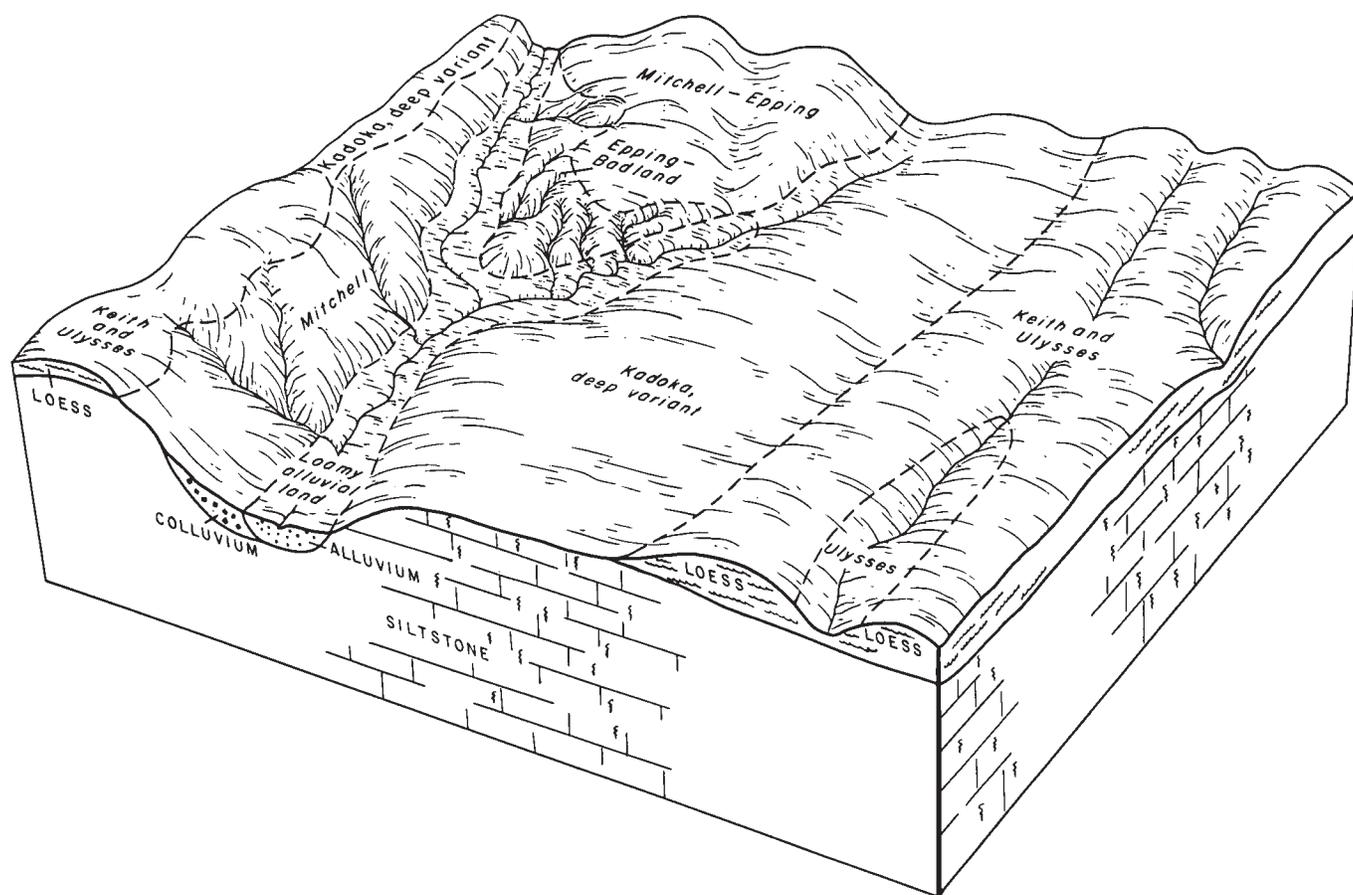


Figure 3.—Typical pattern of soils and parent material in the Kadoka-Keith-Mitchell association.

is silt loam, and their subsoil is silty clay loam. The underlying material is calcareous silt loam.

Keith soils are deep and very gently sloping to strongly sloping. They are on rounded ridgetops of drainage divides on uplands. They formed in loess. Their surface layer is silt loam. Their subsoil is light silty clay loam in the upper part and silt loam in the lower part. The underlying material is calcareous silt loam.

Mitchell soils are deep and nearly level to steep. They are on side slopes of uplands and on foot slopes. They formed in material weathered from siltstone. Their surface layer, transitional layer, and underlying material are calcareous silt loam.

Minor in this association are soils in the Bridget, Duroc, Epping, Ulysses, Keota, and Schamber series and areas of Loamy alluvial land and Badland. Bridget soils are on foot slopes and stream terraces. Duroc soils are in upland swales. Epping, Keota, and Schamber soils are on ridges and knolls and on breaks to intermittent drainageways. Ulysses soils are on smooth side slopes on uplands. Loamy alluvial land is on bottom lands of creeks that cross the area and is subject to flooding. Badland is along breaks to upland drainageways.

This association is divided about equally between farming and ranching operations. Farms are mainly of the combination cash grain-livestock type. The main livestock enterprise of both ranches and farms is the production of feeder calves. Some farmers also raise dairy cattle, hogs, sheep, and chickens. About 50 percent of this association is cultivated cropland. Dry-farmed wheat, oats, and alfalfa are the principal crops. Wheat is the main cash crop, and oats and alfalfa are used mostly for livestock feed. The rest of the association is in native grass and is used for grazing or hay.

Soils in this association are suited to irrigation, but a lack of adequate underground water limits the development of irrigation. Some irrigation from reservoirs and streams is possible when seasonal rainfall is adequate to fill the reservoirs and maintain streamflow. Wells generally supply ample good-quality water for livestock and domestic uses. Some water for livestock comes from creeks and ponds. Controlling soil blowing and water erosion is the main concern of management. Conserving moisture and maintaining soil fertility are also concerns.

Farm and ranch headquarters are scattered throughout the association. Gravel or graded roads are on some section lines. Trails from these roads provide

access where needed. Products of the farms and ranches are sold at nearby markets.

Silty Soils on Uplands of Chalky Shale

Only one association is in this group. The soils are very gently sloping to steep and are well drained.

5. *Minnequa-Penrose association*

Moderately deep to shallow, very gently sloping to steep, well-drained silty soils that formed in material weathered from chalky shale; on uplands

This association is in the extreme northeastern corner of the county. It consists of undulating and rolling hills and ridges between broad swale-like drainageways. Rough broken side slopes and escarpments are along some of the deeply entrenched drainageways. Runoff water flows toward the White River.

This association occupies about 1 percent of the county, or 9,900 acres. About 46 percent of the association is Minnequa soils and 16 percent Penrose soils. Minor soils and land types make up the remaining 38 percent.

Minnequa soils are moderately deep and very gently sloping to steep. They are on smooth slopes on uplands. Their surface layer and transitional layer are calcareous silty clay loam. The underlying material is light silty clay loam. Chalky shale is at a depth of 20 to 40 inches.

Penrose soils are shallow and strongly sloping to steep. They are on upland ridgetops and on breaks adjacent to intermittent drainageways. Their surface layer is calcareous silty clay loam. The underlying material is calcareous silty clay loam. Chalky shale is at a depth of 10 to 20 inches.

Minor in this association are soils in the Bufton, Kyle, Pierre, and Samsil series and areas of Shale outcrop. Bufton soils are on the lower part of upland side slopes and on stream terraces. Kyle soils are mostly on broad upland divides. Pierre and Samsil soils are on steep breaks and divides on uplands. Shale outcrop is mostly very steep and is intermixed with areas of Penrose and Samsil soils.

Nearly all of this association is in native grass, which is used for grazing. A few of the more gently sloping soils are cultivated. Alfalfa, wheat, and oats are the principal crops. Ranching, the main enterprise in this association, consists mostly of the production of feeder calves. Ranchers cut hay for winter feed. The major soils in this association contain selenium, and livestock that graze continuously in the area are subject to selenium poisoning.

A lack of seasonal rainfall limits the growth of grasses. Grazing is limited by an inadequate supply of livestock water. Except in areas served by water pipelines from the Pine Ridge, water for livestock is limited mostly to precipitation caught and held in stock water ponds. Wells yield low quantities of highly mineralized water, some of which is not suitable for domestic use. Water erosion and soil blowing are hazards in cultivated areas. The soils are low in natural fertility and have poor tilth.

Very few ranch headquarters are located in the association. Trails supplement the one gravel road that

crosses the area. Local markets are available for products of the ranches.

Loamy and Silty Soils on Uplands and Foot Slopes of the Pine Ridge Area

Only one association is in this group. The soils are moderately steep to very steep and are well drained.

6. *Canyon-Bridget-Oglala association*

Deep and shallow, moderately steep to very steep, well-drained loamy and silty soils that formed in colluvium and in material weathered from sandstone; on uplands and foot slopes

This association consists of loamy and silty soils in the Pine Ridge area. Steep to very steep slopes and deep canyons make up about 60 percent of the association, and scenic buttes and outcrops of sandstone are common. The remaining 40 percent is moderately steep to steep foot slopes and intervening ridges. The numerous, deeply entrenched tributaries of the White River cross this association and form the drainage system. This association, with its cover of ponderosa pine trees, is one of the most scenic areas in the county (fig. 4).

This association occupies about 15 percent of the county, or 128,800 acres. Canyon soils make up 33 percent of this association; Bridget soils 29 percent; and Oglala soils 15 percent (fig. 5). Minor soils and land types make up the remaining 23 percent.

Canyon soils are shallow and steep to very steep. They are on rolling ridges and on the sides of valleys and canyons. They formed in material weathered from sandstone. Their surface layer, transitional layer, and underlying material are calcareous loam. Fine-grained sandstone is at a depth of 10 to 20 inches.

Bridget soils are deep and strongly sloping to steep. They are on foot slopes. They formed in colluvium-alluvium that washed down from soils on higher elevations. Their surface layer and transitional layer are silt loam. The underlying material is calcareous very fine sandy loam.

Oglala soils are deep and moderately steep to steep. They are on the middle and lower parts of side slopes on uplands. They formed in material weathered from sandstone. Their surface layer and transitional layer are silt loam. The underlying material is calcareous silt loam that contains fragments of fine-grained sandstone.

Minor in this association are soils in the Alliance, Busher, Duroc, Jayem, Keith, Rosebud, Tassel, Ulysses, and Vetal series and areas of Loamy alluvial land and Rock outcrop. Alliance, Busher, Jayem, Keith, Rosebud, Tassel, and Ulysses soils are on hillsides and ridgetops on uplands. Duroc and Vetal soils are on foot slopes and in upland swales. Loamy alluvial land is on bottom lands along drainageways. Rock outcrop, which consists of sandstone bedrock, is in the upper part of very steep areas and in some places in vertical canyon walls or buttes.

Nearly all of this association is in native grass and woodland. Ranching, the main enterprise, consists of the production of feeder calves. Ranchers raise dry-farmed alfalfa for winter feed. Much of the association

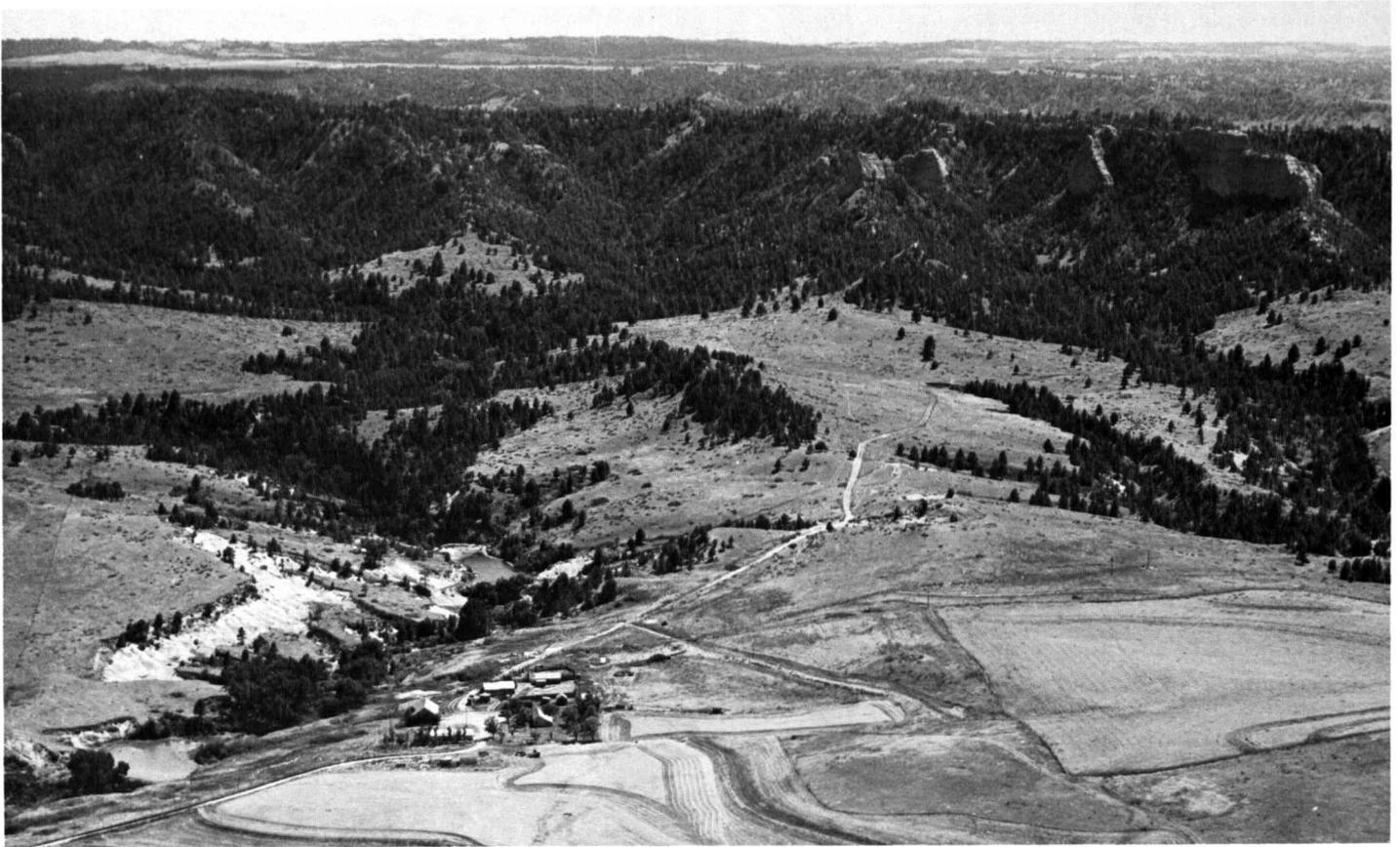


Figure 4.—A scenic area in the Canyon-Bridget-Oglala association.

is government-owned land that ranchers use by permit. Only about 5 percent of this association is cultivated, and the crops are dryfarmed. Wheat, oats, and alfalfa are the main crops. Over half of the association is in ponderosa pine trees, and about 20 percent has potential for production of timber for commercial purposes.

Steep to very steep slopes and shallow soils limit the use of most areas of this association to range, woodland, recreational areas, and wildlife habitat. Wells yield ample quantities of good water for domestic and livestock use. A few of the pipelines that supply water to areas farther north originate from wells in this association. Water erosion, soil blowing, and shallow soils are the main concerns of management in cultivated areas.

This association provides good recreational sites and excellent habitat for deer, turkey, and other upland wildlife. Chadron State Park is located here. The association has good potential for further development of wildlife habitat and recreational sites. Some spring-fed streams have potential as fish ponds. The numerous ridges, buttes, and canyons covered with pine trees offer excellent scenery for tourists and desirable sites for vacation cabins or lodges.

Only a few farms and ranch headquarters are located in the association. Two paved highways cross

the area. Graded roads and trails provide access to a limited part of this association. Because of the extremely rough terrain, much of the area is accessible only by horseback or by foot. Local markets are available for livestock, grain, and timber produced in the area.

Loamy and Silty Soils on Uplands

Two soil associations are in this group. The soils are very gently sloping to steep and are well drained.

7. *Richfield-Alliance-Rosebud association*

Deep and moderately deep, very gently sloping, well-drained silty soils that formed in loess and in material weathered from sandstone; on uplands

This association consists of gently undulating to rolling, smooth uplands. It is on the highest elevations in the county and constitutes a drainage divide between the White River to the north and the Niobrara River to the south.

This association occupies about 4 percent of the county, or 31,300 acres. Richfield soils make up 53 percent of this association; Alliance soils 21 percent; and Rosebud soils 15 percent. Minor soils make up the remaining 11 percent.

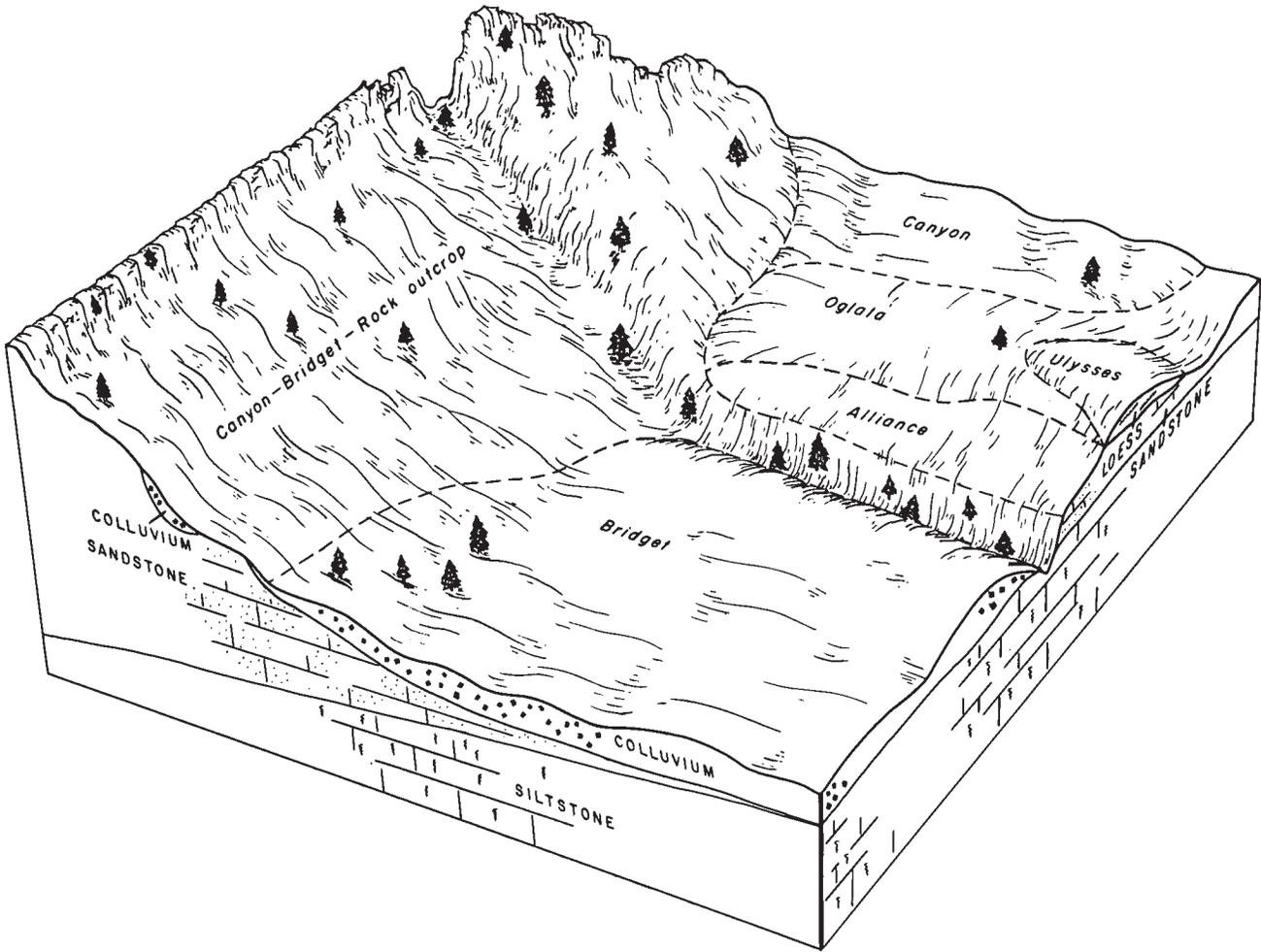


Figure 5.—Typical pattern of soils and parent material in the Canyon-Bridget-Oglala association.

Richfield soils are deep. They are on the higher parts of the landscape where loess has capped the underlying bedrock. Their surface layer is silt loam and light silty clay loam. Their subsoil is heavy silty clay loam in the upper part and calcareous light silty clay loam in the lower part. The underlying material is silt loam.

Alliance soils are deep and very gently sloping. They generally are between Richfield and Rosebud soils on the landscape. They formed in material weathered from sandstone. Their surface layer is silt loam. Their subsoil is silty clay loam in the upper part and silt loam in the lower part. The underlying material is calcareous very fine sandy loam that contains fragments of sandstone.

Rosebud soils are moderately deep and very gently sloping. They formed in material weathered from sandstone. They are on the lower part of smooth uplands, generally between areas of Alliance soils and the breaks to upland drainageways. Their surface layer is silt loam. Their subsoil is light silty clay loam, and the underlying material is calcareous silt loam. Fine-grained sandstone is at a depth of 20 to 40 inches.

Minor in this association are soils in the Canyon, Duroc, and Keith series. Canyon soils are on breaks to upland drainageways. Duroc soils are in upland swales. Keith soils are on the highest rounded ridges where loess has capped the underlying bedrock.

About 75 percent of this association is cultivated, and wheat, oats, and alfalfa are the main crops. Wheat is the main cash crop. Most of the oats and alfalfa are used for livestock feed. Farms in this association are of the diversified cash grain-livestock type. Most farmers produce some feeder calves, and a few raise hogs and sheep. Only a few ranches are in this association. The main ranching enterprise is the production of feeder calves.

Soils in this association are well suited to irrigation, but a lack of sufficient water limits the development of irrigation. Depth to ground water for irrigation generally exceeds 200 feet, and sources are not always reliable. Wells generally yield ample quantities of good water for livestock and domestic uses. Controlling soil blowing and water erosion are the main concerns of management in cultivated areas. Conserving soil moisture and maintaining soil fertility are also concerns.

Gravel or graded roads are on some section lines. Trails from these roads provide access where needed. Local markets are available for farm products.

8. Canyon-Alliance-Rosebud association

Deep to shallow, gently sloping to steep, well-drained loamy and silty soils that formed in material weathered from sandstone; on uplands

This association consists mostly of undulating to rolling uplands broken by deeply entrenched creeks and drainageways that have rough, steep sides. The creeks and numerous drainageways that cross the area flow southeastward toward the Niobrara River.

This association occupies about 19 percent of the county, or 166,500 acres. Canyon soils make up 25 percent of the association; Alliance soils 24 percent; and Rosebud soils 16 percent (fig. 6). Minor soils and land types make up the remaining 35 percent.

Canyon soils are shallow and gently sloping to steep. They are on narrow, rolling ridgetops, knolls, and on the breaks to creeks and drainageways. Their surface layer, transitional layer, and underlying material are

calcareous loam. Fine-grained sandstone is at a depth of 10 to 20 inches.

Alliance soils are deep and gently sloping to strongly sloping. They are on broad divides and long, smooth slopes on uplands. Their surface layer is silt loam. Their subsoil is silty clay loam in the upper part and silt loam in the lower part. The underlying material is calcareous very fine sandy loam that contains fragments of sandstone.

Rosebud soils are moderately deep and gently sloping to strongly sloping. They are on short convex side slopes and rounded ridgetops on uplands. Their surface layer is silt loam, and their subsoil is silty clay loam. The underlying material is calcareous silt loam. Fine-grained sandstone is at a depth of 20 to 40 inches.

Minor in this association are soils in the Bridget, Keith, Oglala, and Ulysses series and areas of Loamy alluvial land and Rock outcrop. Keith and Ulysses soils are on some of the upland divides and ridges. Oglala soils are on middle and lower side slopes in the more rolling areas. Bridget soils are on foot slopes.

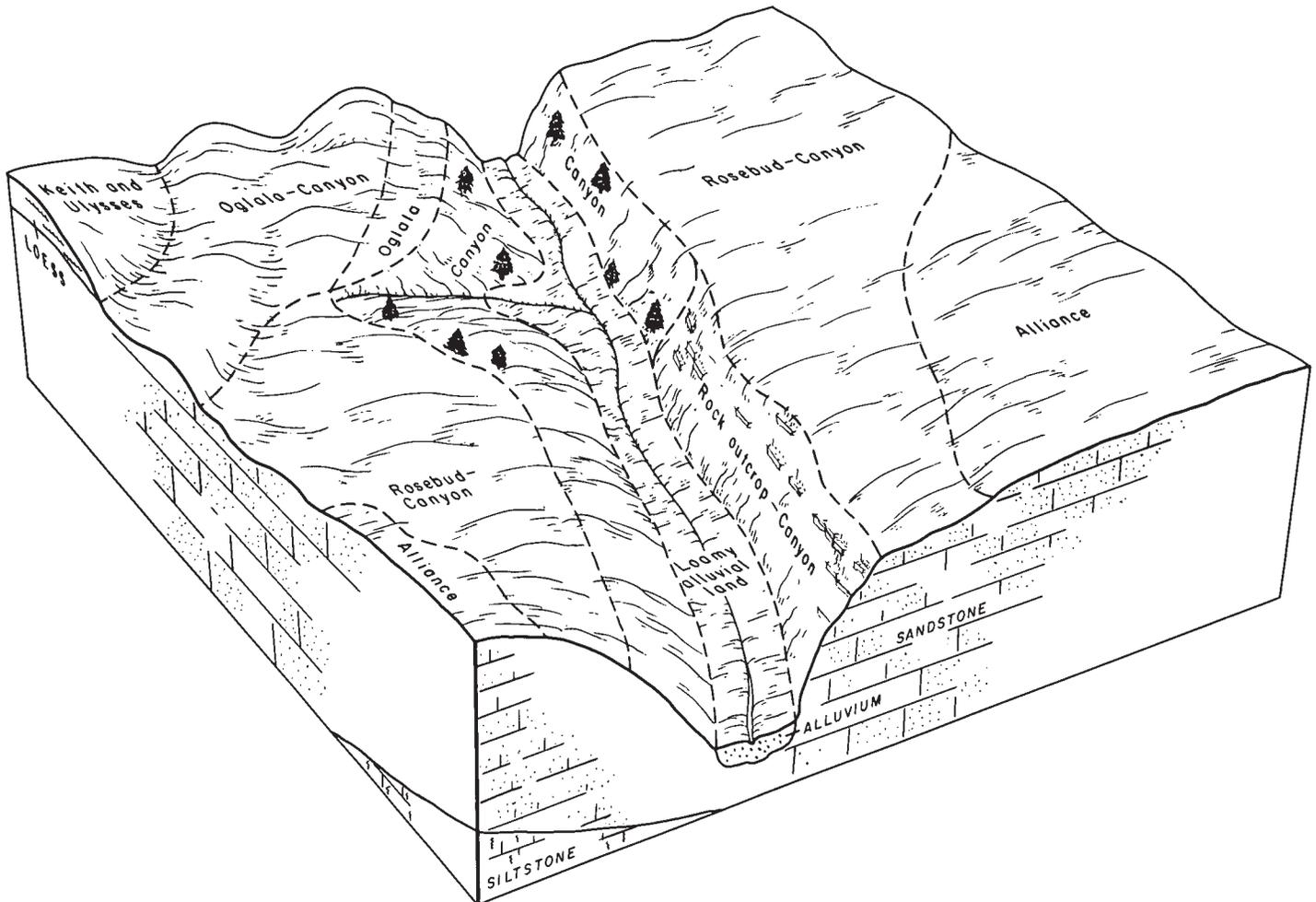


Figure 6.—Typical pattern of soils and parent material in the Canyon-Alliance-Rosebud association.

Loamy alluvial land is on bottom lands of creeks and drainageways and is subject to flooding. Rock outcrop, which consists of sandstone, is along breaks to upland drainageways.

About 70 percent of this association is in native grass, which is used for grazing. Ranching, the main enterprise, consists mainly of the production of feeder calves. Ranchers also raise dryfarmed alfalfa for winter feed. The rest of the area is in cultivated crops. A few areas are irrigated. Farms in this association are combination cash grain-livestock types. Wheat is the main cash crop, and a small acreage of irrigated corn is grown. Alfalfa and oats are grown as livestock feed. Most of the livestock on farms consists of feeder calves, but some farmers raise sheep or hogs, dairy cattle, and a few chickens.

A lack of seasonal rainfall limits the growth of grasses. Many of the soils in this association are suited to irrigation, but a lack of adequate ground water and a rough topography limit the development of irrigation. Ground water for irrigation is commonly below a depth of 200 feet, and sources are not always reliable. Wells generally yield ample quantities of good water for livestock and domestic uses. Controlling water erosion and soil blowing, conserving soil moisture, and maintaining soil fertility are concerns of management in cultivated areas.

Farm and ranch headquarters are scattered throughout the association. Two hard-surfaced roads cross the area. Gravel or graded roads and trails provide access to most of the area. Local livestock auctions and other markets are available for products of the ranches and farms.

Sandy Soils on Uplands and Foot Slopes

Two soil associations are in this group. The soils

are very gently sloping to steep and are well drained to excessively drained.

9. *Busher-Tassel-Vetal association*

Deep and shallow, very gently sloping to steep, well-drained to somewhat excessively drained sandy soils that formed in colluvium and in material weathered from sandstone; on uplands and foot slopes

This association consists of sandy soils on undulating to hilly uplands that are crossed by numerous creeks and intermittent drainageways. Rough, broken sides are along the deeply entrenched drainageways. The divides between drainageways are mainly rolling, but in some areas they are broad and gently undulating (fig. 7). Broad swales are between many of the ridges and knolls.

This association occupies about 8 percent of the county, or 74,000 acres. Busher soils make up 35 percent of the association; Tassel soils 32 percent; and Vetal soils 15 percent. Minor soils and land types make up the remaining 18 percent.

Busher soils are deep and very gently sloping to steep. They are mostly on middle and lower side slopes, and are also on rolling ridges and divides between drainageways. They formed in material weathered from sandstone. Their surface layer, transitional layer, and underlying material are loamy very fine sand. Fine-grained sandstone is at a depth of 40 to 60 inches.

Tassel soils are shallow and gently sloping to steep. They are on ridges, knolls, and breaks to drainageways. They formed in material weathered from sandstone on uplands. Their surface layer, transitional layer, and underlying material are calcareous loamy very fine sand. Fine-grained sandstone is at a depth of 10 to 20 inches.



Figure 7.—Typical landscape in the Busher-Tassel-Vetal association, on foot slopes of the Pine Ridge.

Vetal soils are deep and very gently sloping to steep. They are on concave foot slopes and in narrow valleys or swales. They formed in colluvium washed from higher slopes. Their surface layer, transitional layer, and underlying material are loamy very fine sand.

Minor in this association are soils in the Bayard, Jayem, and Sarben series and areas of Sandy alluvial land and Rock outcrop. Jayem and Sarben soils are on undulating uplands that formed from eolian material. Bayard soils are on concave foot slopes and stream terraces. Sandy alluvial land is on bottom lands of creeks and streams and is subject to flooding. Rock outcrop, which consists of sandstone bedrock, is on breaks to upland drainageways.

About 80 percent of this association is in native grass, which is used for grazing and hay. Ranching, the main enterprise, consists mainly of the production of feeder calves. Most ranchers grow dryfarmed alfalfa for winter feed. Farms in the area are mainly the combination cash grain-livestock type. Wheat is the main cash crop. Alfalfa and oats are grown and used mostly for feed.

A lack of seasonal rainfall limits the growth of grasses and grazing in most years. Many of the soils are suited to irrigation, but a lack of adequate ground water and a rolling topography limit the development of irrigation. Ground water in amounts adequate for irrigation is deep, and sources are not always reliable. Most wells supply ample quantities of good water for livestock and domestic use. Soil blowing and water erosion are hazards in cultivated areas. Conserving soil moisture and maintaining high soil fertility are concerns of management.

Ranch and farm headquarters are widely separated in the association. There are few gravel or graded roads. Unimproved roads or trails from these roads provide access where needed. Local markets are available for livestock and grain produced in the area.

10. Valent-Dwyer-Jayem association

Deep, gently sloping to steep, well-drained to excessively drained sandy soils; on uplands

This association consists of hummocky or dunelike upland areas whose topography is typical of a sandhills landscape. It is on both sides of the Niobrara River and in places is associated with several of the principal tributary creeks. Most of the sand formed in sandy alluvium deposited in valleys along the Niobrara River and a few of its main tributaries. The sand was reworked and blown out of the valley by wind.

This association occupies about 3 percent of the county, or 30,700 acres. Valent and Dwyer soils make up 68 percent of the association and Jayem soils 16 percent. Minor soils and land types make up the remaining 16 percent.

Valent soils are deep and gently sloping to steep. They are on rounded, rolling sandhills on uplands and are mixed with Dwyer soils. Their surface layer is loamy fine sand. Their transitional layer and underlying material are fine sand.

Dwyer soils are deep and gently sloping to steep. They are on rounded, rolling sandhills on uplands and are mixed with Valent soils. Their surface layer is

loamy fine sand. Their transitional layer and underlying material are calcareous fine sand.

Jayem soils are gently sloping to strongly sloping. They are undulating and rolling on uplands. They are less sandy than Valent and Dwyer soils. Their surface layer, subsoil, and underlying material are loamy very fine sand. Calcareous material is at a depth of 36 inches.

Minor in this association are soils in the Bankard, Busher, Sarben, Tassel, and Vetal series and areas of Gravelly alluvial land and Sandy alluvial land. Busher, Sarben, and Tassel soils are on sides of hills, ridges, and knolls on uplands. Vetal soils are on concave foot slopes and in swales. Bankard soils, Gravelly alluvial land, and Sandy alluvial land are on bottom lands along upland drainageways and are subject to flooding.

Nearly all of this association is in native grass, which is used for grazing. Ranching, the only important enterprise, consists mainly of the production of feeder calves. Most ranchers in this association also have holdings in the Bankard association, where they raise alfalfa for winter feed or cut native hay. Some small areas of dryfarmed alfalfa are in the Valent-Dwyer-Jayem association.

A lack of adequate rainfall limits the growth of grasses in most years, particularly during summer. Most wells yield ample quantities of good water for livestock and domestic use. Exposed areas are subject to soil blowing. Small blowouts are common on rangeland.

Very few ranch headquarters are in the association. Most of them are in adjacent areas along the Niobrara River. Few gravel or graded roads serve the area. Trails provide access where needed. Local auctions serve as markets for livestock raised on the ranches.

Silty and Sandy Soils on Bottom Lands and Stream Terraces

Two soil associations are in this group. The soils are nearly level to very gently sloping and are somewhat poorly drained to somewhat excessively drained.

11. Tripp-Haverson-Glenberg association

Deep, nearly level to very gently sloping, well-drained and somewhat excessively drained silty and sandy soils; on bottom lands and stream terraces

This association consists of bottom lands and stream terraces along the White River and its major tributaries. Most areas are nearly level, but a few are very gently sloping. Some of the bottom lands are subject to flooding, and some areas on the stream terraces are affected by salts and alkali. Meandering stream channels dissect this association. Trees are common along the White River and on the banks of most creeks.

This association occupies about 4 percent of the county, or 35,000 acres. Tripp soils make up 30 percent of the association; Haverson soils 27 percent; and Glenberg soils 15 percent. Minor soils and land types make up the remaining 28 percent.

Tripp soils are deep and nearly level or very gently sloping. They are higher on the landscape than the other major soils of this association. They formed in

silty and loamy alluvium on stream terraces. Their surface layer is silt loam. Their subsoil is calcareous silt loam, and the underlying material is calcareous very fine sandy loam.

Haverson soils are deep and nearly level to very gently sloping. They formed in silty and loamy alluvium on bottom lands. Some areas are flooded at times. Haverson soils have a surface layer of calcareous silt loam. The underlying material is stratified, calcareous very fine sandy loam that contains loam and silt loam in the upper part and calcareous silt loam in the middle and lower parts.

Glenberg soils are deep and nearly level to very gently sloping. They formed in sandy alluvium on bottom lands. They are generally slightly higher on the landscape than Haverson soils. Some areas are occasionally flooded. Glenberg soils have a surface layer and underlying material of calcareous loamy very fine sand. Coarse sand and gravel are below a depth of 40 inches.

Minor in this association are soils in the Bridget and Las Animas series and areas of Loamy alluvial land, Sandy alluvial land, and Saline-Alkali land. Bridget soils are on concave foot slopes and stream terraces, generally higher than Tripp soils. Las Animas soils are on bottom lands and have a water table at a depth of 2 to 6 feet. Loamy alluvial land and Sandy alluvial land are on the lowest part of the flood plains. Saline-Alkali land is on the lower parts of stream terraces.

About 80 percent of this association is in native grass, which is used for grazing. Most farmers and ranchers in this association have holdings in adjacent associations. The main ranching enterprise is the production of feeder calves. Farms are mostly combination cash grain-livestock types, and most of the cropland is outside of this association. Wheat, alfalfa, and oats are the main crops. Wheat is a cash crop. Alfalfa and oats are generally grown as livestock feed. Only a small acreage of cropland is irrigated, chiefly from nearby streams.

Soils in this association are suited to irrigation, but adequate quantities of surface water or ground water are not always available. Flooding should be controlled on some areas before they can be irrigated. Most wells yield ample quantities of water for livestock and domestic use. Salts and alkali are a concern in some places. Conserving soil moisture and maintaining a balanced high fertility are also concerns of management. In places the trees limit the use of the soils, but the wooded areas provide good habitat for wildlife.

Numerous farm and ranch headquarters are in this association, but most of the acreage of the farms and ranches extends into adjacent associations. Most areas are accessible by gravel or graded roads. Local markets are available for grain and livestock produced in the area.

12. Bankard association

Deep, nearly level to very gently sloping, somewhat poorly drained and somewhat excessively drained sandy soils; on bottom lands

This association consists of level to undulating bottom lands along the Niobrara River. The area has a

water table at a depth of 2 to about 10 feet. The somewhat poorly drained soils are moderately affected to strongly affected by alkali. Numerous small braided channels are in some places. A few scattered clumps of trees or brush are near the river.

This association occupies about 1 percent of the county, or 8,860 acres. Bankard variant soils make up 34 percent of the association and Bankard soils 31 percent. Minor soils and land types make up the remaining 35 percent.

Bankard variant soils are deep and nearly level to very gently sloping. They occupy low positions on bottom lands. They formed in sandy alluvium. Their surface layer and transitional layer are calcareous loamy fine sand. The underlying material is calcareous fine sand in the upper part and coarse sand in the lower part. The water table is at a depth of 2 to 6 feet.

Bankard soils are deep and nearly level to very gently sloping. They occupy high positions on bottom lands. They formed in sandy alluvium. Their surface layer and transitional layer are calcareous loamy fine sand. The underlying material is calcareous fine sand and sand.

Minor in this association are soils in the Bayard, Dwyer, Las Animas, Valent, and Vetal series and areas of Sandy alluvial land and Wet alluvial land. Bayard and Vetal soils are on foot slopes and stream terraces and are higher on the landscape than Bankard soils. Dwyer and Valent soils are nearly level to rolling and are in low dune-like areas of stream terraces. Las Animas soils occupy low positions and have a moderately high water table. Sandy alluvial land is in narrow low areas that are subject to frequent flooding. Wet alluvial land occupies lower positions on the landscape than Bankard variant soils. It has a water table that fluctuates from the surface to a depth of about 2 feet, and it is subject to occasional flooding.

Nearly all of this association is in native grass, which is used for grazing or for hay. Ranching, the main enterprise, consists of the production of feeder calves. Subirrigated meadows in the area are mowed for hay for winter feed. A small acreage of alfalfa, forage crops, and pasture is irrigated. Irrigation water comes from wells or is pumped from the Niobrara River. It is delivered to the soil by gravity and sprinkler irrigation systems. Water for crops, livestock, and domestic use is plentiful.

In low-lying areas, the high water table limits the use of the soils mainly to grass. Bankard soils have a low available water capacity and are droughty if dry-farmed. They are susceptible to soil blowing if cultivated. Areas upstream from the Box Butte Reservoir are subject to some flooding, mostly during spring. Box Butte Reservoir is a good recreational site, mainly for fishing and boating. Campsites and picnic sites are also available. The Niobrara River upstream from the reservoir provides fair to good trout fishing.

Only a small part of most of the ranches are in this association. Ranch headquarters are generally located in this association because of the abundant water supply. Part of the association is served by gravel or improved roads. Trails or unimproved roads provide access where needed. Local markets are available for livestock raised in the area.

Descriptions of the Soils

This section describes the soil series and mapping units in Dawes County. A soil series is described in detail, and then, briefly, each mapping unit in that series. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. Color terms are for dry soil unless otherwise stated. The profile described in the series is representative for mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are stated in describing the mapping unit, or they are differences that are apparent in the name of the mapping unit.

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

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

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the "Glossary" at the end of this survey, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (8).

A given soil series in this county may be identified by a different name in a recently published soil survey of an adjacent county. Some soil boundaries may not match adjoining areas. Such differences result from changes in concepts of soil classification that have occurred since publication.

Alliance Series

The Alliance series consists of deep, well-drained soils that formed in material weathered from sandstone. The soils are on uplands. Slopes range from 1 to 9 percent.

In a representative profile the surface layer is very friable, grayish-brown silt loam about 11 inches thick. The subsoil extends to a depth of 26 inches. It is light

brownish-gray, friable silty clay loam in the upper part; brown, friable silty clay loam in the middle part; and pale-brown, very friable silt loam in the lower part. The underlying material is light-gray very fine sandy loam to a depth of 60 inches. Lime is at a depth of 26 inches.

Permeability is moderate, and available water capacity is high. Natural fertility is medium, and organic-matter content is moderate. These soils are easy to work.

About half the acreage of Alliance soils is cultivated. These soils are suited to both dryfarmed and irrigated crops. Areas in native grass are used for grazing and hay. Alliance soils are suited to trees and shrubs, habitat for wildlife, and recreation.

Representative profile of Alliance silt loam, 1 to 3 percent slopes, in a cultivated field 1,600 feet north and 100 feet west of the southeast corner of sec. 26, T. 30 N., R. 51 W:

- Ap—0 to 8 inches, grayish-brown (10YR 5/2) silt loam, very dark brown (10YR 2/2) when moist; weak, fine, granular structure; soft, very friable; mildly alkaline; abrupt, smooth boundary.
- A12—8 to 11 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, subangular blocky structure parting to weak, fine, granular; slightly hard, very friable; mildly alkaline; clear, smooth boundary.
- B21t—11 to 15 inches, light brownish-gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure parting to moderate, medium and fine, subangular blocky; slightly hard, friable; mildly alkaline; clear, smooth boundary.
- B22t—15 to 20 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) when moist; weak, coarse, prismatic structure parting to moderate, medium and fine, subangular blocky; slightly hard, friable; mildly alkaline; clear, smooth boundary.
- B3—20 to 26 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) when moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; slightly hard, very friable; few, medium and coarse, sandstone fragments; mildly alkaline; clear, smooth boundary.
- C—26 to 60 inches, light-gray (10YR 7/2) very fine sandy loam, light brownish gray (10YR 6/2) when moist; massive; soft, very friable; many fine to coarse sandstone fragments; violent effervescence; moderately alkaline.

Depth to lime averages about 21 inches but ranges from 16 to 30 inches. In some areas, fine-grained sandstone is at a depth of 40 to 60 inches.

The A horizon is mainly silt loam, but loam, very fine sandy loam, and fine sandy loam are in some areas. It is dark gray to grayish brown and ranges from 7 to 14 inches in thickness. It is neutral or mildly alkaline.

The B2t horizon is heavy silt loam, silty clay loam, or clay loam that contains 25 to 35 percent clay. It is neutral or mildly alkaline.

The C horizon is silt loam, very fine sandy loam, fine sandy loam, or loamy very fine sand and generally contains numerous fragments of sandstone. It is mildly alkaline or moderately alkaline.

Alliance soils are near Rosebud, Keith, Oglala, and Richfield soils on the landscape. They are deeper over sandstone than Rosebud soils. They formed in material weathered from sandstone, and Keith and Richfield soils formed in loess. They have a silty B horizon that is lacking in Oglala soils.

AcB—Alliance silt loam, 1 to 3 percent slopes. This soil is mainly in smooth areas on uplands. Areas are as much as 500 acres in size.

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

Soil	Acres	Percent	Soil	Acres	Percent
Alliance silt loam, 1 to 3 percent slopes -----	20,250	2.3	Keith and Ulysses silt loams, 3 to 9 percent slopes -----	16,500	1.9
Alliance silt loam, 3 to 9 percent slopes -----	10,400	1.2	Keota silt loam, 1 to 3 percent slopes -----	1,300	.1
Alliance silt loam, 3 to 9 percent slopes, eroded -----	15,400	1.7	Keota-Epping silt loams, 3 to 9 percent slopes -----	3,950	.4
Badland -----	4,250	.5	Kyle silty clay, 0 to 1 percent slopes -----	6,000	.7
Bankard loamy fine sand, 0 to 2 percent slopes -----	3,500	.4	Kyle silty clay, 1 to 5 percent slopes -----	39,200	4.4
Bankard loamy fine sand, wet variant, 0 to 2 percent slopes -----	2,600	.3	Kyle-Slickspots complex, 0 to 2 percent slopes -----	7,300	.8
Breaks-Alluvial land complex -----	4,050	.5	Las Animas soils, 0 to 2 percent slopes -----	1,900	.2
Bridget silt loam, 0 to 1 percent slopes -----	5,000	.6	Loamy alluvial land -----	10,700	1.2
Bridget silt loam, 1 to 3 percent slopes -----	11,400	1.3	Minnequa silty clay loam, 1 to 5 percent slopes -----	770	(¹)
Bridget silt loam, 3 to 9 percent slopes -----	10,000	1.1	Minnequa silty clay loam, 5 to 12 percent slopes -----	3,500	.4
Bridget silt loam, 9 to 20 percent slopes -----	5,900	.6	Mitchell silt loam, 0 to 1 percent slopes -----	1,550	.2
Buffington silty clay, 0 to 1 percent slopes -----	2,050	.2	Mitchell silt loam, 1 to 5 percent slopes -----	790	(¹)
Buften silty clay loam, 0 to 1 percent slopes -----	3,100	.3	Mitchell silt loam, 5 to 9 percent slopes -----	3,750	.4
Buften silty clay loam, 1 to 3 percent slopes -----	4,400	.5	Mitchell silt loam, 9 to 20 percent slopes -----	16,200	1.8
Buften silty clay loam, 3 to 9 percent slopes -----	9,000	1.0	Mitchell-Epping silt loams, 9 to 30 percent slopes -----	3,000	.3
Buften silty clay loam, 9 to 20 percent slopes -----	4,150	.5	Norrest silty clay loam, 1 to 3 percent slopes -----	1,300	.1
Buften-Slickspots complex, 0 to 9 percent slopes -----	6,200	.7	Norrest silty clay loam, 3 to 9 percent slopes -----	6,800	.8
Busher loamy very fine sand, 1 to 5 percent slopes -----	2,850	.3	Norrest silty clay loam, 9 to 20 percent slopes -----	1,800	.2
Busher loamy very fine sand, 1 to 5 percent slopes, eroded -----	1,900	.2	Oglala loam, 9 to 30 percent slopes -----	10,000	1.1
Busher loamy very fine sand, 5 to 9 percent slopes -----	3,750	.4	Oglala-Canyon loams, 9 to 20 percent slopes -----	34,500	3.9
Busher loamy very fine sand, 5 to 9 percent slopes, eroded -----	2,750	.3	Orella silty clay loam, 3 to 30 percent slopes -----	7,900	.9
Busher loamy very fine sand, 9 to 20 percent slopes -----	7,800	.9	Orella-Badland complex, 3 to 50 percent slopes -----	12,100	1.4
Busher and Tassel loamy very fine sands, 5 to 20 percent slopes -----	12,200	1.4	Penrose-Shale outcrop complex, 10 to 50 percent slopes -----	1,150	.1
Canyon-Bridget-Rock outcrop association, steep -----	78,500	9.0	Penrose and Minnequa silty clay loams, 5 to 20 percent slopes -----	1,250	.1
Canyon soils, 3 to 30 percent slopes -----	20,250	2.3	Pierre silty clay, 1 to 5 percent slopes -----	4,500	.5
Canyon soils, 30 to 50 percent slopes -----	16,400	1.9	Pierre silty clay, 5 to 30 percent slopes -----	56,000	6.3
Clayey alluvial land -----	8,300	.9	Pierre-Slickspots complex, 3 to 9 percent slopes -----	12,000	1.4
Duroc very fine sandy loam, 1 to 3 percent slopes -----	6,800	.8	Richfield silt loam, 1 to 3 percent slopes -----	18,400	2.1
Epping silt loam, 3 to 30 percent slopes -----	2,300	.3	Rock outcrop-Canyon complex, 30 to 60 percent slopes -----	23,000	2.6
Epping-Badland complex, 3 to 50 percent slopes -----	6,500	.7	Rosebud silt loam, 1 to 3 percent slopes -----	5,800	.7
Glenberg loamy very fine sand, 0 to 3 percent slopes -----	1,700	.2	Rosebud-Canyon loams, 3 to 9 percent slopes -----	33,500	3.8
Glenberg loamy very fine sand, occasionally flooded, 0 to 3 percent slopes -----	3,350	.4	Saline-Alkali land -----	1,350	.2
Gravelly alluvial land -----	2,600	.3	Samsil silty clay, 3 to 30 percent slopes -----	61,000	6.8
Haverson silt loam, 0 to 3 percent slopes -----	1,250	.1	Samsil-Shale outcrop complex, 9 to 50 percent slopes -----	3,850	.4
Haverson silt loam, occasionally flooded, 0 to 3 percent slopes -----	5,700	.6	Sandy alluvial land -----	4,150	.5
Haverson silty clay loam, occasionally flooded, 0 to 3 percent slopes -----	2,050	.2	Sarben fine sandy loam, 1 to 5 percent slopes -----	2,700	.3
Jayem loamy very fine sand, 1 to 5 percent slopes -----	3,450	.4	Sarben fine sandy loam, 5 to 9 percent slopes -----	2,050	.2
Jayem loamy very fine sand, 5 to 9 percent slopes -----	3,100	.3	Sarben fine sandy loam, 9 to 30 percent slopes -----	1,950	.2
Jayem and Vetal loamy very fine sands, 5 to 9 percent slopes -----	3,350	.4	Sarben and Vetal loamy very fine sands, 9 to 30 percent slopes -----	7,900	.9
Kadoka silt loam, deep variant, 1 to 3 percent slopes -----	10,000	1.1	Schamber soils, 3 to 30 percent slopes -----	2,350	.3
Kadoka silt loam, deep variant, 3 to 9 percent slopes -----	12,400	1.4	Tassel soils, 3 to 30 percent slopes -----	19,700	2.2
Kadoka silt loam, deep variant, 3 to 9 percent slopes, eroded -----	14,700	1.7	Tripp silt loam, 0 to 1 percent slopes -----	6,100	.7
Keith silt loam, 1 to 3 percent slopes -----	15,000	1.7	Tripp silt loam, 1 to 3 percent slopes -----	2,500	.3
Keith silt loam, 3 to 9 percent slopes -----	6,000	.7	Tripp silt loam, saline-alkali, 0 to 2 percent slopes -----	1,850	.2
			Ulysses silt loam, 9 to 20 percent slopes -----	9,200	1.0
			Valent and Dwyer loamy fine sands, 0 to 3 percent slopes -----	3,700	.4
			Valent and Dwyer loamy fine sands, 3 to 17 percent slopes -----	21,000	2.4
			Vetal and Bayard soils, 1 to 5 percent slopes -----	12,500	1.4
			Wet alluvial land -----	2,100	.2
			Total land area -----	888,960	100.0
			Water areas greater than 40 acres -----	1,950	

¹ Less than 0.05 percent.

This soil has the profile described as representative for the series. In some areas lime is below a depth of 30 inches.

Included with this soil in mapping were small areas of Rosebud soils on high elevations, Duroc soils in swales, and Richfield soils.

If the surface is not protected, the hazards of soil blowing and water erosion are moderate on this soil. Runoff is slow.

Most areas of this soil are cultivated. Wheat, oats, and alfalfa are the principal crops. Wheat is the main cash crop. Nearly all the cropland is dryfarmed, but a few small areas are irrigated. Corn is the main irrigated crop. Areas in native grass or areas that have been reseeded to tame grasses are used for grazing or for hay. Capability units IIe-1, dryland, and IIe-4, irrigated; Silty range site; windbreak suitability group 4.

AcD—Alliance silt loam, 3 to 9 percent slopes. This soil is on uplands. Areas are as much as 300 acres in size.

This soil has a profile similar to the one described as representative for the series, but its surface layer is slightly thinner. In places a few small areas have a surface layer of very fine sandy loam, a few areas have a surface layer less than 7 inches thick, and in some areas lime is below a depth of 30 inches.

Included with this soil in mapping were a few areas of soils that have a surface layer of fine sandy loam. Areas of Rosebud soils that occupy higher positions on the landscape than this Alliance soil, Duroc soils in swales, and Keith soils were included, and they make up as much as 15 percent of some mapped areas.

Water erosion and soil blowing are the main hazards in cultivated areas. Runoff is medium.

Most of the acreage of this soil is in native grass, which is used for grazing or hay. This soil is suited to cultivation, but suitable management practices and cropping systems are needed to help control erosion. Winter wheat, alfalfa, and feed grain are the main crops. Capability units IIIe-1, dryland, and IIIe-4, irrigated; Silty range site; windbreak suitability group 4.

AcD2—Alliance silt loam, 3 to 9 percent slopes, eroded. This soil is on uplands. Areas are as much as 300 acres in size.

This soil has a profile similar to the one described as representative for the series, but about 50 percent of the area has a surface layer less than 7 inches thick. In places where the surface layer and the upper part of the subsoil have been mixed by cultivation, the surface layer is light silty clay loam. This soil includes areas where lime is at or near the surface, areas where the subsoil is thinner and less clayey than in the representative profile, and areas where the surface layer is light brownish gray or very pale brown.

Included with this soil in mapping were small areas of Duroc soils in swales and Rosebud, Oglala, Keith, and Bridget soils. In some areas outcrops of rock are common on knolls.

Water erosion and soil blowing are hazards if the soil surface is not protected. Natural fertility is medium, and organic-matter content is moderate except in the more eroded areas where natural fertility and organic-matter content are lower. Runoff is medium.

Nearly all the acreage of this soil is cultivated. Winter wheat, alfalfa, and oats are the main crops. Areas of this soil are suited to irrigation, but steepness of slopes and a lack of irrigation water limit the development of irrigation. Some areas are seeded to native or tame grasses and are used for grazing or hay. Capability units IIIe-1, dryland, and IIIe-4, irrigated; Silty range site; windbreak suitability group 4.

Badland

Ba—Badland (3 to 50 percent slopes). This land type consists mainly of exposed siltstone or silty and clay shale (fig. 8). The areas are generally moderately steep to very steep. Barren, eroded exposures of geological materials make up at least 75 percent of the mapped areas. Making up the other percentage are very shallow and shallow soils on side slopes and deep soils in the wide low areas that serve as drainageways.

Runoff is very rapid, and surface erosion is more rapid than the formation of soil.

A few grasses and weeds grow on the low-lying areas. The vegetated areas are small and scattered, and they are generally unsuited to grazing livestock. These areas provide some protection for wildlife, and they can be used as recreational areas. Capability unit VIIIs-8, dryland; not assigned a range site; windbreak suitability group 10.

Bankard Series

The Bankard series consists of deep, well-drained to somewhat excessively drained soils that formed in calcareous, stratified sandy alluvium. These soils are on bottom lands, mostly along the Niobrara River and its tributaries. Slopes range from 0 to 2 percent. The water table is at a depth of about 6 to 10 feet. Some areas are subject to occasional flooding.

In a representative profile the surface layer is very friable, brown loamy fine sand about 6 inches thick. Below this layer is a transitional layer of pale-brown loamy fine sand about 10 inches thick. The underlying material is pale-brown fine sand in the upper part and light-gray sand in the lower part. Lime is at the surface.

Permeability is rapid, and the available water capacity is low. Natural fertility is medium to low, and organic-matter content is low.

Most of the acreage of Bankard soils is in native grass, which is used for grazing or for hay. A few areas are cultivated. Bankard soils are suited to irrigated crops but are rarely used for this purpose. These soils are suited to trees and shrubs, habitat for wildlife, and recreation.

Representative profile of Bankard loamy fine sand, 0 to 2 percent slopes, in native grass 750 feet south and 300 feet east of the center of sec. 2, T. 29 N., R. 49 W:

A—0 to 6 inches, brown (10YR 5/3) loamy fine sand, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; soft, very friable; few medium sandstone fragments; slight effervescence; moderately alkaline; clear, smooth boundary.

AC—6 to 16 inches, pale-brown (10YR 6/3) loamy fine sand, grayish brown (10YR 5/2) when moist; weak,

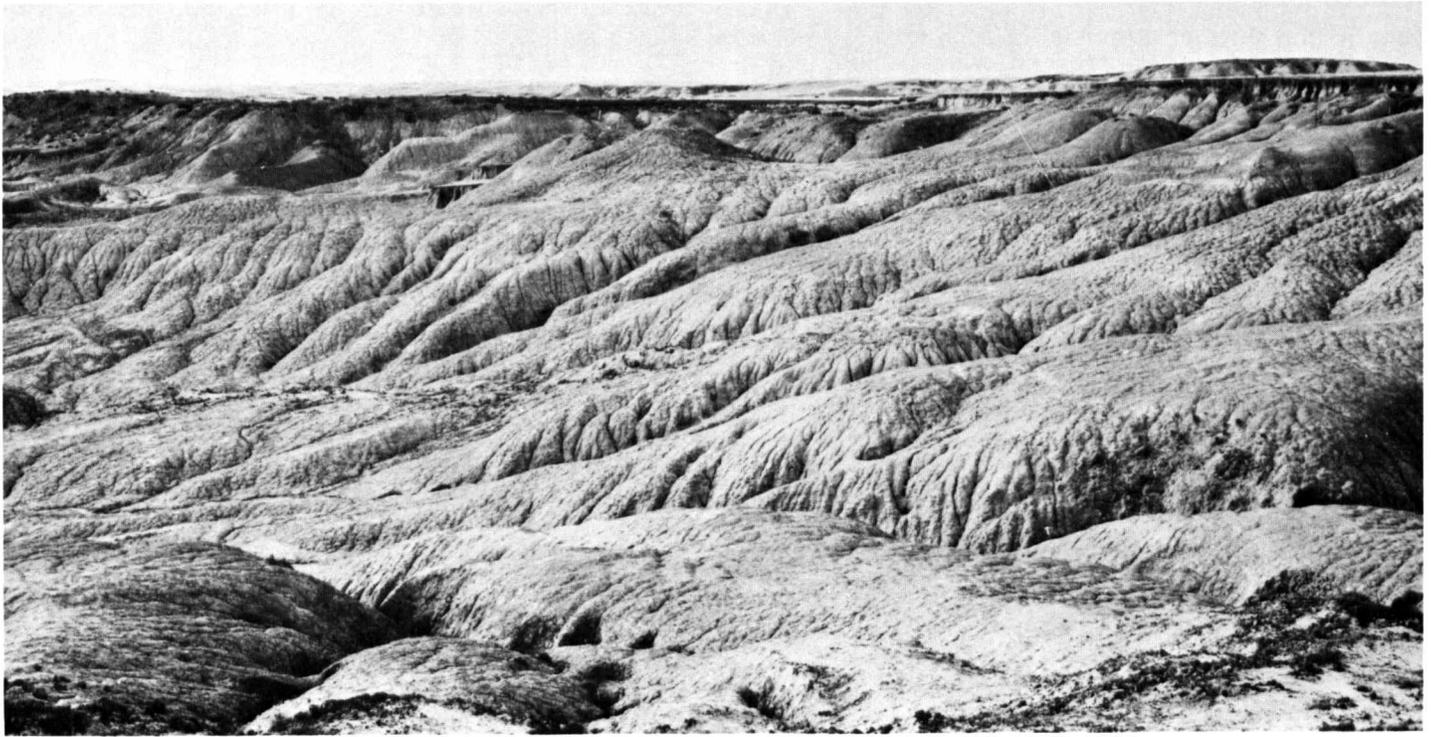


Figure 8.—A typical area of Badland.

medium, subangular blocky structure; soft, very friable; few medium sandstone fragments; strong effervescence; moderately alkaline; clear, smooth boundary.

C1—16 to 48 inches, pale-brown (10YR 6/3) fine sand, grayish brown (10YR 5/2) when moist; single grained; loose; few medium sandstone fragments; strong effervescence; moderately alkaline; clear, smooth boundary.

C2—48 to 60 inches, light-gray (10YR 7/2) sand, light brownish gray (10YR 6/2) when moist; single grained; loose; few medium sandstone fragments; strong effervescence; moderately alkaline.

Lime is typically at the surface but is leached from the upper few inches in some places.

The A horizon ranges from 4 to 10 inches in thickness. It is mostly loamy fine sand but includes fine sandy loam and fine sand. It ranges from dark grayish brown to light brownish gray.

The C horizon is loamy fine sand, fine sand, or sand. In some places it is stratified and has thin layers that range from silt loam to coarse sand.

Bankard soils are near Bankard variant, Glenberg, and Las Animas soils on the landscape. They have better natural drainage than Bankard variant soils. They have more sand in the C1 horizon than Glenberg soils. They have better natural drainage and have more sand in the C horizon than Las Animas soils.

Bc—Bankard loamy fine sand, 0 to 2 percent slopes. This soil is on bottom lands. Areas are as much as 300 acres in size. In places the surface is uneven because of drainage channels or because it has been reworked and roughened by the wind. Some areas are subject to occasional flooding.

Some small areas of this soil have a surface layer of fine sand 10 to 15 inches thick. Included in mapping were small areas of soils that have a surface layer of fine sandy loam. Bankard variant soils and Glenberg

soils, both slightly lower on the landscape than this Bankard soil, were included and make up as much as 15 percent of some mapped areas.

Low available water capacity and susceptibility to soil blowing limit the use of this soil for dryland cultivation. The soil is droughty unless rainfall is timely. Runoff is slow.

Most of the acreage of this soil is in native grass and is used for grazing. A few areas are cultivated, and alfalfa is the main crop. In places the alfalfa is irrigated. Capability units IVE-5, dryland, and IVE-11, irrigated; Sandy Lowland range site; windbreak suitability group 3.

Bankard Variant

These variant soils consist of deep, somewhat poorly drained soils that formed in sandy alluvium. These soils are on bottom lands along the Niobrara River and its tributaries. Slopes range from 0 to 2 percent. The water table is at a depth of 2 to 4 feet. Some areas are subject to occasional flooding.

In a representative profile the surface layer is very friable, grayish-brown loamy fine sand about 6 inches thick. Below this layer is a transitional layer of light brownish-gray loamy fine sand about 14 inches thick. The underlying material is light-gray mottled fine sand in the upper part and white coarse sand that contains small fragments of calcareous sandstone in the lower part. Lime is at the surface.

Permeability is rapid, and the available water capacity is low. Natural fertility is medium or low, and organic-matter content is low.

Most areas of these soils are in native grass, which is used for hay or grazing. A few small areas are cultivated. The moderately high water table subirrigates the soil and provides additional moisture for growing crops during periods of light rainfall. These soils are suited to trees and shrubs, habitat for wildlife, and recreation.

Representative profile of Bankard loamy fine sand, wet variant, 0 to 2 percent slopes, in native grass 2,400 feet west and 25 feet south of the northeast corner of the southeast quarter of sec. 35, T. 29 N., R. 51 W:

- A—0 to 6 inches, grayish-brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; soft, very friable; strong effervescence; moderately alkaline; clear, smooth boundary.
- AC—6 to 20 inches, light brownish-gray (10YR 6/2) loamy fine sand, grayish brown (10YR 5/2) when moist; weak, medium, subangular blocky structure; soft, very friable; strong effervescence; strongly alkaline; gradual, smooth boundary.
- C1—20 to 48 inches, light-gray (10YR 7/2) fine sand, light brownish gray (10YR 6/2) when moist; many, medium, distinct mottles, light yellowish-brown (10YR 6/4) when moist; single grained; loose; strong effervescence; strongly alkaline; abrupt, smooth boundary.
- C2—48 to 60 inches, white (10YR 8/2) coarse sand, light gray (10YR 7/2) when moist; single grained; loose; few, medium and fine, calcareous sandstone fragments; mildly alkaline.

The A horizon ranges from 4 to 7 inches in thickness. It is mostly loamy fine sand but is fine sandy loam and fine sand in places. It is dark gray to grayish brown.

The C horizon is loamy fine sand, very fine sand, sand, or coarse sand. It ranges from grayish brown to white. In places it is thinly stratified and contains material that ranges from silt loam to loamy sand. Lime is lacking in the lower part of the C horizon in some places.

Bankard variant soils are near Bankard and Las Animas soils on the landscape. They have poorer natural drainage than Bankard soils. They have a coarser textured C horizon than Las Animas soils.

Bd—Bankard loamy fine sand, wet variant, 0 to 2 percent slopes. This soil is on bottom lands. The water table is at a depth of 2 to 6 feet.

In some places the soil has a surface layer of fine sand. Included in mapping were areas of soils that have a surface layer of fine sandy loam and a few small areas of soils that are strongly affected by salts and alkali. Las Animas soils and Wet alluvial land, both lower on the landscape than this Bankard variant, were included, and they make up as much as 15 percent of some mapped areas.

The water table subirrigates this soil and provides moisture for crops. Where dryfarmed, the soil is droughty, but deep-rooted crops receive some benefit from subirrigation during dry periods. Before this soil is irrigated, surface drainage ditches or tile drainage systems are needed to lower the water table. Soil blowing is a hazard if the soil surface is not protected. In some areas, white salts are visible on the surface early in spring. A few areas are subject to occasional flooding. Runoff is slow.

Nearly all areas of this soil are in native grass and are used for hay and grazing. The soil is marginal for cultivation, and a few areas are in alfalfa or forage crops. Capability units IVw-5, dryland, and IVw-11,

irrigated; Subirrigated range site; windbreak suitability group 2.

Bayard Series

The Bayard series consists of deep, well-drained soils that formed in sandy alluvium and colluvium on foot slopes and stream terraces. Slopes range from 1 to 5 percent.

In a representative profile the surface layer is very friable, grayish-brown loamy very fine sand about 10 inches thick. Below this layer is a transitional layer of light brownish-gray, very friable loamy very fine sand about 5 inches thick. The underlying material is loamy very fine sand that is very pale brown in the upper part, gray in the middle part, and white in the lower part. Lime is at a depth of 10 inches.

Permeability is moderately rapid, and available water capacity is moderate. Natural fertility is medium, and organic-matter content is moderate.

Bayard soils are suited to both dryfarmed and irrigated crops. They are suited to grass, trees and shrubs, habitat for wildlife, and recreation.

In Dawes County, Bayard soils are mapped only in an undifferentiated group with Vetal soils.

Representative profile of Bayard loamy very fine sand, in an area of Vetal and Bayard soils, 1 to 5 percent slopes, in a cultivated field 500 feet south and 50 feet east of the northwest corner of sec. 3, T. 31 N., R. 52 W:

- Ap—0 to 6 inches, grayish-brown (10YR 5/2) loamy very fine sand, dark brown (10YR 3/3) when moist; weak, fine, granular structure; soft, very friable; mildly alkaline; abrupt, smooth boundary.
- A12—6 to 10 inches, grayish-brown (10YR 5/2) loamy very fine sand, very dark grayish brown (10YR 3/2) when moist; weak, medium, subangular blocky structure parting to weak, medium and fine, granular; soft, very friable; mildly alkaline; clear, smooth boundary.
- AC—10 to 15 inches, light brownish-gray (10YR 6/2) loamy very fine sand, dark grayish brown (10YR 4/2) when moist; weak, medium and coarse, subangular blocky structure parting to weak, fine, subangular blocky; soft, very friable; slight effervescence; mildly alkaline; clear, smooth boundary.
- C1—15 to 32 inches, very pale brown (10YR 7/3) loamy very fine sand, brown (10YR 5/3) when moist; weak, coarse, subangular blocky structure parting to weak, medium, subangular blocky; soft, very friable; strong effervescence; mildly alkaline; clear, smooth boundary.
- C2—32 to 42 inches, gray (10YR 6/1) loamy very fine sand, dark gray (10YR 4/1) when moist; weak, coarse, subangular blocky structure parting to weak, medium, subangular blocky; soft, very friable; strong effervescence; mildly alkaline; clear, smooth boundary.
- C3—42 to 60 inches, white (10YR 8/2) loamy very fine sand, light brownish gray (10YR 6/2) when moist; massive; soft, very friable; violent effervescence; moderately alkaline.

Depth to lime averages about 10 inches but ranges from 0 to 24 inches.

The A horizon ranges from very dark gray to grayish brown. It is loamy very fine sand to very fine sandy loam and ranges from 7 to 20 inches in thickness.

The AC horizon ranges from 4 to 14 inches in thickness.

The C horizon is mostly loamy very fine sand or fine sandy loam, but in some places the lower part is loamy sand.

Bayard soils are near Glenberg, Jayem, and Vetal soils on the landscape. They have a thicker A horizon than Glenberg

soils. They lack the B horizon that is characteristic of Jay-em soils. They have a thinner A horizon than Vetal soils.

Breaks-Alluvial Land Complex

Bf—Breaks-Alluvial land complex (0 to 50 percent slopes). This complex is along upland drainageways. Areas are as much as 100 acres in size. Breaks make up 40 to 70 percent of each mapped area, and Alluvial land makes up the remaining 30 to 50 percent.

Breaks consist of very steep, deep, loamy material on side slopes. Slopes range from 30 to 50 percent. Alluvial land consists of light-colored, nearly level alluvial sediment that has accumulated on the narrow bottom lands between the Breaks. Alluvial land is subject to flooding.

Included with this complex in mapping were small areas where sand and gravel crop out. Also included were some very steep, loamy terrace escarpments that support little or no vegetation.

Nearly all of the complex is used for grazing. Breaks support mostly native grasses and a few shrubs. Alluvial land supports some trees and a mixture of grasses and weeds. The complex is not suited to cultivated crops or to windbreaks, but it provides good habitat for wildlife. Capability unit VIe-7, dryland; Breaks in Thin Loess range site, Alluvial land in Silty Overflow range site; windbreak suitability group 10.

Bridget Series

The Bridget series consists of deep, well-drained soils that formed in loamy colluvial and alluvial sediment on foot slopes and on stream terraces. Slopes range from 0 to 20 percent.

In a representative profile the surface layer is very friable silt loam about 14 inches thick. The upper 6 inches is grayish brown, and the lower 8 inches is gray. A transitional layer of grayish-brown silt loam is about 4 inches thick. The underlying material is very pale brown very fine sandy loam to a depth of 60 inches. Lime is at a depth of 18 inches.

Permeability is moderate, and the available water capacity is high. Natural fertility is medium, and organic-matter content is moderate. These soils are easy to work.

In areas where slopes are less than 9 percent, these soils are used mostly for cultivated dryfarmed crops. They are suited to irrigation. In areas where slopes are greater than 9 percent, these soils are mostly in native grass and are used for grazing and as hayland. Bridget soils are well suited to trees and shrubs, to production of food and cover for wildlife, and for recreation.

Representative profile of Bridget silt loam, 1 to 3 percent slopes, in a cultivated field 1,500 feet north and 50 feet east of the southwest corner of sec. 5, T. 31 N., R. 50 W:

Ap—0 to 6 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft, very friable; mildly alkaline; abrupt, smooth boundary.

A12—6 to 14 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) when moist; weak, coarse, subangular blocky structure parting to weak, fine, granular; soft, very friable; mildly alkaline; clear, smooth boundary.

AC—14 to 18 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, subangular blocky structure parting to weak, fine, subangular blocky; soft, very friable; mildly alkaline; abrupt, wavy boundary.

C—18 to 60 inches, very pale brown (10YR 7/3) very fine sandy loam, pale brown (10YR 6/3) when moist; weak, coarse, subangular blocky structure; soft, very friable; few siltstone fragments; violent effervescence; moderately alkaline.

Lime is commonly at a depth of 10 to 20 inches, but it is at the surface in some cultivated fields.

The A horizon is mostly silt loam, but very fine sandy loam is also common. It is dark gray to grayish brown and ranges from 7 to 20 inches in thickness. It is neutral or mildly alkaline.

The C horizon is mostly very fine sandy loam, but silt loam and loam are common. It is mildly alkaline or moderately alkaline.

Bridget soils are near Bayard, Duroc, Mitchell, and Tripp soils on the landscape. They have a finer texture than Bayard soils. They have a thinner A horizon than Duroc soils and a thicker A horizon than Mitchell soils. They lack the B2 horizon and the B3ca horizon that are characteristic of Tripp soils.

Bg—Bridget silt loam, 0 to 1 percent slopes. This soil is on foot slopes and on stream terraces adjacent to small drainageways and streams. Areas are as much as 200 acres in size.

This soil has a profile similar to the one described as representative for the series, but the surface layer is 14 to 20 inches thick. In places the surface layer and the transitional layer are very fine sandy loam.

Included with this soil in mapping were areas of Duroc and Bayard soils, which make up as much as 25 percent of the mapped areas.

In places soil blowing is a hazard in cultivated areas. Runoff is slow. Conserving moisture is a concern of management.

A large acreage of this soil is cultivated and is dryfarmed. Wheat and alfalfa are the principal crops. This soil is suited to irrigation. Capability units IIc-1, dryland, and I-6, irrigated; Silty range site; windbreak suitability group 4.

BgB—Bridget silt loam, 1 to 3 percent slopes. This soil is on foot slopes and stream terraces near large drainageways. Areas are as much as 500 acres in size.

This soil has the profile described as representative for the series. In places the surface layer is light brownish gray; in other places lime is at a depth of 20 to 42 inches; and in still other places buried soils are below a depth of 24 inches.

Included with this soil in mapping were areas of soils that occupy slightly higher positions than this Bridget soil. The soils have a surface layer or transitional layer of fine sandy loam. Bayard soils, mainly on high elevations, were included, and they make up as much as 15 percent of some mapped areas.

Water erosion or gulying are hazards in areas that receive runoff from adjacent slopes. Soil blowing is a hazard if the soil surface is unprotected. Runoff is slow to medium.

Nearly all areas of this soil are dryfarmed to wheat, oats, or alfalfa. Areas in native grass are used for grazing and hay. Capability units IIe-1, dryland, and IIe-6, irrigated; Silty range site; windbreak suitability group 4.

BgD—Bridget silt loam, 3 to 9 percent slopes. This

soil is on colluvial foot slopes on uplands. Areas are as much as 200 acres in size.

This soil has a profile similar to the one described as representative for the series, but its surface layer is slightly thinner. In some areas the surface layer is more than 20 inches thick; in other areas the surface layer is very fine sandy loam; and in still other areas the surface layer is light brownish gray to pale brown. In places lime is below a depth of 20 inches.

Included with this soil in mapping were soils in higher areas than this Bridget soil that have a surface layer of fine sandy loam. Some areas of Bayard, Keith, or Rosebud soils in the Pine Ridge make up as much as 25 percent of the mapped areas. A few areas of Rock outcrop were also included.

Water erosion is a hazard because of runoff received from adjacent higher areas. Soil blowing is a hazard if the soil surface is unprotected. Runoff is medium.

About half the acreage of this soil is in native grass and is used for range. Cultivated areas are dryfarmed to wheat, oats, or alfalfa. A small acreage is seeded to tame grasses and is used for grazing and hay. Capability units IIIe-1, dryland, and IIIe-6, irrigated; Silty range site; windbreak suitability group 4.

BgF—Bridget silt loam, 9 to 20 percent slopes. This soil is on colluvial foot slopes. It is extensive in the Pine Ridge. Areas are as much as 200 acres in size.

This soil has a profile similar to the one described as representative for the series, but its surface layer is only 7 to 14 inches thick. In some areas the surface layer is more than 20 inches thick; in others the surface layer is light brownish gray to pale brown; and in still others the surface layer is very fine sandy loam. There are some areas where lime is below a depth of 20 inches.

Included with this soil in mapping were a few soils in higher areas than this Bridget soil that have a surface layer of fine sandy loam. Some areas of Bayard, Canyon, Oglala, and Ulysses soils in the Pine Ridge make up about 25 percent of the mapped areas.

Water erosion is a serious hazard if this soil is cultivated. Soil blowing is a hazard if the soil surface is not protected. Runoff is medium to rapid, depending on the degree of slope.

Nearly all areas of this soil are in native grass. Some formerly cultivated areas have been seeded to grass, which is used for grazing or hay. Some areas of this soil that have slopes of 9 to 12 percent are cultivated along with more gently sloping soils, but this soil is generally too steep for cultivation. Capability unit VIe-1, dryland; Silty range site; windbreak suitability group 4.

Buffington Series

The Buffington series consists of deep, well-drained soils that formed in alluvial material weathered from clay shales and siltstone. These soils are on stream terraces along the White River and its tributaries. Slopes range from 0 to 1 percent.

In a representative profile the surface layer is firm, grayish-brown silty clay about 11 inches thick. The subsoil is light-gray silty clay loam about 7 inches thick. The underlying material is light silty clay loam

that is white in the upper part and very pale brown in the lower part. Lime is at the surface.

Permeability is moderately slow, and the available water capacity is high. Natural fertility is medium to low, and organic-matter content is moderately low. These soils have poor tilth and are difficult to work. Because of the silty clay surface layer, they shrink when they dry out, and large cracks form at the surface. These soils absorb moisture slowly.

These soils are suited to both dryfarmed and irrigated crops. They are suited to grass, trees and shrubs, and production of food and cover for wildlife.

Representative profile of Buffington silty clay, 0 to 1 percent slopes, in a cultivated field 2,400 feet east and 50 feet north of the southwest corner of sec. 30, T. 33 N., R. 50 W:

- Ap—0 to 5 inches, grayish-brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; hard, firm; slight effervescence; mildly alkaline; abrupt, smooth boundary.
- A12—5 to 11 inches, grayish-brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) when moist; moderate, medium and fine, granular structure; hard, firm; slight effervescence; mildly alkaline; clear, smooth boundary.
- B2—11 to 18 inches, light-gray (10YR 7/2) silty clay loam, grayish brown (10YR 5/2) when moist; weak, fine, subangular blocky structure; hard, firm; strong effervescence; moderately alkaline; gradual, smooth boundary.
- C1—18 to 28 inches, white (10YR 8/2) light silty clay loam, light brownish gray (10YR 6/2) when moist; weak, medium and fine, subangular blocky structure; slightly hard, friable; violent effervescence; strongly alkaline; gradual, smooth boundary.
- C2—28 to 60 inches, very pale brown (10YR 8/3) light silty clay loam, pale brown (10YR 6/3) when moist; weak, medium, subangular blocky structure; slightly hard, friable; violent effervescence; alkaline.

Lime is typically at the surface, but in places it is leached from the upper few inches.

The A horizon ranges from 7 to 16 inches in thickness. It is dark grayish brown to grayish brown.

The AC horizon ranges from 3 to 14 inches in thickness. It is silty clay or silty clay loam.

The C horizon is silty clay loam or silt loam.

Buffington soils are near Bufton, Kyle, and Tripp soils on the landscape. They have a thicker A horizon than Bufton soils. They have less clay in the B horizon than Kyle soils. They are more clayey and have lime closer to the surface than Tripp soils.

Bh—Buffington silty clay, 0 to 1 percent slopes. This soil is on stream terraces along the White River and Cottonwood Creek. Areas are as much as 500 acres in size.

Small areas of this soil have a surface layer less than 7 inches thick. Included in mapping were small areas of Bufton soils and soils in shallow depressions that are severely affected by salts and alkali. Also included are areas of Tripp soils on stream terraces and Kyle soils in swales. Included soils generally make up less than 15 percent of the mapped areas.

This soil puddles easily if worked when too wet. It lacks good tilth. Good stands of crops are difficult to establish in places. Soil blowing is a hazard if the surface is unprotected. Runoff is slow.

Nearly all of the acreage of this soil is used for crops. Irrigated alfalfa is the main crop. Areas in grass are used for range or hay. Capability units

IIIs-2, dryland, and IIIs-1, irrigated; Clayey range site; windbreak suitability group 4.

Bufton Series

The Bufton series consists of deep, well-drained soils that formed in material weathered from silty shale, in a mixture of materials weathered from silty shale and siltstone, or in colluvial and alluvial sediment weathered from these materials. In some areas the weathered material has been reworked and redeposited by wind. These soils are on uplands and stream terraces. Slopes range from 0 to 20 percent.

In a representative profile the surface layer is firm, grayish-brown silty clay loam about 6 inches thick. The subsoil is about 30 inches thick. It is light brownish-gray, very firm heavy silty clay loam in the upper part, light-gray, very firm heavy silty clay loam in the middle part, and light-gray, firm heavy silty clay loam in the lower part. The underlying material is light-gray heavy silty clay loam. Lime is at the surface.

Permeability is slow to moderately slow, and the available water capacity is high. Natural fertility is low, and organic-matter content is moderately low.

Most areas of Bufton soils are in native or tame grasses, which are used for grazing or hay. A few areas are cultivated. Most of these soils are dryfarmed, but they are suited to irrigation. Bufton soils are suited to trees and shrubs and to production of food and cover for wildlife.

Representative profile of Bufton silty clay loam, 3 to 20 percent slopes, in native grass 2,400 feet west and 200 feet north of the southeast corner of sec. 17, T. 32 N., R. 50 W:

- A—0 to 6 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium and fine, subangular blocky structure parting to moderate, fine, granular; hard, firm; strong effervescence; moderately alkaline; clear, smooth boundary.
- B21—6 to 15 inches, light brownish-gray (10YR 6/2) heavy silty clay loam, grayish brown (10YR 5/2) when moist; moderate, medium and coarse; prismatic structure parting to moderate, medium and fine, subangular blocky; very hard, very firm; violent effervescence; moderately alkaline; clear, smooth boundary.
- B22—15 to 26 inches, light-gray (10YR 7/2) heavy silty clay loam, grayish brown (10YR 5/2) when moist; moderate, medium and coarse, prismatic structure parting the moderate, medium and coarse, subangular blocky; very hard, very firm; violent effervescence; moderately alkaline; clear, wavy boundary.
- B3ca—26 to 36 inches, light-gray (10YR 7/2) heavy silty clay loam, grayish brown (10YR 5/2) when moist; moderate, coarse, prismatic structure parting to weak, coarse, subangular blocky; hard, firm; violent effervescence; strongly alkaline; gradual, wavy boundary.
- C—36 to 60 inches, light-gray (2.5Y 7/2) heavy silty clay loam, grayish brown (2.5Y 5/2) when moist; weak, coarse, prismatic structure; hard, firm; violent effervescence; moderately alkaline.

Lime is generally at the surface, but in places it is leached to depths below the A horizon. Glass shards are present throughout the profile and are abundant in the residual shale material in the C horizon. Bedded silty shale is common at a depth of 40 to 60 inches. Chalcedony fragments are commonly on the surface and throughout the profile.

The A horizon ranges from 2 to 7 inches in thickness. It is dark grayish brown to light brownish gray. It is mostly

silty clay loam, but silt loam or clay loam is common. It is mildly alkaline to moderately alkaline.

The B2 horizon is clay loam, silty clay loam, or light clay that is 35 to 45 percent clay. Some thin layers are more than 50 percent clay. The B2 horizon is mildly alkaline to strongly alkaline.

The B3ca and C horizons are clay loam, silty clay loam, or light clay. They are moderately alkaline to strongly alkaline.

Bufton soils are near Keith, Kyle, Norrest, and Orella soils on the landscape. They have a thinner A horizon and contain more clay than Keith soils. They contain less clay than Kyle soils. They are deeper than Orella and Norrest soils.

Bn—Bufton silty clay loam, 0 to 1 percent slopes. This soil is on uplands and stream terraces. Areas are as much as 100 acres in size.

This soil has a profile similar to the one described as representative for the series, but its subsoil and underlying material are less clayey. In some places the surface layer is 2 to 4 inches thick.

Included with this soil in mapping were areas of soils in which the underlying material contains pebbles. Also included were small areas of Tripp soils on stream terraces and small areas of soils in shallow depressions that are strongly affected by salts and alkali.

This soil puddles readily if it is worked or grazed when wet. It is somewhat droughty. Soil blowing is a hazard in cultivated areas. Runoff is slow.

About half the acreage of this soil is used for crops and half for range. Areas in native or tame grasses are grazed or cut for hay. Cultivated areas are mostly dryfarmed to alfalfa, wheat, and oats. Capability units IIIs-2, dryland, and IIIs-3, irrigated; Limy Upland range site; windbreak suitability group 4.

BnB—Bufton silty clay loam, 1 to 3 percent slopes. This soil is on uplands and stream terraces. Areas are as much as 300 acres in size.

This soil has a profile similar to the one described as representative for the series, but its subsoil and underlying material are less clayey. In some places the surface layer is 2 to 4 inches thick and lime is at a depth of 18 inches, and in some areas the subsoil is silty clay. In some places weathered shale is at a depth of 40 to 60 inches.

Included with this soil in mapping were some areas of Norrest and Orella soils that make up as much as 15 percent of the mapped areas. Also included were a few areas of soils in depressions that are strongly affected by salts and alkali.

This soil puddles if worked or grazed when too wet. Water erosion and soil blowing are hazards in cultivated areas. Conserving soil moisture is a major concern of management. Runoff is medium.

Most of the acreage of this soil is in native grass and is used for grazing or hay. Some areas are seeded to tame grasses. Cultivated areas are mostly dryfarmed to alfalfa, wheat, and oats. Capability units IIIe-1, dryland, and IIIe-3, irrigated; Limy Upland range site; windbreak suitability group 4.

BnD—Bufton silty clay loam, 3 to 9 percent slopes. This soil is on uplands and colluvial foot slopes. Areas are as much as 300 acres in size.

This soil has the profile described as representative for the series. In some places the surface layer is 2 to 4 inches thick, and in other places lime is at a depth of 18 inches. In other areas weathered shale is at a depth of 40 to 60 inches.

Included with this soil in mapping were areas of soils that have a surface layer and a subsoil of silt loam and small areas of soils in shallow depressions that are affected by salts and alkali. Also included were small areas of Norrest, Orella, and Richfield soils. Inclusions make up less than 25 percent of the mapped areas.

Water erosion is the main hazard, but soil blowing is a hazard in some cultivated areas. Conserving soil moisture is a major concern of management. This soil puddles if worked or grazed when too wet. It takes in water slowly, and if rainfall is not timely it tends to be somewhat droughty. Runoff is medium to rapid.

Most areas of this soil are in native grass or tame grass and are used for grazing or hay. Cultivated areas are dryfarmed, mostly to alfalfa, wheat, and oats. Capability units IVE-1, dryland, and IVE-3 irrigated; Limy Upland range site; windbreak suitability group 4.

BnF—Bufton silty clay loam, 9 to 20 percent slopes. This soil is on smooth upland slopes and along sides of upland drainageways. Areas are as much as 300 acres in size.

This soil has a profile similar to the one described as representative for the series, but its subsoil is thinner. In some places the surface layer is 2 to 4 inches thick. Included in mapping were areas of Norrest, Mitchell, and Orella soils, which make up as much as 25 percent of the mapped areas.

The hazard of water erosion is very severe if this soil is not protected by a good grass cover. Runoff is rapid.

Nearly all areas of this soil are in native grass and are used for grazing or hay. This soil is not suited to crops, because of steepness of slope. Capability unit VIe-1, dryland; Limy Upland range site; windbreak suitability group 4.

BoD—Bufton-Slickspots complex, 0 to 9 percent slopes. This complex is on stream terraces and colluvial-alluvial foot slopes along upland drainageways. Areas are as much as 200 acres in size. Bufton silty clay loam makes up 50 to 80 percent of this complex, and Slickspots make up the remaining 20 to 50 percent.

The Bufton soil has a profile similar to the one described as representative for the Bufton series, but it is moderately affected to strongly affected by salts or alkali between depths of 10 and 36 inches. The Slickspots have characteristics similar to those described for Slickspots. They are in small, shallow, irregularly shaped depressions within areas of Bufton soils. They give the area a pockmarked appearance. Bufton soil is 3 to 12 inches higher on the landscape than the Slickspots.

Included with this complex in mapping were areas of Bufton soils that occupy higher positions than this Bufton soil and that have a surface layer of fine sandy loam 10 to 12 inches thick.

Surface water ponds in the depressions. Runoff is very slow to medium depending on the slope and vegetation.

Except for a few small areas that are cultivated along with larger areas of more suitable soils, all of this complex is in native grass and is used for grazing. Vegetation is sparse in areas of Slickspots, and some

areas are bare. This complex is not suited to cultivated crops. Capability unit VIe-1, dryland; Bufton soil in Saline Lowland range site, Slickspots in Panspots range site; Bufton soil in windbreak suitability group 4, Slickspots in windbreak suitability group 10.

Busher Series

The Busher series consists of deep, well drained to somewhat excessively drained soils that formed in material weathered from sandstone. These soils are on uplands. Slopes range from 1 to 20 percent.

In a representative profile the surface layer is very friable, grayish-brown loamy very fine sand about 10 inches thick. Below this layer is a transitional layer of light brownish-gray loamy very fine sand about 14 inches thick. The underlying material is loamy very fine sand that is light brownish gray in the upper part and light gray in the lower part. White, partly weathered, fine-grained sandstone is at a depth of 44 inches. Lime is at a depth of 29 inches.

Permeability is moderately rapid, and the available water capacity is moderate. Natural fertility is medium to low, and organic-matter content is moderate.

Busher soils are mostly in native grasses, which are used for grazing or for hay. Where slopes are less than 9 percent, these soils are suited to cultivation and irrigation. These soils are suited to trees and shrubs and production of food and cover for wildlife.

Representative profile of Busher loamy very fine sand, 9 to 20 percent slopes, in native grass 2,100 feet north and 100 feet west of the southeast corner of sec. 36, T. 31 N., R. 52 W:

- A—0 to 10 inches, grayish-brown (10YR 5/2) loamy very fine sand, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft, very friable; neutral; gradual, smooth boundary.
- AC—10 to 24 inches, light brownish-gray (10YR 6/2) loamy very fine sand, dark grayish-brown (10YR 4/2) when moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; soft, very friable; neutral; gradual, wavy boundary.
- C1—24 to 29 inches, light brownish-gray (10YR 6/2) loamy very fine sand, brown (10YR 5/3) when moist; weak, coarse, prismatic structure parting to weak, coarse, subangular blocky; soft, very friable; few fine sandstone fragments; neutral; clear, wavy boundary.
- C2—29 to 44 inches, light-gray (10YR 7/2) loamy very fine sand, light brownish gray (10YR 6/2) when moist; weak, coarse, prismatic structure; soft, very friable; strong effervescence; many, medium and coarse, sandstone fragments; moderately alkaline; gradual, wavy boundary.
- C3—44 to 60 inches, white (10YR 8/2), partially weathered, fine-grained sandstone, light brownish gray (10YR 6/2) when moist; strong effervescence; moderately alkaline.

Depth to lime averages about 30 inches but ranges from 18 to 60 inches or more. Soft fragments of sandstone are throughout the profile but are common in the C horizon. Glass shards are common throughout the profile.

The A horizon is dark grayish-brown to brown fine sandy loam or loamy very fine sand. It ranges from 7 to 20 inches in thickness. It is neutral to mildly alkaline.

The AC horizon ranges from 8 to 21 inches in thickness. It is fine sandy loam or loamy very fine sand.

The C horizon is fine sandy loam to very fine sand. Soft, fine-grained sandstone is typically at a depth of 40 to 60 inches.

Busher soils are near Jayem, Tassel, and Vetal soils on

the landscape. They formed in weathered sandstone, and Jayem soils formed in eolian sand. They have a thicker A horizon and are deeper over bedrock than Tassel soils. They have a thinner A horizon than Vetal soils.

BuC—Busher loamy very fine sand, 1 to 5 percent slopes. This soil is on uplands. Areas are as much as 100 acres in size.

This soil has a profile similar to the one described as representative for the series, but its surface layer is 10 to 20 inches thick. Included in mapping were areas of soils that have a surface layer of very fine sandy loam or fine sandy loam; areas of soils that have a transitional layer of loam or very fine sandy loam; and areas where bedrock is at a depth of 20 to 40 inches. Areas of Bridget, Jayem, and Vetal soils and Tassel soils, on low ridgetops and knolls were included, and they make up as much as 15 percent of the mapped areas.

Soil blowing and water erosion are hazards in cultivated areas. Conserving soil moisture and maintaining high fertility are concerns of management. Runoff is slow.

Nearly all areas of this soil are in native grass, which is used for grazing or hay. A small acreage is dryfarmed to wheat, alfalfa, and oats. This soil is suited to irrigation. Capability units IIIe-5, dryland, and IIIe-8, irrigated; Sandy range site; windbreak suitability group 3.

BuC2—Busher loamy very fine sand, 1 to 5 percent slopes, eroded. This soil is on uplands. Areas are as much as 200 acres in size.

This soil has a profile similar to the one described as representative for the series, but its surface layer is 4 to 7 inches thick. In places on the middle and upper parts of slopes the surface layer is less than 7 inches thick and is brown to light brownish gray. In places lime is at a depth of 12 to 18 inches.

Included with this soil in mapping were areas of soils that have a surface layer of fine sandy loam and areas where bedrock is at a depth of 20 to 36 inches. Also included were areas of Bridget, Jayem, or Vetal soils, which make up as much as 15 percent of the mapped areas. Tassel soils, on ridgetops and knolls, were included, and they make up as much as 35 percent of some mapped areas.

Water erosion and soil blowing are severe hazards on this soil. Moderately rapid permeability and moderate available water capacity make this soil droughty. Natural fertility is low. Runoff is slow.

Nearly all areas of this soil are cultivated and dryfarmed. Wheat, alfalfa, and oats are the principal crops. A few areas are seeded to grass, which is used for grazing or hay. Capability units IIIe-5, dryland, and IIIe-8, irrigated; Sandy range site; windbreak suitability group 3.

BuD—Busher loamy very fine sand, 5 to 9 percent slopes. This soil is on uplands. Areas are as much as 250 acres in size.

This soil has a profile similar to the one described as representative for the series, but its transitional layer is thinner. In places the surface layer is less than 7 inches thick, and lime is at a depth of 12 to 18 inches.

Included with this soil in mapping were areas of soils that have a surface layer of fine sandy loam and areas where bedrock is at a depth of 20 to 36 inches. Also included were a few small areas of Bridget, Jayem,

and Vetal soils. Tassel soils and small areas of sandstone outcrop on high elevations were also included.

Soil blowing and water erosion are hazards if the soil surface is unprotected. Runoff is medium.

Most areas of this soil are in native grass, which is used for grazing and for hay. A few areas are dryfarmed to wheat, alfalfa, and oats. This soil is suited to irrigation. Capability units IVe-5, dryland, and IVe-8, irrigated; Sandy range site; windbreak suitability group 3.

BuD2—Busher loamy very fine sand, 5 to 9 percent slopes, eroded. This soil is on uplands. Areas are as much as 100 acres in size.

This soil has a profile similar to the one described as representative for the series, but its surface layer is 4 to 7 inches thick. In areas of this soil on middle and upper parts of slopes the surface layer is brown to light brownish gray. In places lime is at a depth of 10 to 18 inches.

Included with this soil in mapping were areas of soils that have a surface layer of fine sandy loam and areas where bedrock is at a depth of 20 to 36 inches. Jayem, Bridget, and Vetal soils were included, and they make up as much as 15 percent of some mapped areas. Small areas of Rock outcrop and Tassel soils on high elevations were also included.

Soil blowing and water erosion are serious hazards. Fertility is low. This soil is somewhat droughty. Runoff is medium.

Nearly all areas of this soil are dryfarmed. Wheat, alfalfa, and oats are the main crops. A few areas are seeded to grass, which is used for grazing or hay. Capability units IVe-5, dryland, and IVe-8, irrigated; Sandy range site; windbreak suitability group 3.

BuF—Busher loamy very fine sand, 9 to 20 percent slopes. This soil is on uplands. Areas are as much as 200 acres in size.

This soil has the profile described as representative for the series. In some areas the surface layer is 3 to 7 inches thick and lime is at a depth of less than 18 inches.

Included with this soil in mapping were areas of soils that have a surface layer of fine sandy loam; areas of soils that have a surface layer of very fine sandy loam; and areas where bedrock is at a depth of 20 to 36 inches. Bridget, Jayem, Tassel, or Vetal soils make up as much as 15 percent of some mapped areas.

Water erosion and soil blowing are serious hazards if the native grass cover is removed from this soil. Conserving soil moisture is a major concern of management. Runoff is medium.

Nearly all areas of this soil are in native grass, which is used for grazing or for hay. A small acreage is cultivated along with areas of less sloping soils. The hazard of erosion and steepness of slope make this soil unsuited to cultivation. Most areas that were once cultivated have been seeded to native or tame grasses and are now used for grazing or hay. Capability unit VIe-5, dryland; Sandy range site; windbreak suitability group 3.

BxF—Busher and Tassel loamy very fine sands, 5 to 20 percent slopes. This mapping unit is on uplands. Slopes are mostly 9 to 20 percent, but range from 5 to 20 percent. Areas are as much as 100 acres in size. Busher loamy very fine sand makes up about 60 percent

of this unit, and Tassel loamy very fine sand makes up about 40 percent. A delineated area, however, can contain either one or both of these soils. Busher soils are on the middle and lower part of side slopes, and Tassel soils are on ridgetops, knolls, and sides of small drainageways.

In places Busher soils have a surface layer that is less than 7 inches thick and that is brown to light gray. Included in mapping were areas where bedrock is at a depth of 20 to 36 inches. Bridget, Jayem, and Vetat soils and small areas of outcrops of sandstone were included, and they make up as much as 15 percent of some mapped areas.

Soil blowing and water erosion are serious hazards if the native grass cover is removed from these soils. Runoff is medium.

Some areas of this mapping unit are in native grass. Most are used for grazing, and some are cut for hay. The soils generally are not suited to cultivation. Capability unit VIe-5, dryland; Busher soil in Sandy range site, Tassel soil in Shallow Limy range site; Busher soil in windbreak suitability group 3, Tassel soil in windbreak suitability group 10.

Canyon Series

The Canyon series consists of shallow, well-drained soils that formed in material weathered from sandstone (fig. 9). These soils are on ridges, knolls, and the sides of upland drainageways. They are extensive in the Pine Ridge. Slopes range mostly from 3 to 30 percent, but in areas of the Pine Ridge and along some upland canyons, slopes are as much as 60 percent.

In a representative profile the surface layer is very friable, grayish-brown loam about 5 inches thick. Below this layer is a transitional layer of friable, light brownish-gray loam 6 inches thick. The underlying material is light-gray loam. White, fine-grained sandstone is at a depth of 15 inches. Lime is at the surface.

Permeability is moderate, and the available water capacity is low. Natural fertility and organic-matter content are low. These soils absorb moisture easily but only until the material above the bedrock is saturated.

Canyon soils are generally too steep and too shallow for crops, but small areas of Canyon soils within larger areas of deep soils are cultivated. Canyon soils are mostly in native grass and are used for grazing. They are too shallow for trees. They have limited uses as habitat for wildlife and as recreational areas.

Representative profile of Canyon loam, in an area of Canyon soils, 3 to 30 percent slopes, in native grass 1,300 feet east and 300 feet south of the northwest corner of sec. 5, T. 30 N., R. 49 W:

- A—0 to 5 inches, grayish-brown (10YR 5/2) loam, dark brown (10YR 3/3) when moist; weak, fine, granular structure; soft, very friable; strong effervescence; moderately alkaline; clear, wavy boundary.
- AC—5 to 11 inches, light brownish-gray (10YR 6/2) loam, grayish brown (10YR 5/2) when moist; weak, fine, subangular blocky structure parting to weak, medium and fine, granular; soft, very friable; few small sandstone fragments; strong effervescence; moderately alkaline; clear, wavy boundary.
- C1—11 to 15 inches, light-gray (10YR 7/2) loam, light brownish gray (10YR 6/2) when moist; weak, medium, subangular blocky structure parting to weak,

fine, subangular blocky; slightly hard, very friable; many small to large sandstone fragments; violent effervescence; moderately alkaline; abrupt, wavy boundary.

R—15 to 24 inches, white (10YR 8/1) fine-grained sandstone, light gray (10YR 7/1) when moist; violent effervescence.

Lime is generally at the surface but is leached below the A horizon in places. Few to many sandstone fragments are common throughout the profile.

The A horizon is dark grayish brown to light brownish gray and ranges from 3 to 6 inches in thickness. It is loam, silt loam, or very fine sandy loam. It is mildly alkaline to moderately alkaline.

The AC horizon ranges from 3 to 8 inches in thickness. It is loam, silt loam, or very fine sandy loam. The AC horizon is lacking in some profiles.

The C horizon is loam, silt loam, or very fine sandy loam.

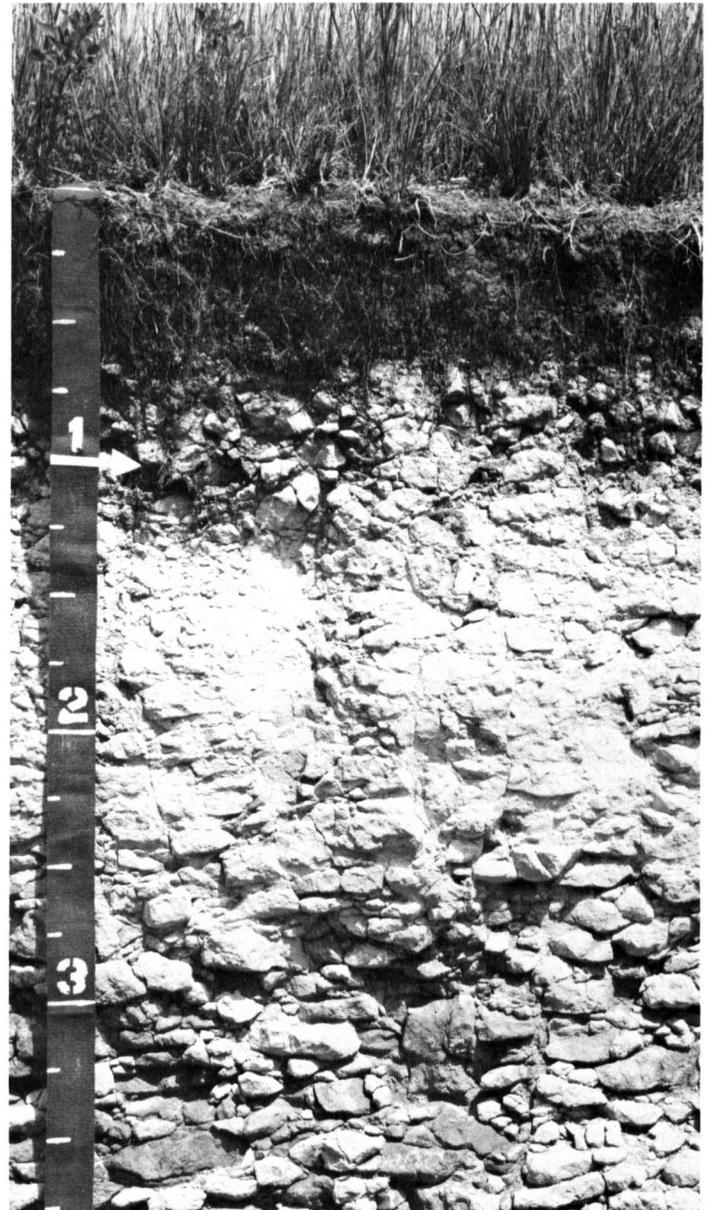


Figure 9.—Profile of Canyon loam. Fine-grained calcareous sandstone is at a depth of about 12 inches.

The bedrock is very pale brown to white, calcareous fine-grained sandstone.

Canyon soils are near Oglala, Rosebud, and Tassel soils on the landscape. They are thinner over bedrock than Oglala and Rosebud soils. They are not so well developed as Rosebud soils. They have a finer texture than Tassel soils.

CaG—Canyon-Bridget-Rock outcrop association, steep (11 to 70 percent slopes). This association is on the rough, broken, tree-covered areas of the Pine Ridge. Slopes are generally greater than 30 percent but range from 11 to 70 percent. Deeply entrenched drainageways that flow northward dissect the areas. Except for isolated small areas, the areas are generally several thousand acres in size. Canyon soils make up 20 to 40 percent of each mapped area; Bridget soils 20 to 35 percent; Rock outcrop 10 to 20 percent; and other soils about 25 to 40 percent.

Canyon soils are on ridgetops, side slopes, and the sides of upland drainageways. They mainly have south- and west-facing exposures. Bridget soils are on colluvial foot slopes. They generally have north- and east-facing exposures. Canyon and Bridget soils in an area of this association have the profiles described as representative for their respective series. Rock outcrop, which consists of sandstone, is intermingled with Canyon soils. A few areas of Rock outcrop are more than 10 acres in size. Many are almost vertical exposures of very pale brown to white fine-grained sandstone.

Included with this association in mapping were Alliance, Busher, Rosebud, Jayem, Keith, Ulysses, and Oglala soils on broad ridges and on upland side slopes. Also included were Duroc and Vetal soils on foot slopes and in swales and Tassel soils, mainly on ridgetops. Except for the Tassel soils, the included soils commonly have north- and east-facing exposures. Areas of Loamy alluvial land on bottom lands along drainageways were also included.

This association is used for grazing and timber. It supports good stands of native grasses and poor to good stands of ponderosa pine trees. Dense stands of trees are common on north- and east-facing exposures, where the soils are deepest. This association is not suited to cultivation. It provides excellent food and cover for wildlife and has good potential for recreation. Capability unit VIIs-4, dryland; Canyon and Bridget soils in Savannah range site, Rock outcrop not assigned a range site; Canyon soil in windbreak suitability group 10, Bridget soil in windbreak suitability group 4, Rock outcrop in windbreak suitability group 10.

CcF—Canyon soils, 3 to 30 percent slopes. These soils are on ridgetops, knolls, and the sides of drainageways on uplands (fig. 10). Areas are as much as 500 acres in size.

This mapping unit has the profile described as representative for the series. The surface layer is silt loam, loam, or very fine sandy loam. In some areas the surface layer is more than 6 inches thick.

Included with these soils in mapping were areas of soils that have a surface layer of fine sandy loam and areas where the bedrock is at a depth of less than 10 inches. Also included were areas of Bridget, Rosebud, Oglala, and Tassel soils and outcrops of sandstone. Inclusions generally make up less than 20 percent of the mapped areas.

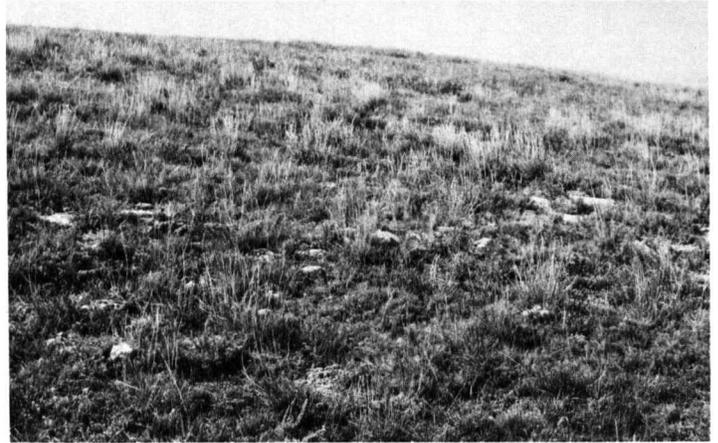


Figure 10.—An area of Canyon soils, 3 to 30 percent slopes, in native grass. Fragments of fine-grained sandstone are on the surface.

Water erosion and soil blowing are very severe hazards if the surface of the soils is unprotected. Low available water capacity and a shallow root zone make these soils droughty. Conserving soil moisture is a concern of management. Runoff is medium to rapid.

Nearly all areas of these soils are in native grass and are used for grazing. Steepness of slope and shallow depth to bedrock make the soils unsuited to cultivation. In places small areas of Canyon soils on low ridgetops and knolls are cultivated along with deeper soils. In such areas the Canyon soils are easily recognized because of their whitish color and sandstone fragments on the surface. Capability unit VI-4, dryland; Shallow Limy range site; windbreak suitability group 10.

CcG—Canyon soils, 30 to 50 percent slopes. These soils are on the sides of upland drainageways. Areas are as much as 500 acres in size.

These soils have a profile similar to the one described as representative for the series, but the surface layer contains silt loam, very fine sandy loam, and loam. In places these soils are less than 10 inches thick over bedrock.

Included with these soils in mapping were areas of Rock outcrop, consisting of sandstone, and areas of Tassel, Busher, and Rosebud soils. These soils and land types make up 15 to 30 percent of some mapped areas.

Very steep slopes, shallowness, and outcrops of rock limit the use of these soils to range, woodland, and habitat for wildlife. Runoff is very rapid.

All areas of these soils are in native grasses, and they support fair to good stands of ponderosa pine trees. They are used mostly for grazing and production of food and cover for wildlife. Some timber is cut from these areas. Capability unit VII-4, dryland; Savannah range site; windbreak suitability group 10.

Clayey Alluvial Land

Cf—Clayey alluvial land (0 to 3 percent slopes). This land type is on bottom lands along upland drainageways. The areas are 50 to 250 feet wide. Slopes are

mostly 1 percent but range from 0 to 3 percent. Many areas are dissected by meandering stream channels. This land type is subject to flooding and continuous deposition of sediment. The soil material consists mostly of deep, calcareous, stratified silty clay loam, silty clay, and clay sediment washed from surrounding uplands.

Included with this land type in mapping were small areas of Kyle soils and small areas of soils on low elevations that are strongly affected by salts and alkali. Very steep streambanks and deep stream channels were also included.

This land type is in native grass and is used mostly for grazing. It is generally unsuited to cultivation and to windbreak plantings. It provides limited habitat for wildlife. Capability unit VIw-1, dryland; Clayey Overflow range site; windbreak suitability group 10.

Duroc Series

The Duroc series consists of deep, well-drained soils that formed in colluvial or alluvial materials derived mostly from loess and weathered sandstone. These soils are in upland swales, on foot slopes, and on stream terraces throughout the county. Slopes range from 1 to 3 percent.

In a representative profile the surface layer is very friable, dark grayish-brown and grayish-brown very fine sandy loam about 33 inches thick. The underlying material is calcareous, light-gray very fine sandy loam to a depth of 60 inches.

Permeability is moderate, and the available water capacity is high. Natural fertility is medium, and organic-matter content is moderate. These soils absorb water easily and release it readily to plants.

Duroc soils are well suited to cultivation and irrigation. They are suited to grass, trees and shrubs, and habitat for wildlife.

Representative profile of Duroc very fine sandy loam, 1 to 3 percent slopes, in a cultivated field 2,100 feet east and 150 feet north of the southwest corner of sec. 9, T. 31 N., R. 50 W:

- Ap—0 to 8 inches, dark grayish brown (10YR 4/2) very fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft, very friable; mildly alkaline; abrupt, smooth boundary.
- A12—8 to 21 inches, dark grayish-brown (10YR 4/2) very fine sandy loam, very dark brown (10YR 2/2) when moist; weak, medium, subangular blocky structure; soft, very friable; mildly alkaline; clear, smooth boundary.
- A13—21 to 33 inches, grayish-brown (10YR 5/2) very fine sandy loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, subangular blocky structure; soft, very friable; mildly alkaline; gradual, smooth boundary.
- Cca—33 to 60 inches, light-gray (10YR 7/2) very fine sandy loam, dark grayish brown (10YR 4/2) when moist; massive; soft, very friable; strong effervescence; moderately alkaline.

Depth to lime ranges from 24 inches to more than 60 inches.

The A horizon ranges from 20 to 59 inches in thickness. It is mainly very fine sandy loam, but silt loam and loam are common. It is dark grayish brown to light brownish gray.

The C horizon is loam, silt loam, or very fine sandy loam. Duroc soils are near Alliance, Keith, and Bridget soils

on the landscape. They lack the B horizon that is characteristic of Alliance and Keith soils, and they have a thicker A horizon. They have a thicker A horizon than Bridget soils.

DuB—Duroc very fine sandy loam, 1 to 3 percent slopes. This soil is in upland swales and on stream terraces. Areas are as much as 300 acres in size.

In some areas the surface layer is silt loam. Included in mapping were areas of soils that have a surface layer of fine sandy loam or loamy very fine sand. Also included were small areas of Alliance, Bridget, Keith, Richfield, and Rosebud soils, all generally on slightly higher elevations. Inclusions make up less than 15 percent of the mapped areas.

In some places, this soil receives additional moisture from adjacent areas. Runoff is slow.

Much of the acreage of this soil is cultivated. It is suited to irrigation but is mostly dryfarmed to wheat, oats, and alfalfa. The rest of the acreage is in native and tame grasses, which are used for grazing or for hay. Capability units IIe-1, dryland, and IIe-6, irrigated; Silty range site; windbreak suitability group 4.

Dwyer Series

The Dwyer series consists of deep, excessively drained soils that formed in eolian sand. These soils are on uplands and stream terraces along the White River and along the Niobrara River and its tributaries. Slopes range from 0 to 17 percent.

In a representative profile the surface layer is very friable, grayish-brown loamy fine sand about 5 inches thick. Below this layer is a transitional layer of pale-brown, loose fine sand 6 inches thick. The underlying material is very pale brown fine sand to a depth of 60 inches.

Permeability is rapid, and the available water capacity is low. Natural fertility and organic-matter content are low. These soils absorb moisture easily and release it readily to plants.

These soils are better suited to native grasses than to other uses. They are not suited to dryland cultivation, but some areas are suited to irrigation. Dwyer soils are suited to trees and shrubs and to production of food and cover for wildlife.

In Dawes County, Dwyer soils are mapped only in an undifferentiated soil group with Valent soils.

Representative profile of Dwyer loamy fine sand from an area of Valent and Dwyer loamy fine sands, 3 to 17 percent slopes, in native grass 2,500 feet north and 100 feet west of the southeast corner of sec. 10, T. 32 N., R. 51 W:

- A—0 to 5 inches, grayish-brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) when moist; weak, medium, granular structure; soft, very friable; mildly alkaline; clear, smooth boundary.
- AC—5 to 11 inches, pale-brown (10YR 6/3) fine sand, brown (10YR 5/3) when moist; weak, coarse, subangular blocky structure; loose; slight effervescence; mildly alkaline; gradual, wavy boundary.
- C—11 to 60 inches, very pale brown (10YR 7/3) fine sand, pale brown (10YR 6/3) when moist; single grained; loose; slight effervescence; mildly alkaline.

Lime is commonly at or near the surface, but is leached to a depth of 30 inches in places.

The A horizon ranges from 4 to 10 inches in thickness and is dark grayish brown to light brownish gray. It is loamy fine sand to fine sand.

Color and texture of the AC horizon is intermediate between those of the A and C horizons. The AC horizon ranges from 5 to 15 inches in thickness.

The C horizon is loamy fine sand to fine sand.

Dwyer soils are near Valent, Busher, and Jayem soils on the landscape. They have lime higher in the profile than Valent soils. They are coarser textured and have a thinner A horizon than Busher and Jayem soils. They formed in eolian sand, and Busher soils formed in material weathered from sandstone.

Epping Series

The Epping series consists of shallow, well-drained soils that formed in material weathered from siltstone. They are on uplands in an area north of the Pine Ridge. Siltstone bedrock is at a depth of 10 to 20 inches (fig. 11). Slopes are mostly 11 to 31 percent, but range from 3 to 50 percent.

In a representative profile the surface layer is very friable, light brownish-gray silt loam about 4 inches thick. Below this layer is a transitional layer of light-gray silt loam about 5 inches thick. The underlying material is light-gray silt loam about 6 inches thick. White siltstone bedrock is at a depth of 15 inches. Lime is at the surface. Siltstone fragments are throughout the profile.

Permeability is moderate above the siltstone bed-

rock, and the available water capacity is low. Natural fertility and organic-matter content are low.

These soils are suited to native grass. The shallow depth to bedrock generally makes them unsuited to cultivated crops and trees. Epping soils provide limited food and cover for wildlife.

Representative profile of Epping silt loam, in an area of Mitchell-Epping silt loams, 9 to 30 percent slopes, in native grass 200 feet north and 400 feet east of the southwest corner of sec. 5, T. 31 N., R 50 W:

- A—0 to 4 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, medium, granular structure parting to weak, fine, granular; soft, very friable; few small siltstone chips; strong effervescence; mildly alkaline; abrupt, smooth boundary.
- AC—4 to 9 inches, light-gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) when moist; weak, coarse, granular structure parting to weak, medium, granular; soft, very friable; few small siltstone chips; violent effervescence; moderately alkaline; clear, smooth boundary.
- C1—9 to 15 inches, light-gray (10YR 7/2) silt loam; light brownish gray (10YR 6/2) when moist; weak, medium, subangular blocky structure parting to weak, fine, subangular blocky; soft, friable; many siltstone chips; violent effervescence; moderately alkaline; clear, smooth boundary.
- C2—15 to 20 inches, white (10YR 8/2) siltstone bedrock, light gray (10YR 7/2) when moist; violent effervescence.

Lime is commonly at the surface but is leached below the A horizon in places.

The A horizon ranges from 3 to 6 inches in thickness. It is light brownish gray to very pale brown.

The C horizon ranges from 7 to 14 inches in thickness.

The siltstone bedrock is massive or fractured, and weakly calcareous to strongly calcareous.

Epping soils are near Kadoka variant, Keota, and Mitchell soils on the landscape. They have a thinner A horizon and lack the B horizon that is characteristic of Kadoka variant soils. They are not so deep over bedrock as Keota and Mitchell soils.

EpF—Epping silt loam, 3 to 30 percent slopes. This soil is on uplands, ridgetops, knolls, and the sides of drainageways. It has the profile described as representative for the series. In some areas bedrock is within a depth of 10 inches. Outcrops of siltstone bedrock are common.

Included with this soil in mapping were areas of soils that have a surface layer of silty clay loam and sandy loam. Also included were areas of Keota, Kadoka variant, and Mitchell soils, all of which generally occupy slightly lower positions on the landscape than this soil. They make up as much as 15 percent of some mapped areas.

Water erosion is a serious hazard if the soil surface is not protected. The low available water capacity makes this soil droughty. Runoff is medium to rapid, depending on the degree of slope.

Most areas of this soil are in native grass and are used for grazing. This soil is not suited to cultivation. Capability unit VIs-4, dryland; Shallow Limy range site; windbreak suitability group 10.

EsG—Epping-Badland complex, 3 to 50 percent slopes. This complex is on side slopes on uplands and along deeply dissected drainageways that extend northward from the Pine Ridge area. The areas are as much as 300 acres in size. Actively eroding gullies are common. Epping soils make up 40 to 65 percent of each



Figure 11.—Profile of an Epping silt loam. Siltstone is at a depth of about 14 inches.

mapped area, Badland 25 to 50 percent, and other soils about 10 percent.

The Epping soils are on ridgetops and along the sides of drainageways. An Epping soil in an area of this complex has the profile described as representative for the Epping series. Badland, which consists of areas of barren, eroded siltstone, is intermingled with the Epping soils.

Included with this complex in mapping were Kadoka variant, Mitchell, and Keota soils and areas of Loamy alluvial land, all of which occupy low elevation. The included soils make up less than 15 percent of the mapped areas.

Water erosion is the main hazard. Runoff is very rapid.

The areas of Epping soils are in native grass and are used for grazing. The areas of Badland are nearly barren. This complex is not suited to crops, but it produces some food and cover for wildlife. Capability unit VII_s-3, dryland; Epping soils in Shallow Limy range site, Badland not assigned a range site; windbreak suitability group 10.

Glenberg Series

The Glenberg series consists of deep, well-drained soils that formed in stratified alluvial sediment. The soils are on flood plains and high bottom lands along drainageways. Slopes range from 0 to 3 percent.

In a representative profile the surface layer is very friable grayish-brown loamy very fine sand about 8 inches thick. The underlying material is light brownish-gray loamy very fine sand to a depth of 48 inches and white, coarse sand and gravel to a depth of 60 inches. Lime is at the surface.

Permeability is moderately rapid, and the available water capacity is moderate. Natural fertility is medium to low, and organic matter content is low. These soils readily release water to plants.

These soils are suited to native grass and to dry-farmed and irrigated crops. They are also suited to trees and shrubs in windbreaks and to production of food and cover for wildlife.

Representative profile of Glenberg loamy very fine sand, occasionally flooded, 0 to 3 percent slopes, in native grass 500 feet north and 100 feet east of the southwest corner of sec. 16, T. 32 N., R. 51 W:

- A—0 to 8 inches, grayish-brown (10YR 5/2) loamy very fine sand, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; soft, very friable; strong effervescence; mildly alkaline; gradual, wavy boundary.
- C1—8 to 48 inches, light brownish-gray (10YR 6/2) stratified loamy very fine sand, grayish brown (10YR 5/2) when moist, that contains thin lenses of very fine sandy loam; weak, coarse, subangular blocky structure; soft, very friable; many small pebbles; strong effervescence; mildly alkaline; clear, wavy boundary.
- IIC2—48 to 60 inches, white (10YR 8/2) coarse sand and gravel, light brownish gray (10YR 6/2) when moist; single grained; strong effervescence; moderately alkaline.

Lime is typically at the surface, but the A horizon is leached in some areas.

The A horizon ranges from 4 to 8 inches in thickness and is grayish brown to pale brown. It is mainly loamy very

fine sand, but areas of fine sandy loam and very fine sandy loam are included.

An AC horizon is in some areas. It is loamy very fine sand or fine sandy loam. It is commonly stratified and contains materials that vary in color and texture, depending on the origin of the sediment. Sand or mixed sand and gravel is below a depth of 40 inches.

Glenberg soils are near Bankard, Bayard, and Haverson soils on the landscape. They are finer textured than Bankard soils and coarser textured than Haverson soils. They are lower on the landscape and have a thinner A horizon than Bayard soils, and the lower part of their C horizon is coarser textured.

GbB—Glenberg loamy very fine sand, 0 to 3 percent slopes. This soil is on high bottom lands along drainageways. Areas are as much as 100 acres in size.

This soil has a profile similar to the one described as representative for the series, but it is less stratified. It is on bottom lands that are seldom flooded.

Included with this soil in mapping were some areas of soils that have a surface layer of fine sandy loam or very fine sandy loam. Also included were a few small areas of Bankard soils that occupy higher positions on the landscape than this soil and Haverson soils that occupy lower positions.

This soil is easy to work. Soil blowing is a hazard if the soil surface is unprotected. Runoff is slow.

Most acreage of this soil is cultivated. Wheat, oats, and alfalfa are dryfarmed. A small acreage of alfalfa is irrigated. The rest of this soil is in native or tame grasses and is used for grazing or hay. Capability units III_e-5, dryland, and II_e-8, irrigated; Sandy Lowland range site; windbreak suitability group 3.

GoB—Glenberg loamy very fine sand, occasionally flooded, 0 to 3 percent slopes. This soil is on bottom lands along drainageways. Areas are as much as 150 acres in size.

This soil has the profile described as representative for series. Some areas have a surface layer of fine sandy loam or very fine sandy loam.

Included with this soil in mapping were areas of soils that have a surface layer of loamy sand; small areas of soils that are not subject to flooding; and small areas of Bankard soils on high elevations and of Haverson soils on low elevations. Also included were small areas of Sandy alluvial land along the stream channels.

Flooding follows heavy rains but is of short duration. Flood waters deposit trash and damage fences and crops. Soil blowing is a hazard if the soil is cultivated and the surface is not protected. Runoff is slow.

Small areas of this soil are cultivated. Alfalfa is the principal dryfarmed crop, but some wheat and oats are grown. This soil is suited to irrigation, but dikes are needed in places to control flooding. The rest of the area is in native or tame grasses and is used for grazing or hay. Capability units III_w-6, dryland, and III_w-8, irrigated; Sandy Lowland range site; windbreak suitability group 3.

Gravelly Alluvial Land

Gr—Gravelly alluvial land (0 to 3 percent slopes). This land type consists of sandy and gravelly alluvial sediment along major drainageways. The areas are narrow and are as much as 300 acres in size. They are subject to frequent flooding and continuous deposition of material. Gravelly alluvial land is variable in tex-

ture and is commonly highly stratified. Gravel is exposed at the surface on about 35 percent of the acreage of this land type, and is at a depth of less than 10 inches in the remaining 65 percent. The soil material deposited over the gravel is calcareous gravelly loamy sand or gravelly sand. Rounded fragments of sandstone, as much as 4 inches in diameter, are mixed with the sandy material.

Included with this land type in mapping were small areas of Bankard and Glenberg soils that occupy higher positions on the landscape than this land type.

Permeability is very rapid, and the available water capacity is very low. Runoff is very slow because most of the water penetrates the gravelly material.

Gravelly alluvial land is not suited to cultivation and is fairly well suited to poorly suited to range. Stands of grass are generally poor, and some areas have no vegetation. The land type is not suited to trees and provides poor habitat for wildlife. Capability unit VII_s-3, dryland; Shallow to Gravel range site; windbreak suitability group 10.

Haverson Series

The Haverson series consists of deep, well-drained soils that formed in stratified silty and loamy alluvium (fig. 12). These soils are on bottom lands and low stream terraces. Areas that are very low on bottom lands are subject to occasional flooding. Slopes range from 0 to 3 percent.

In a representative profile the surface layer is very friable, light brownish-gray silt loam about 6 inches thick. Next is light-gray, stratified very fine sandy loam that contains lenses of loam and silt loam. Below is light brownish-gray and light-gray silt loam. Lime is at the surface.

Permeability is moderate and moderately slow, and the available water capacity is high. Natural fertility is medium to low, and organic-matter content is low. These soils absorb water easily and readily release moisture to plants.

These soils are suited to crops and to grasses. They are well suited to irrigation. Haverson soils are suited to trees and shrubs in windbreaks and to production of food and cover for wildlife.

Representative profile of Haverson silt loam, occasionally flooded, 0 to 3 percent slopes, in native grass 1,300 feet east and 500 feet south of the northwest corner of sec. 4, T. 32 N., R. 50 W:

- A—0 to 6 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; soft, very friable, strong effervescence; moderately alkaline; abrupt, smooth boundary.
- C1—6 to 16 inches, light-gray (10YR 7/2) stratified very fine sandy loam, that contains lenses of loam and silt loam, grayish brown (10YR 5/2) when moist; weak, fine, platy structure; soft, very friable; strong effervescence; moderately alkaline; abrupt, smooth boundary.
- Ab—16 to 21 inches, light brownish-gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) when moist; weak, fine, subangular blocky structure parting to moderate, medium and fine, granular; soft, very friable; strong effervescence; moderately alkaline; clear, smooth boundary.
- C2b—21 to 60 inches, light-gray (2.5Y 7/2) silt loam, grayish brown (2.5Y 5/2) when moist; massive; soft,

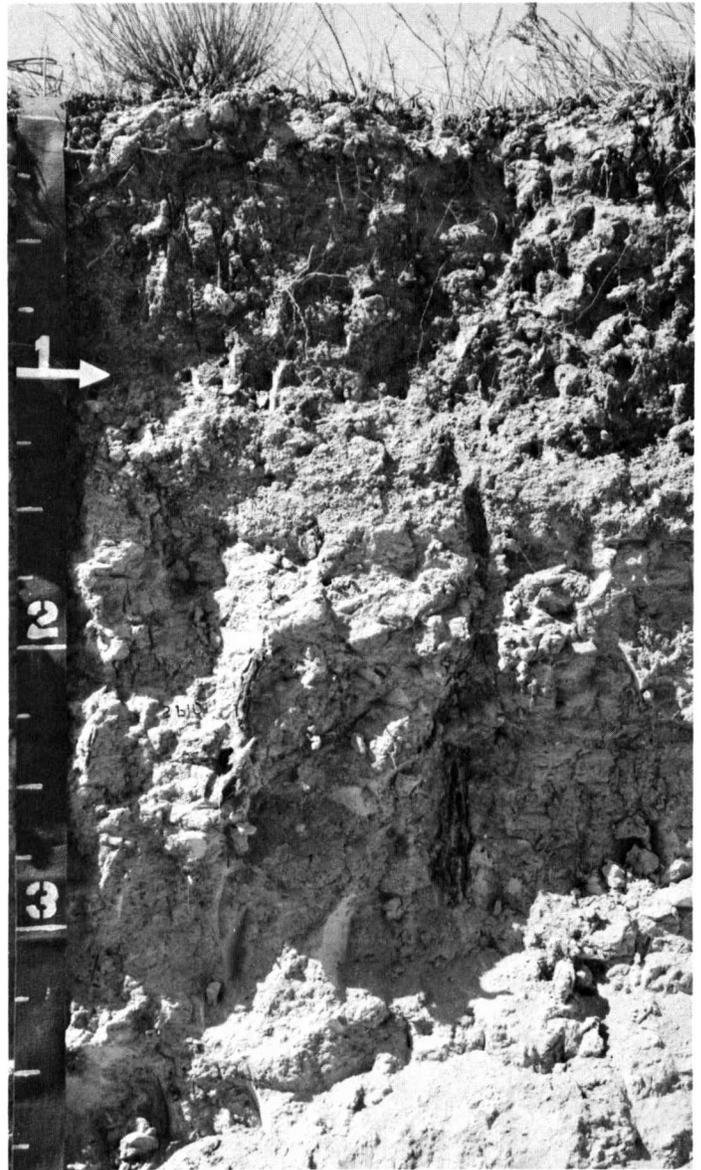


Figure 12.—Profile of a Haverson silt loam. Arrow is directed toward the lower boundary of the surface layer. This soil is rich in lime and has strata of finer textured material.

very friable; strong effervescence; strongly alkaline.

Lime is typically at or near the surface.

The A horizon is dominantly silt loam but includes very fine sandy loam, loam, and silty clay loam. It is dark grayish brown to light brownish gray. It ranges from 4 to 16 inches in thickness.

The C horizon is very fine sandy loam, loam, or silt loam and contains strata of silty clay and fine sandy loam in some places. In some areas loose sand is at a depth of 40 to 60 inches. Some profiles are mottled below a depth of 48 inches.

Haverson soils are near Glenberg and Tripp soils on the landscape. They are finer textured than Glenberg soils. They have a thinner A horizon than Tripp soils and lack the B horizon that is characteristic of those soils.

HaB—Haverson silt loam, 0 to 3 percent slopes. This

soil is on high areas on bottom lands and on low stream terraces along the major drainageways. The areas are as much as 50 acres in size.

This soil has a profile similar to the one described as representative for the series, but it is less stratified in the upper part of the profile.

Included with this soil in mapping were small areas of Glenberg soils that occupy slightly higher positions than this soil and Tripp soils on stream terraces. The included soils make up less than 15 percent of the mapped area.

Soil blowing is a hazard if the soil surface is not protected. Runoff is slow.

Most of the acreage of this soil is used for cultivated crops. Alfalfa, wheat, and oats are the main crops. A few small areas of alfalfa are irrigated. The acreage that is not cultivated is in native or tame grasses, which are used for grazing or hay. Capability units IIc-1, dryland, and I-6, irrigated; Silty Lowland range site; windbreak suitability group 1.

HbB—Haverson silt loam, occasionally flooded, 0 to 3 percent slopes. This soil is on flood plains along major drainageways (fig. 13). It is in irregular, long areas that range from 100 to 2,500 feet in width. The areas are as much as 750 acres in size.

This soil has the profile described as representative for the series. Included in mapping were areas of soils that have a surface layer of silty clay loam. Also included were small areas of Glenberg soils that occupy higher positions on the landscape than this soil and areas of Loamy alluvial land that occupy lower positions.

Occasional flooding, which damages fences and deposits sediment and trash, is the main hazard. Soil blowing is a hazard if the soil surface is unprotected. Runoff is slow.

About half the acreage of this soil is in crops and, half is in range. Alfalfa is the main crop. Trees and

shrubs cover some areas. This soil is suitable to irrigation if flooding is controlled. Capability units IIw-3, dryland, and IIw-6, irrigated; Silty Overflow range site; windbreak suitability group 1.

HcB—Haverson silty clay loam, occasionally flooded, 0 to 3 percent slopes. This soil is on bottom lands. Areas are as much as 200 acres in size.

This soil has a profile similar to the one described as representative for the series, but its surface layer is silty clay loam. Included in mapping were areas of soils that have a surface layer of silt loam or silty clay; areas of higher lying Glenberg soils; and areas of lower lying Loamy alluvial land. Inclusions generally make up less than 20 percent of the mapped area.

This soil is subject to flooding that deposits sediment and trash and damages fences. Tilth is poor, and the soil is difficult to cultivate. The surface puddles if worked when too wet. This soil is sticky when wet and cracks when it dries out. Permeability is moderately slow. Runoff is slow.

A large acreage of this soil is in native or tame grasses, which are used for grazing or for hay. Alfalfa is the main crop in cultivated areas. Trees and shrubs cover a few areas. This soil is suited to irrigation if flooding is controlled. Capability units IIw-3, dryland, and IIw-3, irrigated; Silty Overflow range site; windbreak suitability group 1.

Jayem Series

The Jayem series consists of deep, well-drained to somewhat excessively drained soils that formed in eolian sands. These soils are on uplands. Slopes range from 1 to 9 percent.

In a representative profile the surface layer is very friable, grayish-brown loamy very fine sand about 13 inches thick. The subsoil is very friable, grayish-brown loamy very fine sand about 12 inches thick. The under-



Figure 13.—An area of Haverson silt loam, occasionally flooded, 0 to 3 percent slopes.

lying material is pale-brown and very pale brown loamy very fine sand. Lime is at a depth of 36 inches.

Permeability is moderately rapid, and the available water capacity is moderate. Natural fertility is medium, and organic-matter content is moderate. These soils are easy to work.

These soils are suited to both dryfarmed and irrigated crops. Jayem soils are suited to grasses, trees and shrubs in windbreaks, and production of food and cover for wildlife.

Representative profile of Jayem loamy very fine sand, 1 to 5 percent slopes, in a cultivated field 1,320 feet north and 150 feet east of the southwest corner of sec. 21, T. 32 N., R. 52 W:

- Ap—0 to 8 inches, grayish-brown (10YR 5/2) loamy very fine sand, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft, very friable; mildly alkaline; abrupt, smooth boundary.
- A12—8 to 13 inches, grayish-brown (10YR 5/2) loamy very fine sand, very dark brown (10YR 2/2) when moist; weak, coarse, subangular blocky structure parting to weak, medium, granular; soft, very friable; mildly alkaline; clear, wavy boundary.
- B—13 to 25 inches, grayish-brown (10YR 5/2) loamy very fine sand, dark grayish brown (10YR 4/2) when moist; weak, coarse, subangular blocky structure; soft, very friable; mildly alkaline; gradual, wavy boundary.
- C1—25 to 36 inches, pale-brown (10YR 6/3) loamy very fine sand, dark brown (10YR 4/3) when moist; massive; soft, very friable; mildly alkaline; abrupt, wavy boundary.
- C2—36 to 60 inches, very pale brown (10YR 7/3) loamy very fine sand, brown (10YR 5/3) when moist; massive; soft, very friable; violent effervescence; moderately alkaline.

Lime is typically below a depth of 36 inches.

The A horizon ranges from 7 to 20 inches in thickness. It is dominantly loamy very fine sand but includes small areas of fine sandy loam. It is dark grayish brown to pale brown.

The C horizon is fine sandy loam, loamy very fine sand, or loamy fine sand that contains layers of fine sand or loam in some places.

Jayem soils are near Busher, Keith, Vetal, and Valent soils on the landscape. They have a B horizon which is not present in Busher soils, and they lack sandstone fragments in the lower part of the C horizon, which is characteristic of Busher soils. They contain more sand than Keith soils. They have a thinner A horizon than Valent and Vetal soils and contain less sand than Valent soils.

JmC—Jayem loamy very fine sand, 1 to 5 percent slopes. This soil is on uplands. Areas are as much as 200 acres in size.

This soil has the profile described as representative for the series. Lime is at a depth of 10 to 26 inches in some areas.

Included with this soil in mapping were areas of soils that have a surface layer of very fine sandy loam. Also included and making up as much as 15 percent of some mapped areas were Keith, Sarben, and Vetal soils.

Soil blowing is a hazard if the soil surface is unprotected. Runoff is slow because the soil generally absorbs rain as rapidly as it falls.

Much of the acreage of this soil is in native grass, which is used for grazing or hay. The rest of the acreage is cultivated. Wheat and alfalfa are the main crops. This soil is suited to irrigation. Capability units IIIe-5, dryland, and IIIe-8, irrigated, Sandy range site; windbreak suitability group 3.

JmD—Jayem loamy very fine sand, 5 to 9 percent slopes. This soil is on uplands. Areas are as much as 100 acres in size.

This soil has a profile similar to the one described as representative for the series, but its subsoil is thinner. Lime is at a depth of 10 to 36 inches in some areas.

Included with this soil in mapping were small areas of Bayard, Busher, Sarben, and Valent soils, which generally make up less than 20 percent of the mapped area.

Soil blowing is a hazard if the soil is not protected by a grass cover. Runoff is slow to medium because the soil absorbs most of the rainfall.

Nearly all areas of this soil are in native grass and are used for grazing or hay. This soil is suited to both dryland and irrigation farming. Capability units IVe-5, dryland, and IVe-8, irrigated; Sandy range site; windbreak suitability group 3.

JvD—Jayem and Vetal loamy very fine sands, 5 to 9 percent slopes. This mapping unit is on uplands and foot slopes. The areas are as much as 300 acres in size. Jayem and Vetal soils each make up about 50 percent of the acreage of this mapping unit. The areas, however, can contain either one or both of the soils. Jayem soils are on the upper part of side slopes and on ridgetops. Vetal soils are on the lower part of side slopes and in swales.

Included with this unit in mapping were areas of soils that have a surface layer of loamy fine sand and areas where lime is at a depth of 10 to 36 inches. Also included and making up as much as 15 percent of some mapped areas were Busher and Tassel soils and Sarben soils that occupy high positions.

Water erosion is a hazard in cultivated areas. Soil blowing is a hazard if the soil surface is not protected. These soils are easy to work. Runoff is slow to medium.

Most areas of these soils are in native grasses, which are used for grazing and for hay. A small acreage is cultivated to wheat, alfalfa, and oats. These soils are suited to irrigation. Capability units IVe-5, dryland, and IVe-8, irrigated; Sandy range site; windbreak suitability group 3.

Kadoka Variant

This variant consists of deep, well-drained soils that formed in material weathered from siltstone. These soils are on uplands mostly in an area between the White River and the Pine Ridge. Slopes range from 1 to 9 percent.

In a representative profile the surface layer is very friable grayish-brown and gray silt loam about 9 inches thick. The subsoil is about 12 inches thick. It is friable, pale-brown silty clay loam in the upper part and friable, pale-brown silty clay loam in the lower part. The underlying material is very pale brown silt loam that contains small fragments of siltstone. Lime is at a depth of 21 inches.

Permeability is moderately slow, and the available water capacity is high. Natural fertility is medium, and organic-matter content is moderate. These soils are easy to work.

These soils are suited to both dryfarmed and irri-

gated crops. They are suited to range, trees and shrubs, and production of food and cover for wildlife.

Representative profile of Kadoka silt loam, deep variant, 3 to 9 percent slopes, eroded, in a cultivated field 2,900 feet north and 50 feet east of the southwest corner of sec. 20, T. 33 N., R. 47 W :

- Ap—0 to 6 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft, very friable; mildly alkaline; abrupt, smooth boundary.
- A12—6 to 9 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) when moist; weak, coarse, subangular blocky structure parting to weak, fine and medium, granular; soft, very friable; mildly alkaline; clear, smooth boundary.
- B2t—9 to 17 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 5/3) when moist; weak, coarse, subangular blocky structure parting to moderate, fine, subangular blocky; slightly hard, friable; mildly alkaline; clear, smooth boundary.
- B3—17 to 21 inches, pale-brown (10YR 6/3) light silty clay loam, brown (10YR 5/3) when moist; weak, coarse, subangular blocky structure parting to weak, medium, subangular blocky; slightly hard, friable; mildly alkaline; abrupt, wavy boundary.
- C—21 to 60 inches, very pale brown (10YR 7/3) silt loam, pale brown (10YR 6/3) when moist; massive, soft, very friable; few small siltstone fragments; violent effervescence; moderately alkaline.

Lime is at a depth of 17 to 28 inches. Glass shards are common throughout the profile.

The A horizon ranges from 7 to 14 inches in thickness. It is dominantly silt loam, but it is very fine sandy loam or loam in places. It is dark grayish brown to grayish brown.

The B2t horizon is heavy silt loam, clay loam, or silty clay loam, and it averages between 25 and 35 percent clay. It ranges from 6 to 12 inches in thickness.

The B3 horizon contains lime in some profiles.

In some profiles bedded siltstone bedrock is at a depth of 40 to 60 inches. Buried soils are common.

Kadoka, deep variant, soils are near Keith, Keota, and Mitchell soils on the landscape. They formed in material weathered from siltstone, and Keith soils formed in loess. They have a thicker A horizon and a clayey B horizon that is lacking in Keota and Mitchell soils. In addition, they are deep, and Keota soils are moderately deep over the underlying siltstone bedrock.

KaB—Kadoka silt loam, deep variant, 1 to 3 percent slopes. This soil is on uplands. Areas are as much as 500 acres in size.

This soil has a profile similar to the one described as representative for the series, but its surface layer and subsoil are thicker. Included in mapping were areas of soils that occupy slightly higher positions on the landscape than this variant soil. These soils have a surface layer of fine sandy loam. Also included were areas of soils that have a subsoil of silt loam or loam and some areas where bedded siltstone is at a depth of 20 to 40 inches. Small areas of Keota soils that occupy high positions, Keith soils, and Mitchell soils were also included. The included soils make up less than 15 percent of the mapped areas.

Soil blowing is the main hazard in cultivated areas. Conserving soil moisture is a concern of management. Runoff is slow.

Nearly all of the acreage of this soil is cultivated. Wheat, oats, and alfalfa are the principal dryfarmed crops. A few areas of alfalfa are irrigated. Areas in native grass are used for grazing or the grass is cut for hay. Capability units IIe-1, dryland, and IIe-4, irrigated; Silty range site; windbreak suitability group 4.

KaD—Kadoka silt loam, deep variant, 3 to 9 percent slopes. This soil is on the middle and lower part of side slopes on uplands. Areas are as much as 300 acres in size.

This soil has a profile similar to the one described as representative for the series, but its surface layer is thicker. Included in mapping were areas of soils that occupy slightly higher positions on the landscape than this variant. These soils have a surface layer of fine sandy loam. Also included were areas of soils that have a subsoil of silt loam or loam and areas where bedded siltstone is at a depth of 20 to 40 inches. Keota soils on knolls and ridges and Bridget, Keith, Mitchell, and Ulysses soils were included and make up as much as 15 percent of some mapped areas.

Water erosion and soil blowing are hazards if this soil is cultivated. Runoff is medium.

Most acreage of this soil is used for range. Some areas of grass are cut for hay. Capability units IIIe-1, dryland, and IIIe-4, irrigated; Silty range site; windbreak suitability group 4.

KaD2—Kadoka silt loam, deep variant, 3 to 9 percent slopes, eroded. This soil is on uplands on the middle and lower part of side slopes that are eroded.

This soil has the profile described as representative for the series. In some areas the surface layer is 4 to 7 inches thick, in some areas it is brown to pale brown, and in some areas it has been mixed with the subsoil by tillage and is light silty clay loam.

Included with this soil in mapping were areas of severely eroded soils where the light brownish-gray to very pale brown, calcareous underlying material is exposed. Bedded siltstone is at a depth of 20 to 40 inches in some places. Keota soils on ridges and knolls, Keith, Mitchell, and Ulysses soils were included, and they make up as much as 15 percent of some mapped areas.

Water erosion is the main hazard, and soil blowing is also a hazard. Conserving soil moisture and controlling erosion are the main concerns of management. Runoff is medium.

Nearly all the acreage of this soil is cultivated. Wheat, alfalfa, and oats are the main crops. A few areas are seeded to grass, which is used for grazing or for hay. Capability units IIIe-1, dryland, and IIIe-4, irrigated; Silty range site; windbreak suitability group 4.

Keith Series

The Keith series consists of deep, well-drained soils that formed in loess (fig. 14). These soils are on uplands and tablelands. Slopes range from 1 to 9 percent.

In a representative profile the surface layer is very friable, grayish-brown silt loam about 9 inches thick. The subsoil is about 15 inches thick. It is friable, brown light silty clay loam in the upper part and friable, pale-brown silt loam in the lower part. Very pale brown silt loam is at a depth of 24 inches. Lime is at a depth of 24 inches.

Permeability is moderate, and the available water capacity is high. Natural fertility is medium, and organic-matter content is moderate. These soils are easy to work.

These soils are suited to both dryfarmed and irri-

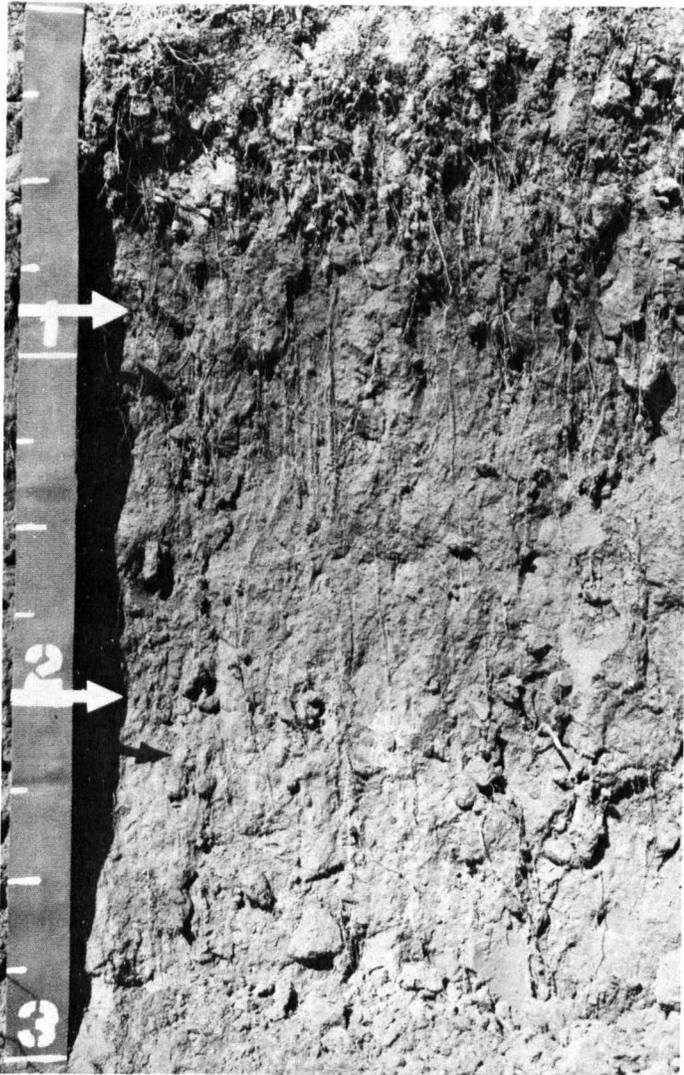


Figure 14.—Profile of a Keith silt loam. Arrows are directed toward the lower boundaries of the surface layer and the subsoil. The underlying material is loess that is rich in lime.

gated crops. They are suited to grass, trees and shrubs, and habitat for wildlife.

Representative profile of Keith silt loam, 3 to 9 percent slopes, in a cultivated field 1,600 feet west and 100 feet north of the southeast corner of sec. 32, T. 32 N., R. 50 W:

- Ap—0 to 6 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft, very friable; mildly alkaline; abrupt, smooth boundary.
- A12—6 to 9 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, subangular blocky structure parting to weak, fine, granular; soft, very friable; mildly alkaline; clear, wavy boundary.
- B2t—9 to 17 inches, brown (10YR 5/3) light silty clay loam, dark brown (10YR 4/3) when moist; weak, coarse, prismatic structure parting to moderate, medium and fine, subangular blocky; slightly hard, friable; mildly alkaline; gradual, smooth boundary.
- B3—17 to 24 inches, pale-brown (10YR 6/3) silt loam,

brown (10YR 5/3) when moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; soft, very friable; mildly alkaline; abrupt, wavy boundary.

- C—24 to 60 inches, very pale brown (10YR 7/3) silt loam, pale brown (10YR 6/3) when moist; massive; soft, very friable; strong effervescence; moderately alkaline.

Depth to lime averages about 25 inches but ranges from 18 to 30 inches. Lime is in the B3 horizon in some areas. Glass shards are present throughout the profile but are most common in the C horizon.

The A horizon ranges from 7 to 16 inches in thickness. It is very fine sandy loam to silt loam and is dark gray to grayish brown.

The B horizon ranges from 9 to 21 inches in thickness. It is silt loam, clay loam, or silty clay loam.

The B2t horizon averages between 25 and 33 percent clay.

The C horizon is very fine sandy loam to silt loam. Bedded sandstone is below a depth of 40 inches in some areas.

Keith soils are near Richfield, Ulysses, and Kadoka variant soils on the landscape. They have a B2t horizon that is not so clayey as that in Richfield soils. They have a thicker A horizon and more clay in the B horizon than Ulysses soils. They formed in loess, and Kadoka variant soils formed in material weathered from siltstone.

KeB—Keith silt loam, 1 to 3 percent slopes. This soil is on uplands (fig. 15). Areas are as much as 500 acres in size.

This soil has a profile similar to the one described as representative for the series, but its subsoil is thicker. In some places the A horizon is loam or very fine sandy loam and is 3 to 7 inches thick. In places lime is at a depth of 12 to 18 inches. Dark-colored buried soils are common.

Included with this soil in mapping were areas of soils that have a surface layer of fine sandy loam. Also included were small areas of Alliance soils, Duroc soils in swales, and Richfield soils.

Water erosion is a hazard in some areas, but soil blowing is the main hazard. These soils are easy to work. Runoff is slow.

This soil is used for both crops and range. Winter wheat, alfalfa, and oats are the principal dryfarmed crops. A few small areas of alfalfa are irrigated. Some areas are in grass, which is used for hay or for grazing. Capability units IIe-1, dryland, and IIe-4, irrigated; Silty range site; windbreak suitability group 4.

KeD—Keith silt loam, 3 to 9 percent slopes. This soil is on ridges and side slopes. Areas are as much as 300 acres in size.

This soil has the profile described as representative for the series. In some areas the surface layer is loam or very fine sandy loam.

Included with this soil in mapping are areas of higher soils that have a surface layer of fine sandy loam. Also included were areas of Duroc soils in swales and Kadoka variant, Richfield, and Ulysses soils, which generally make up less than 20 percent of the mapped area.

Water erosion is a hazard in cultivated areas. Soil blowing is a concern of management. Runoff is medium.

A small acreage of this soil is used for crops, but most areas are in native grass and are used for grazing or for hay. Wheat and alfalfa are the main cultivated crops, and some oats are grown. Capability units IIIe-1, dryland, and IIIe-4, irrigated; Silty range site; windbreak suitability group 4.

KfD—Keith and Ulysses silt loams, 3 to 9 percent



Figure 15.—An area of Keith silt loam, 1 to 3 percent slopes. This soil is well suited to alfalfa and other crops.

slopes. This mapping unit is on eroded uplands. Areas are as much as 300 acres in size. Keith silt loam makes up about 65 percent of the acreage of this mapping unit and Ulysses silt loam about 35 percent. A delineated area, however, can contain either one or both of the soils. The Keith soils are mostly on the middle and lower parts of hillsides, and the Ulysses soils are on the upper part of side slopes, crests of ridges, and knolls.

In some places the surface layer of this mapping unit is loam or very fine sandy loam, and in some places it is less than 7 inches thick. Included in mapping were areas of soils that have a surface layer of light silty clay loam or fine sandy loam, and areas of soils that have a subsoil of heavy silty clay loam. Also included were small areas of Alliance, Bridget, and Kadoka variant soils, and Duroc soils in swales. Inclusions generally make up less than 15 percent of the mapped areas.

Water erosion is a hazard. Controlling soil blowing is a concern of management. These soils are easily worked. Runoff is medium.

Nearly all of the acreage of this mapping unit is used for crops. Dryfarmed wheat, alfalfa, and oats are the principal crops. Only a few areas are irrigated. A small acreage is seeded to tame grasses, which are used for grazing or for hay. Capability units IIIe-1, dryland, and IIIe-4, irrigated; Silty range site; Keith soil in windbreak suitability group 4, Ulysses soil in windbreak suitability group 5.

Keota Series

The Keota series consists of moderately deep, well-drained soils that formed in material weathered from siltstone. These soils are on uplands, mostly in an area between the White River and the Pine Ridge. Bedded siltstone is at a depth of 20 to 40 inches. Slopes range from 1 to 9 percent.

In a representative profile the surface layer is friable, light brownish-gray silt loam about 4 inches thick. Below this layer is a transitional layer of friable, very pale brown silt loam about 8 inches thick. The underlying material is very pale brown silt loam. White, calcareous bedded siltstone is at a depth of 30 inches. Lime is at the surface.

Permeability is moderate above the siltstone bedrock, and the available water capacity is moderate. Natural fertility is medium to low, and organic-matter content is low. These soils absorb water readily and are easily worked.

Keota soils are suited to both dryfarmed and irrigated crops. They are suited to grass, trees and shrubs, habitat for wildlife, and recreation.

Representative profile of Keota silt loam, in an area of Keota-Epping silt loams, 3 to 9 percent slopes, in a cultivated field 1,300 feet north and 1,300 feet west of the southeast corner of sec. 10, T. 32 N., R. 49 W:

Ap—0 to 4 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; soft, friable; strong effervescence; moderately alkaline; abrupt, smooth boundary.

AC—4 to 12 inches, very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) when moist; weak, coarse, subangular blocky structure parting to weak, medium, subangular blocky; slightly hard, friable; few siltstone fragments; violent effervescence; moderately alkaline; clear, smooth boundary.

C1—12 to 30 inches, very pale brown (10YR 8/3) silt loam, pale brown (10YR 6/3) when moist; massive; slightly hard, friable; few siltstone fragments; violent effervescence; moderately alkaline; clear, wavy boundary.

C2—30 to 40 inches, white (10YR 8/2) bedded siltstone, light gray (10YR 7/2) when moist; violent effervescence.

Lime is typically at the surface, but in areas of native grass it is commonly leached from the A horizon. Glass shards are throughout the profile.

The A horizon ranges from 3 to 6 inches in thickness. It is dark grayish brown to light brownish gray. It is dominantly silt loam, but loam and very fine sandy loam are also common.

Keota soils are near Epping, Kadoka variant, and Mitchell soils on the landscape. They are deeper over siltstone bedrock than Epping soils. They are less clayey than Kadoka variant soils, and they lack the B horizon that is characteristic of those soils. They are not so deep over siltstone bedrock as Mitchell soils.

KoB—Keota silt loam, 1 to 3 percent slopes. This soil is on ridgetops and the upper part of side slopes in an area north of the Pine Ridge. The areas are as much as 50 acres in size.

This soil has a profile similar to the one described as representative for the series, but its surface layer is slightly thicker. Included in mapping were areas of Kadoka variant and Mitchell soils, which occupy lower positions than this soil, and Epping soils on knolls. Inclusions generally make up less than 25 percent of the mapped areas.

Soil blowing and water erosion are hazards. Conserving soil moisture and maintaining soil fertility are concerns of management. Runoff is generally slow, but on narrow ridgetops it is medium.

Much of the acreage of this soil is cultivated or has been seeded to grass. Wheat is the principal dryfarmed crop. Areas of grass are used for grazing or cut for hay. Capability units IIIe-1, dryland, and IIIe-7, irrigated; Limy Upland range site; windbreak suitability group 5.

KpD—Keota-Epping silt loams, 3 to 9 percent slopes. This mapping unit is on side slopes and ridgetops on uplands. Areas are as much as 100 acres in size. Each area is made up of about 50 to 80 percent Keota silt loam and 20 to 40 percent Epping silt loam. The Keota soils are on the longer middle and lower slopes, and the Epping soils are on the upper part of side slopes, ridgetops, and knolls.

Included with this unit in mapping were small areas of Bridget, Kadoka variant, Keith, and Mitchell soils, all of which occupy lower positions than this soil. These included soils generally make up less than 20 percent of the mapped areas.

Water erosion and soil blowing are hazards. Conserving soil moisture and maintaining soil fertility are concerns of management. Runoff is medium.

Most of the acreage of this mapping unit is used for dryfarmed crops. Wheat, oats, and alfalfa are the main crops. The rest of the acreage is in native or tame grasses, which are used for grazing or for hay. Capability units IVe-1, dryland, and IVe-7, irri-

gated; Keota soil in Limy Upland range site, Epping soil in Shallow Limy range site; Keota soil in windbreak suitability group 5, Epping soil in windbreak suitability group 10.

Kyle Series

The Kyle series consists of deep, well-drained soils that formed in material weathered from clay shale and alluvial clay material. These soils are on uplands and stream terraces north of the White River. Areas are level to depressional, and slopes range from 0 to 5 percent.

In a representative profile the surface layer is very firm, grayish-brown silty clay about 3 inches thick. The subsoil is about 27 inches thick. It is very firm, olive-gray clay in the upper part and firm, light olive-gray clay in the lower part. The underlying material is light brownish-gray clay that contains gypsum crystals and other salts in the upper part. Lime is at a depth of 3 inches.

Permeability is very slow, and the available water capacity is moderate. Natural fertility is medium to low, and organic-matter content is moderately low. These soils have poor tilth and are difficult to work. Large cracks form as these soils dry out. Water is released slowly to plants, and these soils are droughty.

Kyle soils are suited to both dryfarmed and irrigated crops. They are suited to grasses, trees and shrubs, and habitat for wildlife.

Representative profile of Kyle silty clay, 1 to 5 percent slopes, in native grass 1,300 feet north and 500 feet east of the southwest corner of sec. 34, T. 33 N., R. 51 W:

A—0 to 3 inches, grayish-brown (2.5Y 5/2) silty clay, very dark grayish brown (2.5Y 3/2) when moist; moderate, fine, granular structure; hard, very firm; mildly alkaline; abrupt, smooth boundary.

B21—3 to 15 inches, olive-gray (5Y 5/2) clay, olive gray (5Y 4/2) when moist; moderate, coarse, prismatic structure parting to moderate, medium, subangular blocky; very hard, very firm; strong effervescence; mildly alkaline; clear, smooth boundary.

B22—15 to 24 inches, olive-gray (5Y 5/2) clay, olive gray (5Y 4/2) when moist; moderate, coarse, prismatic structure parting to moderate, medium, angular blocky; very hard, very firm; strong effervescence; moderately alkaline; clear, smooth boundary.

B3—24 to 30 inches, light olive-gray (5Y 6/2) clay, olive gray (5Y 4/2) when moist; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky; very hard, firm; strong effervescence; moderately alkaline; abrupt, wavy boundary.

C1cs—30 to 45 inches, light brownish-gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) when moist; weak, coarse, prismatic structure parting to weak, coarse, subangular blocky; hard, firm; strong effervescence; mildly alkaline; segregations of salts and gypsum crystals; clear, smooth boundary.

C2—45 to 60 inches, light brownish-gray (2.5Y 6/2) clay, grayish brown (2.5Y 5/2) when moist; massive; hard, firm; many small weathered shale fragments; strong effervescence; mildly alkaline.

Lime is typically at the surface, but it is commonly leached below the A horizon in some profiles.

The A horizon ranges from 2 to 6 inches in thickness. It is dark grayish-brown to grayish-brown silty clay or clay.

The B horizon ranges from 10 to 28 inches in thickness. The B3 horizon is lacking in some profiles.

The C horizon is silty clay or clay. It contains accumula-

tions of gypsum crystals and lime segregations. Unweathered shale is below a depth of 40 inches.

Kyle soils are near Bufton, Pierre, and Samsil soils on the landscape. They contain more clay than Bufton soils. They are deeper over shale than Pierre and Samsil soils.

Ky—Kyle silty clay, 0 to 1 percent slopes. This soil is on stream terraces. Areas are as much as 1,000 acres in size.

This soil has a profile similar to the one described as representative for the series, but its subsoil is slightly thicker. In some areas the surface layer is clay; in some areas it is 6 to 12 inches thick. Lime is at a depth of 12 to 18 inches in some areas.

Included with this soil in mapping were areas of Bufton and Buffington soils that make up as much as 15 percent of the mapped areas.

This soil releases water slowly to plants and is quite droughty. A clayey texture, very slow permeability, and poor tilth make this soil difficult to manage. Runoff is slow. Much of the water enters the cracks that form as the soil dries out.

Much of the acreage of this soil is cultivated. Wheat and oats are dryfarmed. A small acreage of alfalfa is irrigated. The rest of the acreage is in native or tame grasses, which are used for grazing or for hay. Capability units IVs-2, dryland, and IVs-1, irrigated; Clayey range site; windbreak suitability group 9.

KyC—Kyle silty clay, 1 to 5 percent slopes. This soil is on uplands and stream terraces. Areas are as much as 1,500 acres in size.

This soil has the profile described as representative for the series. In some areas the surface layer is 6 to 12 inches thick. Included in mapping are Bufton and Buffington soils and Pierre soils, which occupy high positions. These included soils make up as much as 15 percent of some mapped areas.

Water erosion and soil blowing are hazards in cultivated areas. A clayey texture, very slow permeability, and poor tilth make this soil difficult to manage. Conserving soil moisture and controlling erosion are the main concerns of management if this soil is used for crops. Runoff is medium.

Most areas of this soil are used for range. Some areas are cultivated, but the soil is difficult to work. Dryfarmed wheat, oats, and alfalfa are the main crops. Capability unit IVe-4, dryland; Clayey range site; windbreak suitability group 9.

Kz—Kyle-Slickspots complex, 0 to 2 percent slopes. This complex is on colluvial-alluvial fans and stream terraces. Areas are as much as 500 acres in size. Individual areas contain from about 50 to 75 percent Kyle soils and from 25 to 50 percent Slickspots. Slickspots are in small depressions, and Kyle soils are in slightly higher areas between the depressions. The numerous depressions are as much as 25 feet or more in diameter. They are 3 to 12 inches lower than the surrounding soil and give the area a scabby or pockmarked appearance.

Kyle soils have the profile described as representative for the Kyle series. Slickspots have the characteristics described for the land type.

Included with this complex in mapping were small areas of Bufton soils, and Pierre soils that occupy high positions. Inclusions make up less than 15 percent of the mapped areas.

Runoff is slow. Runoff received from higher areas collects in the depressions and remains until it evaporates or slowly enters the soil.

This complex is in native grass and is used for grazing. It is not suited to cultivation because the areas of Slickspots are moderately saline. Capability unit VIs-1, dryland; Kyle soil in Clayey range site, Slickspots in Panspots range site; Kyle soils in windbreak suitability group 9, Slickspots in windbreak suitability group 10.

Las Animas Series

The Las Animas series consists of deep, somewhat poorly drained soils on bottom lands. These soils formed in stratified loamy and sandy alluvium. They have a water table at a depth of 2 to 6 feet. Slopes range from 0 to 2 percent.

In a representative profile the surface layer is grayish-brown silt loam about 6 inches thick. The light-gray underlying material is stratified very fine sandy loam and loamy fine sand in the upper part and fine sandy loam that contains strata of coarse sand in the lower part.

Permeability is moderately rapid, and the available water capacity is moderate. Natural fertility is medium to low, and organic-matter content is moderately low. These soils are subirrigated by a moderately high water table that provides extra moisture during dry periods. They are subject to occasional flooding.

These soils are suited to both dryfarmed and irrigated crops. They are suited to range, grasses, trees and shrubs, and habitat for wildlife.

Representative profile of Las Animas silt loam, in an area of Las Animas soils, 0 to 2 percent slopes, in native grass 2,500 feet east and 50 feet south of the northwest corner of sec. 12, T. 29 N., R. 48 W:

- A—0 to 6 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft, very friable; strong effervescence; mildly alkaline; abrupt, smooth boundary.
- C1—6 to 20 inches, light-gray (10YR 7/2) stratified very fine sandy loam and loamy fine sand, grayish brown (10YR 5/2) when moist; massive; soft, very friable; strong effervescence; mildly alkaline; abrupt, smooth boundary.
- C2—20 to 60 inches, light-gray (10YR 7/2) fine sandy loam that contains strata of coarse sand, grayish brown (10YR 5/2) when moist; few, medium, faint mottles; yellowish brown (10YR 5/4) when moist; single grained; loose; strong effervescence; moderately alkaline.

Lime is typically at the surface, but it is commonly leached to a depth below the A horizon.

The A horizon ranges from 4 to 8 inches in thickness. It is very dark grayish-brown to light brownish-gray fine sandy loam, loam, or silt loam.

The C horizon is stratified sandy loam or very fine sandy loam that contains loamy fine sand or sand in the upper part, and stratified fine sandy loam or loamy sand that contains coarse sand or gravel in the lower part. Mottles are at a depth of 12 to 33 inches. Buried soils are common.

Las Animas soils are near Bankard variant, Glenberg, and Haverson soils on the landscape. They contain less sand in the upper part of the C horizon than Bankard variant soils. They have poorer natural drainage than Glenberg soils. They contain more sand and have poorer natural drainage than Haverson soils.

La—Las Animas soils, 0 to 2 percent slopes. These

soils are on bottom lands along major drainageways. Areas are as much as 200 acres in size.

The soils have a surface layer of fine sandy loam, very fine sandy loam, loam, or silt loam. Included in mapping were areas of soils that have a transitional layer of silt loam to very fine sandy loam. Also included were Bankard variant and Glenberg soils that occupy higher positions than this soil, and Haverson soils and Wet alluvial land on low elevations. The included soils make up as much as 15 percent of some mapped areas. A few small areas of soils affected by salts and alkali were also included.

A high water table provides subirrigation in dry periods, but in some years it causes the soils to be wet in spring and delays planting of some crops. If these soils are cultivated, soil blowing is a hazard unless the areas are protected by crop residue, crops, or a grass cover. Maintaining balanced soil fertility is a concern of management, particularly in irrigated areas. Runoff is slow.

A few areas of these soils are cultivated. Alfalfa is the principal crop. A few small areas are irrigated. Most of the acreage is in native grass, which is used for grazing or for hay. Capability units IIw-4, dryland, and IIw-8, irrigated; Subirrigated range site; windbreak suitability group 2.

Loamy Alluvial Land

Lo—Loamy alluvial land (0 to 3 percent slopes). This land type is on bottom lands along drainageways. Slopes range from 0 to 3 percent but are mainly 1 percent or less. Many of the long, narrow flood plains are dissected into small, irregular-shaped areas by meandering stream channels. The areas are as much as 300 acres in size.

This land type consists of deep, stratified, calcareous loamy sediment washed from the surrounding uplands. It is grayish-brown to white very fine sandy loam to silty clay loam. In some places it is stratified and contains sandy material. Many areas are bordered by short, steep stream banks or breaks that make up 25 to 50 percent of the mapped areas. Included in mapping were small areas of Haverson soils on high elevations and areas of Sandy alluvial land and Clayey alluvial land.

Areas of Loamy alluvial land are well drained. They are subject to severe flooding after heavy rains, but floods are of short duration. Runoff is slow.

Most areas of this land type are used for grazing, but grass in a few areas is cut for hay. The hazard of flooding and deposition of sediment generally makes this land type unsuited to cultivation. The native vegetation is mostly grasses, and some areas support trees or shrubs. Most areas provide good food and cover for wildlife. Capability unit VIw-3, dryland; Silty Overflow range site; windbreak suitability group 10.

Minnequa Series

The Minnequa series consists of moderately deep, well-drained soils that formed in material weathered from chalk and chalky shale. These soils are on uplands. Slopes range from 1 to 12 percent.

In a representative profile the surface layer is brown, friable silty clay loam about 4 inches thick. Below this

layer is a transitional layer of pale-brown silty clay loam about 12 inches thick. The underlying material is very pale brown light silty clay loam. Very pale brown, calcareous chalky shale is at a depth of 38 inches. Lime is at the surface.

Permeability is moderately slow, and the available water capacity is moderate. Natural fertility and organic-matter content are low. These soils contain varying amounts of selenium.

These soils are better suited to range than to other uses. They are suited to crops where slopes are less than 5 percent. They are suited to trees and shrubs and to production of food and cover for wildlife.

Representative profile of Minnequa silty clay loam, 5 to 12 percent slopes, in native grass 2,100 feet north and 500 feet west of the southeast corner of sec. 20, T. 35 N., R. 47 W:

- A—0 to 4 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) when moist; weak, fine, granular structure; slightly hard, friable; violent effervescence; moderately alkaline; clear, smooth boundary.
- AC—4 to 16 inches, pale-brown (10YR 6/3) silty clay loam, yellowish brown (10YR 5/4) when moist; weak, medium, prismatic structure parting to weak, fine, subangular blocky; slightly hard, friable; violent effervescence; moderately alkaline; gradual, wavy boundary.
- C1—16 to 38 inches, very pale brown (10YR 7/4) light silty clay loam, light yellowish brown (10YR 6/4) when moist; massive; slightly hard, very friable; violent effervescence; moderately alkaline; clear, wavy boundary.
- C2—38 to 60 inches, very pale brown (10YR 8/4) chalky shale, very pale brown (10YR 7/4) when moist; violent effervescence.

The A horizon ranges from 3 to 6 inches in thickness. It is grayish brown to very pale brown. It is commonly silty clay loam, but silt loam or clay loam are present in places.

The AC horizon ranges from 5 to 12 inches in thickness. It is silty clay loam or clay loam.

Fragments of chalky shale are common in the C horizon and in places are scattered throughout the profile. Chalky shale is at a depth of 20 to 40 inches.

Minnequa soils are near Bufton, Kyle, and Penrose soils on the landscape. They lack the B horizon that is characteristic of Bufton soils and are not so deep as these soils. They are less clayey than Kyle soils. They are deeper over chalky shale than Penrose soils.

MnC—Minnequa silty clay loam, 1 to 5 percent slopes. This soil is on the lower part of hillsides and on ridgetops. Areas are as much as 100 acres in size.

This soil has a profile similar to the one described as representative for the series, but the surface layer is slightly thicker. Included in mapping were soils in low lying areas where chalky shale is below a depth of 40 inches. Also included were small areas of Bufton and Kyle soils on the lower part of side slopes and in swales. Inclusions generally make up less than 20 percent of the mapped areas.

Water erosion and soil blowing are severe hazards if this soil is cultivated. This soil has poor tilth and is difficult to work. It puddles if grazed or worked when too wet. The areas contain varying amounts of selenium, and livestock that graze continuously are subject to selenium poisoning. Runoff is medium.

Nearly all the acreage of this soil is in native grass, which is used for grazing or for-hay. Capability units IVE-9, dryland, and IVE-3, irrigated; Limy Upland range site; windbreak suitability group 4.

MnD—Minnequa silty clay loam, 5 to 12 percent slopes. This soil is on hillsides. Areas are as much as 200 acres in size.

This soil has the profile described as representative for the series. Included in mapping were areas where chalky shale is below a depth of 40 inches. Bufton, Kyle, and Pierre soils on the lower part of side slopes and Penrose soils on ridges, knolls, and the upper part of side slopes were also included and make up as much as 20 percent of some mapped areas.

Water erosion is a very severe hazard. Soil blowing is a hazard if a good grass cover is not maintained. The areas contain varying amounts of selenium, and livestock that graze continuously are subject to selenium poisoning. Runoff is medium.

The entire acreage of this soil is in native grass, which is used for grazing or for hay. Capability unit VIe-9, dryland; Limy Upland range site; windbreak suitability group 4.

Mitchell Series

The Mitchell series consists of deep, well-drained soils that formed in material that weathered from siltstone. Some of the weathered material was transported and redeposited by wind and water to lower parts of the landscape. Mitchell soils are on uplands and foot slopes in an area north of the Pine Ridge. Slopes range from 0 to 30 percent.

In a representative profile the surface layer is friable, light brownish-gray silt loam about 6 inches thick. Below this layer is a transitional layer of very pale brown silt loam about 10 inches thick. The underlying material is very pale brown silt loam to a depth of 60 inches. Lime is throughout the profile.

Permeability is moderate, and the available water capacity is high. Natural fertility is medium to low, and organic-matter content is low. Excess lime reduces the amount of phosphorous available to plants.

Where slopes are less than 9 percent, these soils are suited to cultivated crops. They are suited to grass, trees and shrubs, and habitat for wildlife.

Representative profile of Mitchell silt loam, 9 to 20 percent slopes, in native grass 500 feet north and 150 feet west of the southeast corner of sec. 17, T. 33 N., R. 47 W:

- A—0 to 6 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; soft, friable; strong effervescence; moderately alkaline; abrupt, smooth boundary.
- AC—6 to 16 inches, very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) when moist; weak, medium, subangular blocky structure; soft, friable; violent effervescence; moderately alkaline; gradual, wavy boundary.
- C—16 to 60 inches, very pale brown (10YR 8/3) silt loam, light brownish gray (10YR 6/2) when moist; massive; violent effervescence; moderately alkaline.

Lime is at a depth of 0 to 10 inches. Glass shards are common throughout the profile.

The A horizon ranges from 3 to 10 inches in thickness. It is grayish brown to very pale brown. It is dominantly silt loam, but loam and very fine sandy loam are common. The AC horizon has the same range in texture as the A horizon.

Siltstone fragments are common in many profiles. In some areas bedded siltstone is at a depth of 40 to 60 inches.

Mitchell soils are near Bridget, Epping, Keota, and Kadoka variant soils on the landscape. They have a thinner A horizon than Bridget soils. They are deeper over bedrock than Epping and Keota soils. They have a thinner A horizon than Kadoka variant soils and lack the B horizon that is characteristic of those soils.

Mt—Mitchell silt loam, 0 to 1 percent slopes. This soil is on foot slopes. Areas are as much as 300 acres in size.

This soil has a profile similar to the one described as representative for the series, but the surface layer is very pale brown. Weakly developed buried soils are common.

Included with this soil in mapping were areas of soils that have a surface layer of fine sandy loam and areas where buried soils are at a depth of 2 to 4 feet. Bridget soils were also included, and they make up as much as 15 percent of some mapped areas.

Soil blowing is a hazard in cultivated areas. Conserving soil moisture and improving fertility are concerns of management. This soil is easy to work. Runoff is slow.

Most areas of this soil are used for crops. Wheat, oats, and alfalfa are the principal crops. Areas in native grass are used mostly for grazing. Capability units IIc-1, dryland, and I-6, irrigated; Limy Upland range site; windbreak suitability group 5.

MtC—Mitchell silt loam, 1 to 5 percent slopes. This soil is on colluvial foot slopes, upland side slopes, and ridges or knolls. Areas are as much as 300 acres in size.

This soil has a profile similar to the one described as representative for the series, but the transitional layer is slightly thicker. Areas in native grass have a dark grayish-brown surface layer 3 to 7 inches thick. In places this soil has a dark grayish-brown surface layer 8 to 12 inches thick. In some areas buried soils are at a depth of 2 to 5 feet.

Included with this soil in mapping were areas of soils that have a surface layer of fine sandy loam. Bridget and Kadoka variant soils and Epping and Keota soils that occupy higher positions than this soil were included, and they make up as much as 15 percent of some mapped areas.

Water erosion and soil blowing are hazards in cultivated areas. Some areas are eroded, and small gullies are common. Conserving soil moisture is a concern of management. These soils are easily worked. Runoff is slow or medium.

Most of the acreage of this soil is cultivated and is mainly dryfarmed. Wheat, oats, and alfalfa are the principal crops. The rest of the acreage is in native or tame grasses, which are used for grazing or for hay. Capability units IIIe-1, dryland, and IIIe-6, irrigated; Limy Upland range site; windbreak suitability group 5.

MtD—Mitchell silt loam, 5 to 9 percent slopes. This soil is on upland side slopes and ridges or knolls. Areas are as much as 300 acres in size.

This soil has a profile similar to the one described as representative for the series, but the transitional layer is slightly thicker. Areas in native grass have a dark grayish-brown surface layer 3 to 7 inches thick. Included in mapping were Kodoka variant and Keith soils, and Epping and Keota soils on ridges and knolls.

These soils make up as much as 15 percent of some mapped areas.

Water erosion is a very serious hazard in cultivated areas. Soil blowing is also a hazard. Eroded areas have numerous small gullies and are low in natural fertility. This soil is easy to work. Runoff is medium.

A large acreage of this soil is cultivated. Dryfarmed wheat, oats, and alfalfa are the principal crops. A small acreage is in native grass, which is used for grazing or for hay. Capability units IVe-1, dryland, and IVe-6, irrigated; Limy Upland range site; windbreak suitability group 5.

MtF—Mitchell silt loam, 9 to 20 percent slopes. This soil is on upland side slopes and ridgetops in an area between the White River and the Pine Ridge. Areas are as much as 300 acres in size.

This soil has the profile described as representative for the series. Areas in native grass have a dark grayish-brown surface layer 3 to 7 inches thick.

Included with this soil in mapping along drainage-ways were soils that have slopes of 20 to 50 percent. Kadoka variant and Ulysses soils, and Epping and Keota soils generally on higher ridges and knolls than this soil, were included, and they make up as much as 15 percent of some mapped areas.

Water erosion is a very serious hazard in areas that are not in native grass. Soil blowing is also a hazard. Eroded areas have numerous small gullies. Runoff is medium to rapid, depending on degree of slope and the kind and amount of vegetation.

A large acreage of this soil is in native grass and is used for grazing. Most of the remaining acreage has been seeded to tame grasses, which are used for hay. This soil is not suited to the crops commonly grown. Capability unit VIe-1, dryland; Limy Upland range site; windbreak suitability group 5.

MxF—Mitchell-Epping silt loams, 9 to 30 percent slopes. These soils are on uplands. Areas are as much as 500 acres in size. Each area of this mapping unit is made up of about 40 to 65 percent Mitchell silt loam and 35 to 60 percent Epping silt loam. The Mitchell soils are on the middle and lower parts of slopes, and the Epping soils are on the upper part of side slopes and ridgetops.

Included with this unit in mapping were small areas of Bridget, Kadoka variant, and Ulysses soils, which generally make up less than 20 percent of the mapped areas. Also included were Keota soils, which make up as much as 30 percent of some mapped areas.

Water erosion and soil blowing are hazards if the surface of the soils is not protected by grass. Runoff is rapid.

Nearly all the acreage of this complex is in native grass. A few small areas were cultivated, but most of them have been reseeded to grass. These soils are better suited to range than to other uses because of steep slopes and outcrops of siltstone bedrock. Capability unit VIe-1, dryland; Mitchell soil in Limy Upland range site, Epping soil in Shallow Limy range site; windbreak suitability group 10.

Norrest Series

The Norrest series consists of moderately deep, well-

drained soils that formed in material weathered from silty shale. These soils are on uplands. Bedded silty shale is at a depth of 20 to 40 inches. Slopes range from 1 to 20 percent.

In a representative profile the surface layer is friable, grayish-brown silty clay loam about 4 inches thick. The firm subsoil is about 21 inches thick. It is grayish-brown light silty clay in the upper part and light brownish-gray heavy silty clay loam in the lower part. The underlying material is light-gray silty clay loam. White, bedded silty shale is at a depth of 34 inches. Lime is at a depth of 4 inches.

Permeability is moderately slow, and the available water capacity is low. Natural fertility is low, and organic-matter content is moderately low. These soils puddle if they are grazed or worked when too wet. They have poor tilth and are difficult to work.

These soils are better suited to grass than to other uses. In areas where slopes are less than 9 percent, they are suited to crops. They are also suited to trees and shrubs in windbreaks and to habitat for wildlife.

Representative profile of Norrest silty clay loam, 3 to 9 percent slopes, in native grass 1,300 feet west and 800 feet north of the southeast corner of sec. 25, T. 33 N., R. 52 W:

- A—0 to 4 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; hard, friable; mildly alkaline; clear, smooth boundary.
- B2t—4 to 17 inches, grayish-brown (2.5Y 5/2) light silty clay, dark grayish brown (2.5Y 4/2) when moist; moderate, fine, subangular blocky structure; very hard, firm; violent effervescence; moderately alkaline; gradual, smooth boundary.
- B3ca—17 to 25 inches, light brownish-gray (2.5Y 6/2) heavy silty clay loam, grayish brown (2.5Y 5/2) when moist; weak, medium, subangular blocky structure; very hard, firm; violent effervescence; moderately alkaline; clear, wavy boundary.
- C1ca—25 to 34 inches, light-gray (10YR 7/2) silty clay loam, light brownish gray (10YR 6/2) when moist; weak, coarse, subangular blocky structure; hard, firm; few shale fragments; violent effervescence; moderately alkaline; clear, smooth boundary.
- C2—34 to 60 inches, white (10YR 8/2) bedded silty shale, light gray (10YR 7/2) when moist; violent effervescence; moderately alkaline.

Lime is typically at the surface but is leached to a depth of 18 inches in some places.

The A horizon ranges from 4 to 8 inches in thickness. It is dominantly silty clay loam, but small areas of clay loam and silt loam are common. It is dark grayish brown to light brownish gray.

The B2t horizon ranges from 8 to 14 inches in thickness. It is light silty clay, silty clay loam, or clay loam.

The silty shale is soft and can be dug with a spade when moist, but it becomes very hard when dry. Chalcedony fragments are commonly scattered on the surface and throughout the profile.

Norrest soils are near Bufton, Kyle, and Orella soils on the landscape. They are not so deep to shale as Bufton soils and have a B2t horizon that is lacking in those soils. They contain less clay than Kyle soils. They are deeper over silty shale than Orella soils.

NrB—Norrest silty clay loam, 1 to 3 percent slopes. This soil is on upland side slopes and ridgetops. Areas are as much as 100 acres in size.

This soil has a profile similar to the one described as representative for the series, but the subsoil is thicker. Included in mapping were areas of soils that have a surface layer of silty clay; areas of soils that

have a subsoil and underlying material of silt loam; and areas where siltstone is at a depth of 20 to 40 inches. Also included were small areas of Bufton and Kyle soils that occupy lower positions than this soil and Orella soils that occupy higher positions. These soils generally make up less than 15 percent of the mapped areas.

Water erosion is a hazard if the grass cover is destroyed. This soil is difficult to work and puddles if worked or grazed when too wet. It is droughty. Runoff is slow to medium.

Nearly all the acreage of this soil is in native grass and is used mostly for grazing. Capability units IIIe-1, dryland, and IIIe-3, irrigated; Clayey range site; windbreak suitability group 5.

NrD—Norrest silty clay loam, 3 to 9 percent slopes. This soil is on side slopes and ridgetops on uplands. Areas are as much as 200 acres in size.

This soil has the profile described as representative for the series. Included in mapping were areas of soils that have a surface layer of silty clay and areas of soils that have a subsoil and underlying material of silt loam. Also included were areas where siltstone is at a depth of 20 to 40 inches. Bufton and Kyle soils on the lower part of side slopes and in swales and Orella soils on ridges and knolls were included, and they make up as much as 20 percent of some mapped areas.

Water erosion is a hazard in areas where the grass cover is sparse. This soil is difficult to work, and it puddles if worked or grazed when too wet. It releases water slowly to plants and is droughty. Runoff is medium.

Nearly all the acreage of this soil is in native grass and is used for grazing. Capability units IVE-1, dryland, and IVE-3, irrigated; Clayey range site; windbreak suitability group 5.

NrF—Norrest silty clay loam, 9 to 20 percent slopes. This soil is on side slopes and ridgetops on uplands. Areas are as much as 100 acres in size.

This soil has a profile similar to the one described as representative for the series, but the subsoil is thinner. Included in mapping were small areas of Bufton and Kyle soils on the lower part of side slopes and in swales. These soils generally make up less than 15 percent of the mapped areas. Orella soils on ridgetops and knolls were also included, and they make up as much as 30 percent of some mapped areas.

Water erosion is a hazard if the grass cover is destroyed. This soil releases water slowly to plants and is droughty in most years. Runoff is rapid.

All the acreage of this soil is in native grass and is used for range. Capability unit VIe-1, dryland; Clayey range site; windbreak suitability group 5.

Oglala Series

The Oglala series consists of deep, well-drained soils that formed in material weathered from fine-grained sandstone. These soils are on the middle and lower part of side slopes on uplands. Slopes range from 9 to 30 percent.

In a representative profile the surface layer is very friable, grayish-brown loam about 14 inches thick.

Below this layer is a transitional layer of pale-brown silt loam about 10 inches thick. The underlying material is very pale brown, calcareous silt loam that contains fragments of fine-grained sandstone.

Permeability is moderate, and the available water capacity is high. Natural fertility is medium, and organic-matter content is moderate. These soils release water readily to plants.

Oglala soils are better suited to native grass than to other uses. They are not suited to crops, because they are too steep. They are suited to trees and shrubs and to habitat for wildlife.

Representative profile of Oglala loam, 9 to 30 percent slopes, in native grass 2,600 feet east of the southwest corner of sec. 35, T. 31 N., R. 50 W:

- A—0 to 14 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft, very friable; mildly alkaline; gradual, smooth boundary.
- AC—14 to 24 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) when moist; weak, coarse, prismatic structure parting to weak, fine, subangular blocky; soft, very friable; mildly alkaline; gradual, wavy boundary.
- C—24 to 60 inches, very pale brown (10YR 7/3) silt loam, pale brown (10YR 6/3) when moist; massive; soft, very friable; many small fragments of soft, fine-grained sandstone; violent effervescence; moderately alkaline.

Lime is typically at a depth of about 24 inches but ranges from 20 to 42 inches or more. Depth to bedrock ranges from 40 to 60 inches or more.

The A horizon ranges from 7 to 18 inches in thickness. It is mostly loam, but silt loam and very fine sandy loam are common. It is grayish brown to brown.

The AC horizon ranges from 7 to 14 inches in thickness. It is very fine sandy loam to silt loam.

The C horizon is very fine sandy loam to silt loam that generally contains small fragments of sandstone.

Oglala soils are near Bridget, Rosebud, and Canyon soils on the landscape. Unlike Bridget soils, they have a C horizon that consist of material weathered from sandstone bedrock and lime is leached deeper in Oglala soils than in Bridget soils. They are deeper over bedrock than Rosebud soils and lack the B2t horizon that is characteristic of those soils. They have a thicker A horizon and are deeper over bedrock than Canyon soils.

OgF—Oglala loam, 9 to 30 percent slopes. This soil is on hillsides. Areas are as much as 200 acres in size.

This soil has the profile described as representative for the series. Included in mapping were areas of soils that have a surface layer 3 to 6 inches thick; areas of soils that have a surface layer of fine sandy loam to loamy very fine sand; and areas where lime is at a depth of less than 20 inches. Also included were areas of eroded soils that have a pale-brown to very pale brown surface layer. Areas of Bridget, Canyon, Rosebud, and Ulysses soils were also included and make up as much as 15 percent of some mapped areas.

Soil blowing and water erosion are hazards if the soil surface is not protected. Runoff is medium to rapid, depending on the gradient of slope and the kind and amount of cover.

Nearly all the acreage of this soil is in native grass. A few areas are seeded to tame grasses. This soil is unsuited to cultivation because of steepness of slopes. Capability unit VIe-1, dryland; Silty range site; windbreak suitability group 4.

OhF—Oglala-Canyon loams, 9 to 20 percent slopes. The soils in this unit are on side slopes and on ridges

and knolls. Each area is about 60 to 75 percent Oglala soils and 25 to 40 percent Canyon soils. The areas are as much as 1,000 acres in size (fig. 16). The Oglala soils are on the middle and lower part of side slopes, and the Canyon soils are on the top of ridges and knolls.

In some areas the soils have a light brownish-gray surface layer, and in other areas lime is at a depth of less than 20 inches. Included in mapping were small areas of Bridget, Duroc, Keith, Rosebud, and Ulysses soils, which make up less than 25 percent of the mapped areas. Fragments of sandstone are on the surface in some areas.

Water erosion is a hazard if the cover of native grass is removed from these soils. Runoff is medium to rapid, depending on the degree of slope and the kind and amount of vegetation.

Nearly all the acreage of this unit is in native grass and is used mostly for grazing. Nearly all of the areas that were cultivated have been seeded to grass. These soils are not suited to cultivation. Capability unit VIe-1, dryland; Oglala soil in Silty range site, Canyon soil in Shallow Limy range site; Oglala soil in windbreak suitability group 4, Canyon soil in windbreak suitability group 10.

Orella Series

The Orella series consists of shallow, well-drained soils that formed in material weathered from silty shale. Bedded shale is at a depth of 10 to 20 inches. Slopes are mostly 5 to 20 percent, but range from 3 to 50 percent.

In a representative profile the surface layer is friable, light brownish-gray silty clay loam about 5 inches

thick. Below this layer is a transitional layer that is friable, light-gray silty clay loam about 5 inches thick. The underlying material is white silty clay loam that is strongly alkaline. White silty shale is at a depth of 17 inches. Lime is at the surface.

Permeability is moderately slow, and the available water capacity is low. Natural fertility and organic-matter content are low. These soils have a poor tilth. Fragments of chalcedony and silty shale are commonly on the surface.

Orella soils are suited to grass, trees and shrubs, and habitat for wildlife. They are not suited to commonly cultivated crops, because of shallow depth and steepness of slope.

Representative profile of Orella silty clay loam, 3 to 30 percent slopes, in native grass 500 feet south and 500 feet east of the northwest corner of sec. 29, T. 33 N., R. 52 W:

A—0 to 5 inches, light brownish-gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; slightly hard, friable; slight effervescence; mildly alkaline; clear, smooth boundary.

AC—5 to 10 inches, light-gray (10YR 7/2) silty clay loam, grayish brown (10YR 5/2) when moist; weak, coarse; prismatic structure parting to moderate, fine, subangular blocky; slightly hard, friable; strong effervescence; moderately alkaline; clear, smooth boundary.

C1—10 to 17 inches, white (10YR 8/2) silty clay loam, light brownish gray (10YR 6/2) when moist; slightly hard, friable; violent effervescence; strongly alkaline; clear, wavy boundary.

C2—17 to 25 inches, white (10YR 8/1) silty shale, light gray (10YR 7/2) when moist; strong effervescence; moderately alkaline.

Lime is typically at or near the surface.

The A horizon ranges from 2 to 5 inches in thickness. It



Figure 16.—An area of Oglala-Canyon loams, 9 to 20 percent slopes, in native grass. The drainageways support a good stand of ponderosa pine trees.

is clay loam to silty clay. It is dark grayish brown to pale brown.

The AC horizon ranges from 5 to 7 inches in thickness. It is lacking in some profiles.

The C1 horizon is clay loam to silty clay. It is strongly alkaline to very strongly alkaline and is slightly saline to strongly saline. White accumulations of salts are common in the C horizon.

Orella soils are near Bufton, Norrest, and Samsil soils on the landscape. They are not so deep over shale as Bufton and Norrest soils. They contain less clay than Samsil soils.

OrF—Orella silty clay loam, 3 to 30 percent slopes. This soil is on uplands. Areas are as much as 200 acres in size.

This soil has the profile described as representative for the series. Included in mapping were areas of soils that have silty shale and clay shale at a depth of less than 10 inches. Also included were small areas of Bufton and Norrest soils on the lower part of side slopes and in swales, Samsil soils, and areas of Badland. Included areas make up less than 15 percent of any mapped area.

Water erosion is a hazard on this soil if the grass cover is destroyed. Alkalinity and a shallow rooting zone are major limitations to the use of this soil. Runoff is medium to rapid.

All the acreage of this soil is used for range. It is not suited to cultivation, because of alkalinity and the shallow rooting zone. Capability unit VI_s-4, dryland; Saline Upland range site; windbreak suitability group 10.

OsG—Orella-Badland complex, 3 to 50 percent slopes. This complex is on upland ridgetops and hill-sides. The areas are as much as 500 acres in size. Orella silty clay makes up 50 to 60 percent of each mapped area, Badland 25 to 50 percent, and other soils about 15 percent.

Badland, which consists of eroded, barren exposures of silty and clayey shale, is intermixed with Orella soils. Included in mapping are areas where shale is at a depth of less than 10 inches. Also included are small areas of Bufton, Norrest, and Samsil soils.

Alkalinity is the major limitation to use of this complex. Water erosion is a hazard, especially in the Badland areas. Runoff is very rapid in most areas of this complex.

This complex is used for range. The Orella soils support all the grass that is suitable for grazing. Badland rarely supports any kind of vegetation, but a small amount grows in low swale areas. These vegetated areas are so scattered that it is difficult and generally impractical to use them for grazing. Capability unit VII_s-3, dryland; windbreak suitability group 10; Orella soils in Saline Upland range site. Badland not assigned a range site.

Penrose Series

The Penrose series consists of shallow, well-drained soils that formed in material weathered from chalk and chalky shale. They are on uplands. Slopes are mostly 5 to 30 percent but range to as much as 50 percent.

In a representative profile the surface layer is friable, pale-brown silty clay loam about 4 inches thick. The underlying material is very pale brown silty clay loam in the upper 12 inches, and white chalky shale is at a depth of 16 inches. Lime is at the surface.

Permeability is moderately slow, and the available

water capacity is low. Natural fertility and organic-matter content are low.

Penrose soils are suited to grass, trees and shrubs in windbreaks, and food and cover for wildlife. They are not suited to cultivation because of shallow depth and steepness of slope.

Penrose soils in Dawes County are mapped in undifferentiated groups with Minnequa soils and with Shale outcrop.

Representative profile of Penrose silty clay loam from an area of Penrose and Minnequa silty clay loams, 5 to 20 percent slopes, in native grass 2,100 feet west and 500 feet north of the southeast corner of sec. 20, T. 35 N., R. 47 W:

A—0 to 4 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 4/3) when moist; weak, fine, granular structure; slightly hard, friable; few small fragments of chalky shale; violent effervescence; moderately alkaline; gradual, wavy boundary.

C1—4 to 16 inches, very pale brown (10YR 7/4) silty clay loam, light yellowish brown (10YR 6/4) when moist; weak, medium, subangular blocky structure parting to weak, medium, granular; slightly hard, friable; numerous fragments of chalky shale; violent effervescence; moderately alkaline; clear, wavy boundary.

C2—16 to 42 inches, white (10YR 8/2) chalky shale, light gray (10YR 7/2) when moist; violent effervescence; moderately alkaline.

Lime is typically at the surface.

The A horizon ranges from 2 to 6 inches in thickness. It is clay loam to silty clay loam. It is brown to light yellowish brown.

The C1 horizon ranges from 8 to 15 inches in thickness. It is light yellowish brown to very pale brown. It is clay loam to silty clay loam.

Shale or chalky shale is at a depth of 10 to 20 inches. Layers of gypsum, marl, or limestone are common in the shale formation.

Penrose soils are near Minnequa and Samsil soils on the landscape. They are shallower than Minnequa soils. They contain less clay than Samsil soils.

PeG—Penrose-Shale outcrop complex, 10 to 50 percent slopes. This complex consists of about 50 to 75 percent Penrose soils and 25 to 50 percent Shale outcrop. Areas are as much as 300 acres in size. The moderately steep to steep Penrose soils are on ridgetops and upland side slopes and in areas that border drainageways. Outcrops of chalky shale are intermixed with the Penrose soils. The outcrops are on steep to very steep side slopes of ridges, on escarpments, and on eroded side slopes that border drainageways.

Shale outcrop consists of barren, eroded exposures of chalky shale and chalk. Included in mapping were areas where the chalky shale is at a depth of less than 10 inches and areas of soils that have a surface layer of silty clay. Minnequa, Pierre, and Samsil soils, generally on the lower part of the landscape, were included, and they make up as much as 15 percent of some mapped areas.

Water erosion is the main hazard. Livestock that graze continuously on these soils are subject to selenium poisoning. Runoff is very rapid.

All the acreage of this complex is in native grass and is used for grazing. Capability unit VII_s-3, dryland; Penrose soil in Shallow Limy range site, Shale outcrop not assigned a range site: Penrose soil and Shale outcrop both in windbreak suitability group 10.

PmF—Penrose and Minnequa silty clay loams, 5 to

20 percent slopes. The soils in this unit are on uplands. The areas are as much as 250 acres in size. Penrose soils make up 70 to 85 percent of the total acreage of this unit, and Minnequa soils make up about 15 to 30 percent. A delineated area, however, can contain one or both of the soils. The Penrose soils are on ridgetops, knolls, and areas that border drainageways, and the Minnequa soils are on the middle and lower parts of side slopes.

The Penrose soil has the profile described as representative for the Penrose series. The Minnequa soil has a profile similar to the one described as representative for the Minnequa series.

Included with this unit in mapping were small areas of Bufton, Pierre, and Samsil soils on the lower part of side slopes and areas of outcrops of chalky shale, which generally make up less than 20 percent of the mapped areas.

Water erosion is a very serious hazard if a good grass cover is not maintained. Livestock that graze these soils continuously are subject to selenium poisoning. Runoff is medium to rapid, depending on the kind and amount of vegetation and the degree of slope.

All the acreage of this mapping unit is in native grass and is used for grazing. Capability unit VIs-4, dryland; Penrose soil in Shallow Limy range site, Minnequa soil in Limy Upland range site; Penrose soil in windbreak suitability group 10, Minnequa soil in windbreak suitability group 4.

Pierre Series

The Pierre series consists of moderately deep, well-drained soils that formed in material weathered from clay shale. These soils are on uplands. Slopes are mainly less than 11 percent but range from 1 to 30 percent.

In a representative profile the surface layer is firm grayish-brown silty clay about 5 inches thick. The subsoil is very firm light brownish-gray clay about 21 inches thick. The underlying material is light-gray clay over light-gray bedded clay shale, which is at a depth of 34 inches. Lime is at a depth of 5 inches.

Permeability is very slow, and the available water capacity is low. Natural fertility is medium to low, and organic-matter content is moderately low. These soils release water slowly to plants and are droughty in most years. They crack badly in dry weather. They have poor tilth and are difficult to cultivate.

In areas where slopes are less than 5 percent, Pierre soils are marginal for cultivated crops. They are better suited to grass, trees and shrubs, and habitat for wildlife.

Representative profile of Pierre silty clay, 5 to 30 percent slopes, in native grass 800 feet east and 100 feet north of the center of sec. 28, T. 35 N., R. 51 W:

- A—0 to 5 inches, grayish-brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) when moist; moderate, fine, granular structure; hard, firm; mildly alkaline; clear, smooth boundary.
- B21—5 to 17 inches, light brownish-gray (2.5Y 6/2) clay, grayish brown (2.5Y 5/2) when moist; weak, coarse, prismatic structure parting to moderate, fine, angular blocky; very hard, very firm; strong effervescence; moderately alkaline; gradual, wavy boundary.
- B22—17 to 26 inches, light brownish-gray (2.5Y 6/2) clay, grayish brown (2.5Y 5/2) when moist; weak,

coarse, prismatic structure parting to moderate, medium, angular blocky; very hard, very firm; strong effervescence; moderately alkaline; clear, smooth boundary.

C1ca—26 to 34 inches, light-gray (2.5Y 7/2) clay, light brownish gray (2.5Y 6/2) when moist; weak, coarse, prismatic structure parting to weak, coarse, subangular blocky; very hard, very firm; violent effervescence; moderately alkaline; abrupt, wavy boundary.

C2—34 to 60 inches, light-gray (10YR 7/2) bedded clay shale; light brownish gray (10YR 6/2) when moist; mildly alkaline.

Lime is typically at the surface but is leached below the uppermost few inches in places. Bedded clay shale is at a depth of 20 to 40 inches.

The A horizon ranges from 3 to 7 inches in thickness. It is grayish brown to light brownish gray. It is dominantly silty clay but includes areas of clay.

The B horizon ranges from 12 to 21 inches in thickness.

The C1ca horizon ranges from 8 to 18 inches in thickness. The shale is mostly olive, gray, and brown and is red and yellow in places. The C1ca horizon contains moderate amounts of gypsum and salts. Accumulations of gypsum and other salts are commonly concentrated in seams within the platy shale.

Pierre soils are near Kyle and Samsil soils on the landscape. They are not so deep over shale as Kyle soils. They have a B horizon that is lacking in Samsil soils and are deeper over shale than those soils.

PrC—Pierre silty clay, 1 to 5 percent slopes. This soil is on side slopes and ridgetops on uplands. Areas are as much as 500 acres in size.

This soil has a profile similar to the one described as representative for the series, but the subsoil is thicker. Included in mapping were areas of soils in which the upper part of the profile is very dark grayish brown to a depth of 10 inches and areas of soils that have a surface layer of silty clay loam. Kyle soils in swales and Samsil soils that occupy higher positions than this Pierre soil were included, and they make up as much as 15 percent of some mapped areas.

Water erosion and soil blowing are serious hazards in cultivated areas. This soil is hard when dry and puddles if worked or grazed when too wet. It is difficult to work and is droughty because the available water capacity is low and the soil releases water slowly to plants. Conserving soil moisture and improving tilth are concerns of management. Runoff is medium.

Most areas of this soil are used for range, but a small acreage is cultivated. Dryfarmed wheat, alfalfa, and oats are the principal crops. Areas in grass are used for grazing or the grass is cut for hay. Capability unit IVe-4, dryland; Clayey range site; windbreak suitability group 9.

PrF—Pierre silty clay, 5 to 30 percent slopes. This soil is on side slopes and ridgetops on uplands. Areas are as much as 2,000 acres in size.

This soil has the profile described as representative for the series. Included in mapping were small areas of Kyle soils in swales and Samsil soils on ridgetops, and areas of Shale outcrop. The included soils generally make up less than 20 percent of the mapped areas.

Water erosion is a very serious hazard if the grass cover is destroyed. Runoff is medium to rapid, depending on the degree of slope.

Nearly all the acreage of this soil is in native grass and is used for grazing. A small acreage is seeded to alfalfa, which is used for hay. This soil is unsuited to crops, because of steepness of slope and the hazard

of erosion. Capability unit VIe-4, dryland; Clayey range site; windbreak suitability group 9.

PsD—Pierre-Slickspots complex, 3 to 9 percent slopes. This complex is in narrow valleys and on colluvial side slopes that border drainageways. Areas are as much as 200 acres in size. Individual areas consist of about 50 to 70 percent Pierre soils and about 30 to 50 percent Slickspots.

The Slickspots are in shallow depressions 3 to 12 inches lower than the surrounding soil. These depressions are irregular in shape and give the area a scabby or pockmarked appearance. Pondered water remains in the depressions for short periods. The Pierre soils are on slightly higher elevations between the Slickspots.

Included with this complex in mapping were small areas of Norrest soils on side slopes and Kyle soils in swales. The included soils make up less than 15 percent of the mapped areas.

Runoff is medium, depending on the degree of slope and the kind and amount of vegetation. This complex receives some runoff from higher areas.

This complex is in native grass, mainly alkali sacaton and inland saltgrass, and is used for grazing. It is not suited to cultivated crops. The Slickspots support little or no vegetation. Capability unit VIe-1, dryland; Pierre soil in Clayey range site, Slickspots in Panspots range site; Pierre soil in windbreak suitability group 9, Slickspots in windbreak suitability group 10.

Richfield Series

The Richfield series consists of deep, well-drained soils that formed in silty loess material that mantles the uplands and high stream terraces. Slopes range from 1 to 3 percent.

In a representative profile the surface layer is very friable grayish-brown silt loam and light silty clay loam about 10 inches thick. The subsoil is about 20 inches thick. It is firm, light brownish-gray, heavy silty clay loam in the upper part, firm, pale-brown, heavy silty clay loam in the middle, and friable, very pale brown, light silty clay loam in the lower part. The underlying material is light-gray silt loam. Lime is at a depth of 24 inches.

Permeability is moderately slow, and the available water capacity is high. Natural fertility is medium, and organic-matter content is moderate.

Richfield soils are suited to both dryfarmed and irrigated crops. They are well suited to grasses, trees and shrubs, and habitat for wildlife.

Representative profile of Richfield silt loam, 1 to 3 percent slopes, in a cultivated field 2,400 feet west and 100 feet south of the northeast corner of sec. 29, T. 31 N., R. 48 W:

- Ap—0 to 7 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft, very friable; mildly alkaline; abrupt, smooth boundary.
- A12—7 to 10 inches, grayish-brown (10YR 5/2) light silty clay loam, very dark brown (10YR 2/2) when moist; weak, medium, subangular blocky structure parting to weak, fine, granular structure; soft, friable; mildly alkaline; clear, smooth boundary.
- B21t—10 to 16 inches, light brownish-gray (10YR 6/2) heavy silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate, coarse, subangular

blocky structure parting to moderate, fine, subangular blocky; slightly hard, firm; mildly alkaline; clear, smooth boundary.

B22t—16 to 24 inches, pale-brown (10YR 6/3) heavy silty clay loam, brown (10YR 5/3) when moist; moderate, coarse, subangular blocky structure parting to moderate, medium, angular blocky; slightly hard, firm; mildly alkaline; gradual, wavy boundary.

B3ca—24 to 30 inches, very pale brown (10YR 7/3) light silty clay loam, pale brown (10YR 6/3) when moist; weak, coarse, subangular blocky structure parting to weak, medium, subangular blocky; slightly hard, friable; strong effervescence; moderately alkaline; abrupt, wavy boundary.

C—30 to 60 inches, light-gray (10YR 7/2) silt loam, pale brown (10YR 6/3) when moist; massive; soft, very friable; violent effervescence; moderately alkaline.

Lime is at a depth of 16 to 30 inches.

The A horizon ranges from 7 to 13 inches in thickness. It is dark grayish brown to brown. It is dominantly silt loam, but in some areas it is very fine sandy loam.

The B horizon ranges from 8 to 30 inches in thickness. It is silty clay loam to light silty clay.

The C horizon is very fine sandy loam to clay loam.

Richfield soils are near Alliance, Keith, Rosebud, and Ulysses soils on the landscape. They have more clay in the B2 horizon than Keith and Ulysses soils. They also have more clay in the B2 horizon than Alliance and Rosebud soils, which formed in material weathered from sandstone.

RhB—Richfield silt loam, 1 to 3 percent slopes. This soil is mostly on broad ridgetops and tablelands on uplands. Areas are as much as 500 acres in size.

In some areas sandstone fragments or sandstone bedrock are below a depth of 40 inches and some areas have a subsoil of clay loam. Other areas are dark grayish brown to a depth of 30 inches.

Included with this soil in mapping were areas of eroded soils that have a surface layer of clay loam or silty clay loam. Alliance soils on the lower part of side slopes, Duroc soils in swales, and Keith soils on ridgetops are included, and they make up as much as 15 percent of some mapped areas.

Soil blowing and water erosion are hazards if the soil surface is not protected. This soil is easy to work. Runoff is slow.

A large acreage of this soil is cultivated. Dryfarmed wheat, alfalfa, and oats are the principal crops. A few areas of alfalfa are irrigated. The remaining acreage is in native grass, which is used for grazing or is cut for hay. Capability units IIe-1, dryland, and IIe-4, irrigated; Silty range site; windbreak suitability group 4.

Rock Outcrop

Rock outcrop consists of very steep to nearly vertical outcrops of sandstone of the shoulders of drainageways and on the upper part of side slopes in the Pine Ridge area. Some areas are large scenic sandstone buttes that are considerably higher than the surrounding landscape. Rock outcrop has no value for farming or for range and little value for wildlife habitat. A few areas have potential for recreation. In Dawes County, Rock outcrop is mapped in undifferentiated soil groups with Canyon and Bridget soils.

RoG—Rock outcrop-Canyon complex, 30 to 60 percent slopes. This complex is mostly on rough, broken, very steep areas along large drainageways (fig. 17).



Figure 17.—An area of Rock outcrop-Canyon complex, 30 to 60 percent slopes.

Rock outcrop makes up about 35 to 65 percent of each mapped area, Canyon soils 35 to 65 percent, and other soils 10 to 30 percent. The areas are as much as 500 acres in size.

Rock outcrop consists of barren sandstone ledges and escarpments on shoulders and the upper part of side slopes of hills. The areas commonly slope to drainageways. The Canyon soils are mostly on the middle and lower parts of side slopes. Canyon soils have a profile similar to the one described as representative for the Canyon series.

Included with this unit in mapping were areas of very shallow soils less than 10 inches thick over sandstone bedrock and areas of soils that are free of lime. Also included, in the southwestern part of the county, were Tassel soils. Small areas of Rosebud soils and Loamy alluvial land along drainageways in the bottom of canyons were also included.

Available water capacity is low to very low. The soils in this complex are droughty. Runoff is very rapid.

Areas of this complex are in native grass. They produce little forage and are easily overgrazed. The areas are generally not suited to trees or shrubs. Capability unit VII_s-3, dryland; Canyon soil in Shallow Limy range site, Rock outcrop not assigned a range site; both Rock outcrop and Canyon soil in windbreak suitability group 10.

Rosebud Series

The Rosebud series consists of moderately deep, well-drained soils that formed in material weathered from sandstone. These soils are on uplands. Sand-

stone bedrock is at a depth of 20 to 40 inches. Slopes range from 1 to 9 percent.

In a representative profile the surface layer is very friable, dark-gray silt loam about 8 inches thick. The friable subsoil is about 17 inches thick. It is gray light silty clay loam in the upper part, grayish-brown and brown silty clay loam in the middle, and pale-brown light silty clay loam in the lower part. The underlying material is calcareous, pale-brown silt loam. White fine-grained sandstone is at a depth of 30 inches.

Permeability and the available water capacity are moderate. Natural fertility is medium, and organic-matter content is moderate. These soils are easy to work, and they release moisture readily to plants.

Rosebud soils are suited to both dryfarmed and irrigated crops, grass, trees and shrubs, and habitat for wildlife.

Representative profile of Rosebud silt loam, 1 to 3 percent slopes, in native grass 25 feet north of the center of sec. 29, T. 31 N., R. 49 W:

- A—0 to 8 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) when moist; weak, fine, granular structure; soft, very friable; neutral; clear, smooth boundary.
- B1—8 to 14 inches, gray (10YR 5/1) light silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, prismatic structure parting to weak, fine, subangular blocky; slightly hard, friable; neutral; clear, smooth boundary.
- B21t—14 to 18 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; weak, medium, prismatic structure parting to moderate, medium and fine, subangular blocky; slightly hard, friable; neutral; clear, smooth boundary.
- B22t—18 to 22 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) when moist; weak, me-

- dium, prismatic structure parting to moderate, medium and fine, subangular blocky; slightly hard, friable; mildly alkaline; clear, smooth boundary.
- B3—22 to 25 inches, pale-brown (10YR 6/3) light silty clay loam, brown (10YR 5/3) when moist; weak, medium, prismatic structure parting to weak, medium, subangular blocky; slightly hard, friable; few sandstone fragments; mildly alkaline; clear, wavy boundary.
- C1—25 to 30 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) when moist; massive; soft, friable; many coarse sandstone fragments; strong effervescence; moderately alkaline; gradual, wavy boundary.
- C2—30 to 60 inches, white (10YR 8/1) fine-grained sandstone, light gray (10YR 7/1) when moist; violent effervescence.

Lime is at a depth of 10 to 25 inches.

The A horizon ranges from 7 to 10 inches in thickness. It is dominantly loam and silt loam but in some areas it is very fine sandy loam. It is dark grayish brown to brown.

The B horizon ranges from 8 to 18 inches in thickness. The B2t horizon is heavy loam to silty clay loam. Some profiles lack a B3ca horizon.

The C horizon is silt loam to sandy loam and grades into fine-grained sandstone. The sandstone is mostly cemented limy sandstone, but in some places it consists of bedded very fine sand and silt that contains fragments of sandstone.

Rosebud soils are near Alliance, Canyon, and Oglala soils on the landscape. They are not so deep over bedrock as Alliance soils. They have a B horizon that is lacking in Canyon soils and are deeper over bedrock. They have a B horizon that is lacking in Oglala soils and are not so deep over bedrock.

Rosebud soils in Dawes County have a B2t horizon that contains more silt than is defined in the range for the series, but this difference does not alter their usefulness or behavior.

RsB—Rosebud silt loam, 1 to 3 percent slopes. This soil is on tablelands on uplands. Areas are as much as 500 acres or more in size.

This soil has the profile described as representative for the series. In some areas the subsoil is silt loam, and in other areas the dark grayish brown color of the surface layer extends to a depth of about 30 inches.

Included with this soil in mapping were small areas of soils that have a surface layer less than 7 inches thick. Alliance soils on the lower part of side slopes and Canyon soils on ridges and knolls were also included and make up as much as 15 percent of some mapped areas.

Soil blowing is the main hazard, and water erosion is also a hazard in places. Controlling erosion and conserving soil moisture are concerns of management. Runoff is slow.

A large acreage of this soil is cultivated. Dryfarmed wheat, alfalfa, and oats are the principal crops. The remaining acreage is in native grasses, which are used for grazing or for hay. This soil is suited to irrigation. Capability units IIIe-1, dryland, and IIIe-7, irrigated; Silty range site; windbreak suitability group 5.

RxD—Rosebud-Canyon loams, 3 to 9 percent slopes. This mapping unit is on gently rolling and rolling uplands. Areas are as much as 500 acres in size. Rosebud loam makes up about 50 to 70 percent of each mapped area, Canyon loam 15 to 30 percent, and other soils 10 to 25 percent.

The Rosebud soils are on side slopes, and the Canyon soils are on ridgetops and knolls. The Rosebud soils have a profile similar to the one described as representative for the Rosebud series, but their surface layer is loam. The Canyon soils have a profile similar

to the one described as representative for the Canyon series. Included in mapping were areas of Alliance, Bridget, Duroc, Keith, and Oglala soils.

If the soils are cultivated, water erosion and soil blowing are hazards. In some places erosion has removed a part of the surface layer, and tillage has mixed the material remaining in the surface layer with that from the subsoil. In places small areas of Canyon soils on low ridgetops and knolls are cultivated along with deeper soils. In such areas the Canyon soils are easily recognized because of their whitish color and sandstone fragments on the surface. Runoff is medium.

A large acreage of this mapping unit is cultivated. Dryfarmed wheat, alfalfa, and oats are the principal crops. The rest of the areas are in native grass, which is used for grazing or for hay. Capability units IVE-1, dryland, and IVE-7, irrigated; Rosebud soils in Silty range site, Canyon soils in Shallow Limy range site; Rosebud soils in windbreak suitability group 5, Canyon soils in windbreak suitability group 10.

Saline-Alkali Land

Sa—Saline-Alkali land (0 to 5 percent slopes). This land type is on uplands and stream terraces. Some areas are in upland depressions where water ponds for short periods after heavy rains. A few areas are underlain by a water table that fluctuates between depths of 2 and 6 feet.

The surface material of this land type is loam, silt loam, sandy loam, or silty clay loam. Colors range from grayish brown to brown. The underlying material is similar to that of the surface layer in texture. It ranges from light brownish gray to white. Alkalinity is strong to very strong, and salinity is moderate.

Included with this land type in mapping were small areas of Bufton and Tripp soils on slightly high elevations. Also included were a few small areas of soils where slopes are greater than 5 percent.

Available water capacity is high, but water intake is generally slow because of poor tilth and poor structure.

Most areas of this land type are in native grass, mainly saltgrass and alkali sacaton. A few areas have been seeded to tame grass. This land type is not suited to cultivation. Capability unit VIIs-1, dryland; Saline Lowland range site; windbreak suitability group 10.

Samsil Series

The Samsil series consists of shallow, well-drained soils that formed in material weathered from clay shale. These soils are on uplands. Slopes are mostly 11 to 30 percent but range from 3 to 50 percent.

In a representative profile the surface layer is very firm, grayish-brown silty clay about 4 inches thick. The underlying material is very firm, light brownish-gray silty clay in the upper 12 inches. Light-gray bedded clay shale is at a depth of 16 inches. Lime is at the surface.

Permeability is slow, and the available water capacity is very low. Natural fertility and organic-matter content are low.

Samsil soils are not suited to the commonly grown crops. Nearly all areas are in native grass and are used for grazing. These soils are not suited to trees but are fairly well suited to food and cover for wildlife.

Representative profile of Samsil silty clay, 3 to 30 percent slopes, in native grass 2,100 feet north of the southwest corner of sec. 1, T. 34 N., R. 52 W:

A—0 to 4 inches, grayish-brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure parting to moderate, medium, granular; very hard, very firm; strong effervescence; moderately alkaline; clear, smooth boundary.

C1—4 to 9 inches, light brownish-gray (10YR 6/2) silty clay, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure parting to moderate, fine, subangular blocky; very hard, very firm; few shale fragments; strong effervescence; moderately alkaline; clear, smooth boundary.

C2—9 to 16 inches, light brownish-gray (10YR 6/2) silty clay, grayish brown (10YR 5/2) when moist; massive; very hard, very firm; many shale fragments; strong effervescence; mildly alkaline; gradual, wavy boundary.

C3—16 to 24 inches, light-gray (10YR 7/2) bedded clay shale, light brownish gray (10YR 6/2) when moist; strong effervescence; mildly alkaline.

The A horizon ranges from 2 to 4 inches in thickness. It is grayish brown to light brownish gray in color. It is dominantly silty clay, but the range includes clay. It contains few to many shale fragments. Shale is at a depth of 10 to 20 inches.

Samsil soils are near Kyle, Orella, and Pierre soils on the landscape. They lack the B horizon that is characteristic of Kyle and Pierre soils and are shallower to shale bedrock. Samsil soils contain more clay than Orella soils.

ShF—Samsil silty clay, 3 to 30 percent slopes. This soil is on the upper part of side slopes and ridgetops and in areas that border drainageways on uplands. Areas are as much as 1,000 acres or more in size.

This soil has the profile described as representative for the series. Included in mapping were areas of soils where shale is at a depth of less than 10 inches, areas of low lying Pierre soils, and small areas of Shale outcrop. Included soils generally make up less than 20 percent of the mapped areas.

Soil blowing and water erosion are hazards if the soil surface is not protected. A shallow rooting zone makes these soils droughty in most years. Runoff is medium to rapid.

This soil is in native grass and is used for grazing. It is too shallow for cultivated crops. Capability unit VIs-4, dryland; Shallow Clay range site; windbreak suitability group 10.

ShG—Samsil-Shale outcrop complex, 9 to 50 percent slopes. This complex is on uplands north of the White River. Areas are as much as 200 acres in size. Samsil soils make up about 60 to 80 percent of the complex, and Shale outcrop 20 to 40 percent.

Samsil soils have the profile described as representative for the Samsil series. Shale outcrop consists of very steep areas of bedded clay shale. Shale outcrop is scattered throughout the mapped areas, but is commonly at the head of drainageways.

Included with this complex in mapping were very shallow soils less than 10 inches deep over shale and small areas of Badland.

Water erosion is a hazard, and actively eroding gullies are common. A shallow rooting zone makes areas

of this mapping unit droughty in most years. Runoff is rapid to very rapid.

This complex is in native grass and is used for grazing, but nearly all of the grass is on the Samsil soils. Shale outcrop is mostly barren of vegetation. This mapping unit is not suited to cultivated crops but provides some food, cover, and protection for wildlife. Capability unit VIIs-3, dryland; Samsil soils in Shallow Clay range site, Shale outcrop not assigned a range site; both Samsil soils and Shale outcrop in windbreak suitability group 10.

Sandy Alluvial Land

Sn—Sandy alluvial land (0 to 3 percent slopes). This land type consists of calcareous alluvial material on bottom lands and on the short, steep sides of intermittent drainageways. The bottom land areas are dry most of the year but are subject to flooding, mainly in the spring. The water table is below a depth of 10 feet in most places.

The surface layer of the alluvial material is fine sandy loam to very fine sandy loam. The underlying material is stratified loamy sand to fine sandy loam and contains layers of fine sand to clay loam. Small rounded fragments of sandstone are on the surface and throughout the underlying material. Gravel is common below a depth of 40 inches. The material on steep sides of drainageways range from fine sand to fine sandy loam.

Included with this land type in mapping were areas of Glenberg soils on high elevations and Loamy alluvial land. The inclusions generally make up less than 20 percent of the mapped areas.

Most floods are of short duration, and flood water drains from the areas rapidly after the streams recede. Permeability is moderately rapid, and the available water capacity is low to moderate. Runoff is slow on the bottom lands and rapid on the steep sides of drainageways.

This land type is generally not suited to cultivation, because of the hazard of flooding and the meandering stream channels that dissect the bottom lands into small, irregular areas. Flooding also causes damage to fences and deposits sediment and trash on the bottom lands.

Most areas of this land type are in native grass and are used for grazing. A few small areas are planted to alfalfa that is cut for hay. This land type is not suited to cultivation or to planting trees in windbreaks. Most areas provide good habitat for wildlife. Capability unit VIw-6, dryland; Sandy Lowland range site; windbreak suitability group 10.

Sarben Series

The Sarben series consists of deep, well-drained soils that formed in wind-deposited sands. These soils are on uplands. Slopes are mostly 5 to 20 percent but range from 1 to 30 percent.

In a representative profile the surface layer is very friable, grayish-brown fine sandy loam about 6 inches thick. Below this layer is a transitional layer about 18 inches thick. It is very friable fine sandy loam that is brown in the upper part and pale brown in the

lower part. The underlying material is very pale brown fine sandy loam. Lime is at a depth of 24 inches.

Permeability is moderately rapid, and the available water capacity is moderate. Natural fertility is medium to low, and organic-matter content is low. These soils release water readily to plants and are easy to work.

Sarben soils are suited to both dryfarmed and irrigated crops, grass, trees and shrubs, and habitat for wildlife.

Representative profile of Sarben fine sandy loam, 5 to 9 percent slopes, in a cultivated field 750 feet west and 50 feet north of the southeast corner of sec. 8, T. 32 N., R. 51 W:

- Ap—0 to 6 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; soft, very friable; mildly alkaline; gradual, smooth boundary.
- AC1—6 to 12 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) when moist; weak, medium, subangular blocky structure; soft, very friable; mildly alkaline; clear, smooth boundary.
- AC2—12 to 24 inches, pale-brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) when moist; weak, coarse, subangular blocky structure; soft, very friable; mildly alkaline; clear, smooth boundary.
- C—24 to 60 inches, very pale brown (10YR 7/3) fine sandy loam, pale brown (10YR 6/3) when moist; massive; soft, very friable; strong effervescence; moderately alkaline.

Lime is at a depth of 24 to 40 inches.

The A horizon ranges from 3 to 10 inches in thickness. It is fine sandy loam or loamy very fine sand. It is dark grayish brown to pale brown. Where the A horizon is dark grayish brown, it is less than 7 inches thick.

The C horizon is fine sandy loam to loamy very fine sand. In some places it is stratified very fine sandy loam or loam that contains loamy sand below a depth of 24 inches.

Sarben soils are near Busher, Jayem, Valent, and Vetal soils on the landscape. They have a thinner A horizon than Busher, Jayem, Valent, and Vetal soils. They formed in wind-deposited material, and Busher soils formed in material weathered from sandstone. They lack the B horizon that is characteristic of Jayem soils. They have more clay and silt in the C horizon than Valent soils.

SrC—Sarben fine sandy loam, 1 to 5 percent slopes. This soil is on gently rolling uplands. Areas are as much as 100 acres in size.

This soil has a profile similar to the one described as representative for the series, but lime is deeper in the profile. In some areas fine-grained sandstone is at a depth of 40 to 60 inches and in other areas lime is at a depth of less than 24 inches.

Included with this soil in mapping were areas of soils that have a surface layer of loamy sand and areas of soils that have a surface layer of very fine sandy loam, loam, or silt loam. Also included were areas of Bayard, Busher, Jayem, Keith, and Vetal soils, which make up as much as 15 percent of some mapped areas.

Water erosion is a hazard in some places but soil blowing is the main hazard. This soil is easy to work and has good tilth. Moderate available water capacity and moderately rapid permeability cause this soil to be somewhat droughty. Conserving moisture and improving fertility are concerns of management. Runoff is slow because most rainfall is absorbed by the soil.

Nearly all the acreage of this soil is in cultivated crops. Dryfarmed wheat, alfalfa, and oats are the principal crops. Some areas are seeded to tame grass, which is used for grazing or is cut for hay. This soil is

suited to irrigation. Capability units IIIe-3, dryland, and IIIe-8, irrigated; Sandy range site; windbreak suitability group 3.

SrD—Sarben fine sandy loam, 5 to 9 percent slopes. This soil is on rolling uplands. Areas are as much as 300 acres in size.

This soil has a profile similar to the one described as representative for the series. In some areas lime is at a depth of 0 to 24 inches and in other areas fine-grained sandstone is at a depth of 40 to 60 inches.

Included with this soil in mapping were areas of soils that have a surface layer of loamy sand. Also included were areas of Busher, Jayem, Keith, and Valent soils, which make up as much as 15 percent of some mapped areas.

Water erosion and soil blowing are hazards in cultivated areas. Rills or gullies are common in some areas. This soil is easy to work. Improving the fertility and the organic-matter content and conserving soil moisture are concerns of management. Runoff is medium.

Nearly all the acreage of this soil is in cultivated crops. Dryfarmed wheat, alfalfa, and oats are the principal crops. Some areas are seeded to tame grass, which is used for grazing or is cut for hay. Capability units IVe-3, dryland, and IVe-8, irrigated; Sandy range site; windbreak suitability group 3.

SrF—Sarben fine sandy loam, 9 to 30 percent slopes. This soil is on uplands. Areas are as much as 100 acres in size.

This soil has a profile similar to the one described as representative for the series, but the transitional layer is thinner. In some areas lime is at a depth of 0 to 24 inches, and in other areas weathered fine-grained sandstone is at a depth of 40 to 60 inches.

Included with this soil in mapping were areas of soils that have a surface layer of loamy sand. Also included were areas of Bayard, Busher, Jayem, Ulysses, and Valent soils, which make up as much as 20 percent of some mapped areas.

Water erosion and soil blowing are major hazards if the soil surface is not protected. Small gullies are common. Runoff is medium.

This soil is generally too steep and too erodible for cultivation, but where it occurs in areas with soils that are suited to crops, it is cultivated along with those soils. Some areas are seeded to tame grass, which is used for grazing or is cut for hay. Most areas in native grass are used for grazing. Capability unit VIe-3, dryland; Sandy range site; windbreak suitability group 3.

SvF—Sarben and Vetal loamy very fine sands, 9 to 30 percent slopes. This mapping unit is on uplands and foot slopes. Areas are as much as 300 acres in size. Sarben soils make up 60 to 80 percent of the unit and Vetal soils about 20 to 40 percent. An individual area, however, can contain one or both of the soils. Slopes are mostly 9 to 20 percent but range to as much as 30 percent.

The Sarben soils are on the upper part of side slopes and ridgetops. They have a profile similar to the one described as representative for the Sarben series, but the surface layer is loamy very fine sand. The Vetal soils are in swales and on the lower part of foot slopes. They have a profile similar to the one described as

representative for the Vetala series. In some areas of this unit lime is at a depth of less than 24 inches.

Included with this unit in mapping were a few areas of soils that have a surface layer of fine sandy loam. Also included were areas of Busher and Jayem soils, and Tassel soils on ridges and knolls. These included soils make up as much as 15 percent of some mapped areas.

Water erosion and soil blowing are hazards if the soil surface is not protected. Conserving moisture is a concern of management. Runoff is medium.

All the acreage of this mapping unit is in native grass, which is used for grazing or is cut for hay. This unit is too steep for the commonly grown crops. Capability unit VIe-5, dryland; Sandy range site; wind-break suitability group 3.

Schamber Series

The Chamber series consists of shallow, somewhat excessively drained soils (fig. 18). They are gently sloping to steep and occupy escarpments of stream terraces along the Niobrara River and ridges and knolls on uplands north of the Pine Ridge. Slopes range from 3 to 30 percent.

In a representative profile the surface layer is very friable, grayish-brown gravelly very fine sandy loam about 4 inches thick. Below this layer is a transitional layer of grayish-brown gravelly very fine sandy loam about 8 inches thick. The underlying material is very pale brown gravel. Lime is at the surface.

Permeability is rapid in the upper part of the soil and very rapid in the underlying material. The available water capacity is very low. Natural fertility and organic-matter content are low.

Schamber soils are not suited to the commonly grown cultivated crops; they are better suited to range. They are not suited to trees or shrubs but are suited to habitat for wildlife.

Representative profile of Chamber gravelly very fine sandy loam, in an area of Chamber soils, 3 to 30 percent slopes, in native grass 1,320 feet east and 400 feet north of the southwest corner of sec. 35, T. 32 N., R. 51 W:

- A—0 to 4 inches, grayish-brown (10YR 5/2) gravelly very fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; soft, very friable; slight effervescence; mildly alkaline; clear, smooth boundary.
- ACca—4 to 12 inches, grayish-brown (10YR 5/2) gravelly very fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, medium, subangular blocky structure; slightly hard, very friable; violent effervescence; moderately alkaline; gradual, smooth boundary.
- Cca—12 to 60 inches, very pale brown (10YR 7/3) gravel, pale brown (10YR 6/3) when moist; single grained; loose; violent effervescence; moderately alkaline.

The A horizon ranges from 4 to 8 inches in thickness. It is grayish-brown to brown gravelly sandy loam to gravelly very fine sandy loam.

The ACca horizon ranges from 3 to 8 inches in thickness. Gravel in the Cca horizon consists of coarse, rounded and subrounded sandstone fragments that are mostly ½ inch to 3 inches in diameter. It also includes some fragments larger than 3 inches and some sand.

Schamber soils are near Keith, Mitchell, and Pierre soils



Figure 18.—Profile of Chamber gravelly very fine sandy loam. The arrow indicates depth to the gravelly material.

on the landscape. They are gravelly, but Keith and Mitchell soils are silty, and Pierre soils are clayey.

SyF—Schamber soils, 3 to 30 percent slopes. These soils are on terrace escarpments and on ridges and knolls. Areas are as much as 50 acres in size.

These soils have a profile similar to the one described as representative for the series, but the surface layer includes gravelly loam. Included in mapping were areas

of soils in which gravel is at a depth of 20 to 40 inches. Also included were Keith, Mitchell, and Pierre soils on low elevations, and they make up as much as 15 percent of some mapped areas.

Soil blowing and water erosion are hazards if the soil surface is not protected. Runoff is medium to rapid.

These soils are in native grass and are used for grazing. Some areas are a suitable source of gravel for roads and other construction purposes. Capability unit VIs-4, dryland; Shallow to Gravel range site; wind-break suitability group 10.

Shale Outcrop

Shale outcrop consists of steep and very steep areas of exposed clay shale or chalky shale. The shale varies widely in color and is generally limy. The areas are highly erodible. The rate of erosion is more rapid than the rate of soil formation.

The areas of Shale outcrop support too little vegetation to be suited to grazing. Areas can be used for recreation, and they provide limited protection and cover for wildlife.

In Dawes County, Shale outcrop is mapped in complexes with Penrose and Samsil soils.

Slickspots

Slickspots consist of poorly drained material that formed in clayey colluvial-alluvial sediment derived from weathered silty and clayey shale. They are strongly alkaline or very strongly alkaline and moderately saline. The areas are nearly level to strongly sloping. Slickspots occupy small, shallow, irregularly shaped depressions that give the area a pock-marked appearance.

Typically, Slickspots have a surface layer of light brownish-gray silty clay or silty clay loam, 1 to 2 inches thick, that ranges from mildly alkaline to very strongly alkaline. Below this layer is firm brown silty clay or silty clay loam, about 10 to 20 inches thick, that is strongly alkaline or very strongly alkaline and moderately saline. The underlying material is light-gray silty clay, silty clay loam, or silt loam and is moderately alkaline and moderately saline.

Permeability is slow. Slickspots absorb water slowly because of the puddled condition of the surface layer. Water stands in some depressions until it evaporates. Slickspots have a high available water capacity, but they take in water slowly. Runoff is very slow to medium.

Slickspots are too alkaline for most cultivated crops and are better suited to grass. The most common native grasses are saltgrass, wheatgrass, and alkali sacaton. Many areas of Slickspots are barren or nearly barren. A few small areas are cultivated, generally where they occur with more tillable soils. Crops usually die in the Slickspot areas.

Slickspots in Dawes County are mapped in complexes with Bufton, Kyle, and Pierre soils.

Tassel Series

The Tassel series consists of shallow, well-drained

soils that formed in material weathered from fine-grained sandstone. These soils are on uplands. Slopes range from 3 to 30 percent.

In a representative profile the surface layer is very friable, grayish-brown loamy very fine sand about 5 inches thick. Below this layer is a transitional layer of light brownish-gray loamy very fine sand about 5 inches thick. The upper part of the underlying material is light-gray loamy very fine sand 8 inches thick. White, fine-grained sandstone is at a depth of about 18 inches. Lime is at the surface.

Permeability is moderately rapid, and the available water capacity is very low. Natural fertility and organic-matter content are low.

Tassel soils are suited to range and to habitat for wildlife. They are too shallow for commonly cultivated crops or to trees and shrubs in windbreaks.

Representative profile of Tassel loamy very fine sand, in an area of Tassel soils, 3 to 30 percent slopes, in native grass 2,100 feet west and 780 feet south of the northeast corner of sec. 18, T. 29 N., R. 51 W:

- A—0 to 5 inches, grayish-brown (10YR 5/2) loamy very fine sand, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; soft, very friable; few sandstone fragments; strong effervescence; mildly alkaline; clear, smooth boundary.
- AC—5 to 10 inches, light brownish-gray (10YR 6/2) loamy very fine sand, grayish brown (10YR 5/2) when moist; weak, fine, subangular blocky structure; soft, very friable; numerous sandstone fragments; violent effervescence; moderately alkaline; clear, smooth boundary.
- C1—10 to 18 inches, light-gray (10YR 7/2) loamy very fine sand, light brownish gray (10YR 6/2) when moist; single grained; loose; many sandstone fragments; violent effervescence; moderately alkaline; clear, smooth boundary.
- C2—18 to 24 inches, white (10YR 8/2) fine-grained sandstone, light gray (10YR 7/2) when moist; slight effervescence; mildly alkaline.

Lime is typically at the surface but is leached from the upper few inches in places. Few to many, soft to hard sandstone fragments are throughout the profile. Depth to bedrock ranges from 10 to 20 inches.

The A horizon ranges from 3 to 8 inches in thickness. It is fine sandy loam, loamy fine sand, and loamy very fine sand. It is grayish brown to light brownish gray.

The C horizon is fine sandy loam to loamy fine sand.

The underlying sandstone bedrock can be easily dug with a spade in some places but is very hard in others.

Tassel soils are near Bayard, Busher, and Canyon soils on the landscape. They have a thinner A horizon than Bayard and Busher soils and are not so deep over bedrock as those soils. They contain more sand than Canyon soils.

TaF—Tassel soils, 3 to 30 percent slopes. These soils are on ridges and knolls and the sides of upland drainageways. Areas are as much as 500 acres in size.

These soils have a profile similar to the one described as representative for the series, but the surface layer is fine sandy loam, loamy very fine sand, or loamy sand. Included in mapping were areas where sandstone is at a depth of 20 to 40 inches, areas where sandstone is at a depth of 4 to 10 inches, and areas of soils that have a surface layer of loam and very fine sandy loam. Small outcrops of sandstone are included. Also included were areas of Bayard, Busher, Canyon, Jayem, and Sarben soils, which make up as much as 20 percent of some mapped areas.

Soil blowing is a hazard if the grass cover is destroyed. These soils tend to be droughty because the

available moisture capacity is low. Conserving moisture is a concern of management. Runoff is slow to rapid, depending on the degree of slope and the kind and amount of vegetation.

Nearly all the acreage of this mapping unit is in native grass and is used for grazing. Steepness of slope and shallow depth to bedrock make Tassel soils unsuited to cultivation. Where these soils occur in areas of deeper soils, they are cultivated along with those soils. Areas of Tassel soils in cultivated areas are easily recognized by their light color and the coarse sandstone fragments on the surface. Capability unit VIs-4, dryland; Shallow Limy range site; windbreak suitability group 10.

Tripp Series

The Tripp series consists of deep, well-drained soils that formed in silty and loamy alluvium. They are on stream terraces along major drainageways. Slopes range from 0 to 3 percent.

In a representative profile the surface layer is very friable, grayish-brown and gray silt loam about 13 inches thick. The subsoil is very friable silt loam about 15 inches thick. It is light brownish gray in the upper part and light gray in the lower part. The underlying material is light brownish-gray very fine sandy loam to a depth of 60 inches. Lime is at a depth of 22 inches.

Permeability is moderate in the upper part of the subsoil, but it is slightly slower in the lower part where lime has accumulated. The available water capacity is high. Natural fertility is medium, and organic-matter content is moderate.

Tripp soils are suited to both dryfarmed and irrigated crops. They are suited to grass, trees and shrubs, and habitat for wildlife.

Representative profile of Tripp silt loam, 0 to 1 percent slopes, in a cultivated field 1,320 feet west and 300 feet north of the southeast corner of sec. 3, T. 33 N., R. 49 W:

- Ap—0 to 7 inches, grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft, very friable; mildly alkaline; abrupt, smooth boundary.
- A12—7 to 13 inches, gray (10YR 5/1) silt loam, very dark brown (10YR 2/2) when moist; weak, medium, subangular blocky structure parting to weak, medium, granular; soft, very friable; mildly alkaline; clear, smooth boundary.
- B2—13 to 22 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, medium, subangular blocky structure parting to weak, fine, subangular blocky; soft, very friable; mildly alkaline; clear, smooth boundary.
- B3ca—22 to 28 inches, light-gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) when moist; weak, medium, subangular blocky structure; soft, very friable; violent effervescence; moderately alkaline; clear, smooth boundary.
- C—28 to 60 inches, light brownish-gray (10YR 6/2) very fine sandy loam, grayish brown (10YR 5/2) when moist; weak, coarse, subangular blocky structure; soft, very friable; strong effervescence; moderately alkaline.

Lime is at a depth of 20 to 40 inches.

The A horizon ranges from 7 to 14 inches in thickness. It is dark grayish brown to grayish brown. It is mainly silt loam but in some areas it is very fine sandy loam.

The B horizon is silt loam or very fine sandy loam.

The underlying material is silt loam, very fine sandy loam, loam, or sandy loam.

Tripp soils are near Bayard, Bridget, Duroc, and Haverson soils on the landscape. They have more clay in the B horizon than Bayard soils. They have a B horizon that is lacking in Bridget, Duroc, and Haverson soils. They have a thinner A horizon than Duroc soils. They have a thicker A horizon than Haverson soils and are not so stratified as those soils.

Tr—Tripp silt loam, 0 to 1 percent slopes. This soil is on stream terraces. Areas are as much as 200 acres in size.

This soil has the profile described as representative for the series. In some areas lime is at a depth of 14 to 20 inches, and in other areas the surface layer is more than 14 inches thick.

Included with this soil in mapping were areas of soils that have a surface layer of fine sandy loam. Also included and making up as much as 15 percent of some mapped areas are Bayard and Bridget soils that occupy high positions and Haverson soils that occupy low positions.

Soil blowing is a hazard if the soil surface is not protected. This soil is easy to work. Runoff is slow.

A large acreage of this soil is used for cultivated crops. Dryfarmed wheat, alfalfa, and oats are the principal crops. Some areas are irrigated. Areas in native grass are used for grazing, or the grass is cut for hay. Capability units IIc-1, dryland, and I-6, irrigated; Silty range site; windbreak suitability group 4.

TrB—Tripp silt loam, 1 to 3 percent slopes. This soil is on stream terraces. Areas are as much as 200 acres in size.

This soil has a profile similar to the one described as representative for the series, but the surface layer and the subsoil are slightly thinner. In some areas lime is at a depth of 10 to 20 inches, and in other areas the surface layer is less than 7 inches thick.

Included with this soil in mapping were areas of Bayard and Bridget soils on high elevations and Duroc and Haverson soils on low elevations. These included soils make up as much as 15 percent of some mapped areas.

Soil blowing and water erosion are hazards if the soil surface is not protected. This soil is easy to work and has good tilth. Runoff is slow.

Nearly all the acreage of this soil is used for cultivated crops. Dryfarmed wheat, alfalfa, and oats are the principal crops. Some areas are irrigated. Areas in native grass are used for grazing or the grass is cut for hay. Capability units IIe-1, dryland, and IIe-6, irrigated; Silty range site; windbreak suitability group 4.

Ts—Tripp silt loam, saline-alkali, 0 to 2 percent slopes. This soil is on stream terraces along the White River and its tributaries. Areas are as much as 250 acres in size.

This soil has a profile similar to the one described as representative for the series, but alkalinity and salinity are greater. In some places the surface layer is affected by strong alkalinity, and in other places the subsoil and underlying material are affected. Alkalinity ranges from moderate to strong, and salinity is moderate. The saline-alkali condition is spotty and is not uniformly distributed throughout the areas. In some places only about 20 percent of an area is af-

affected, and in other places nearly all of an area is affected.

Included with this soil in mapping were areas of soils that have a surface layer 14 to 24 inches thick and a few areas of soils that have slopes of 2 to 5 percent. Also included were small areas of soils in which the water table is at a depth of 2 to 6 feet and areas of soils that are very strongly affected by alkali. Areas of Bayard, Bufton, and Haverson soils and Tripp silt loam were included and make up as much as 15 percent of some mapped areas.

Soil blowing is a hazard if the soil surface is not protected. Water commonly ponds in small depressions after rains. Soil tilth is generally poor in the saline-alkali spots. Runoff is slow.

A large acreage of this soil is in native grass. Inland saltgrass or clumps of alkali sacaton generally grow on the saline-alkaline spots. A small acreage is cultivated, mainly to wheat. Capability units IVs-1, dryland, and IIIs-6, irrigated; Saline Lowland range site; windbreak suitability group 8.

Ulysses Series

The Ulysses series consists of deep, well-drained soils that formed in loess on uplands. Slopes range from 3 to 20 percent.

In a representative profile the surface layer is very friable, grayish-brown silt loam about 8 inches thick. The subsoil is friable, pale-brown silt loam about 8 inches thick. The underlying material is calcareous, very pale brown silt loam.

Permeability is moderate, and the available water capacity is high. Natural fertility is medium, and organic-matter content is moderate. These soils are easy to work and have good tilth.

Where slopes are less than 9 percent, Ulysses soils are suited to both dryfarmed and irrigated crops. The erosion hazard is very severe on steeper areas. They are suited to grass, trees and shrubs, and habitat for wildlife.

Representative profile of Ulysses silt loam, 9 to 20 percent slopes, in a cultivated field 1,300 feet east and 500 feet south of the northwest corner of sec. 11, T. 31 N., R. 50 W:

- Ap—0 to 5 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft, very friable; mildly alkaline; abrupt, smooth boundary.
- A12—5 to 8 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, subangular blocky structure parting to weak, fine, granular; slightly hard, friable; mildly alkaline; clear, smooth boundary.
- B2—8 to 16 inches, pale-brown (10YR 6/3) silt loam, dark grayish brown (10YR 4/2) when moist; weak, medium, prismatic structure parting to weak, medium, subangular blocky; slightly hard, friable; mildly alkaline; gradual, wavy boundary.
- C—16 to 60 inches, very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) when moist; weak, coarse, prismatic structure; soft, very friable; violent effervescence; moderately alkaline.

Lime is at a depth of 6 to 15 inches.

The A horizon ranges from 7 to 10 inches in thickness. It is dominantly silt loam but some areas are loam or very fine sandy loam. It is dark grayish brown to grayish brown.

The B horizon ranges from 4 to 12 inches in thickness. It is silt loam or very fine sandy loam.

The C horizon is silt loam to very fine sandy loam.

Ulysses soils are near Keith, Richfield, and Jayem soils on the landscape. They have less clay in the B horizon than Keith and Richfield soils and have lime nearer to the surface. They contain more clay and silt than Jayem soils.

UsF—Ulysses silt loam, 9 to 20 percent slopes. This soil is on uplands. Areas are as much as 200 acres in size.

This soil has the profile described as representative for the series. In some areas the surface layer is loam or very fine sandy loam, in other areas lime is below a depth of 16 inches, and in still other areas the surface layer is less than 7 inches thick.

Included with this soil in mapping were areas of soils that occupy slightly higher positions on the landscape than this Ulysses soil. The soils have a surface layer of fine sandy loam. Duroc soils in swales and Oglala, Bridget, and Mitchell soils were included. These soils make up as much as 15 percent of some mapped areas.

Water erosion is a very severe hazard if the grass cover is destroyed. Runoff is medium.

Nearly all the acreage of this soil is in native grass and is used for grazing. In a few places, the grass is cut for hay. Because of the moderately steep slopes, this soil is better suited to grass than to other uses. Capability unit VIe-1, dryland; Silty range site; windbreak suitability group 5.

Valent Series

The Valent series consists of deep, excessively drained soils that formed in eolian sands. They are on uplands and on stream terraces along major drainage-ways. The areas are nearly level to steep. Most areas have complex slopes. Slopes are mainly less than 10 percent but range from 0 to 17 percent.

In a representative profile the surface layer is very friable, grayish-brown loamy fine sand about 4 inches thick. Below this layer is a transitional layer of brown fine sand about 10 inches thick. The underlying material is pale-brown fine sand.

Permeability is rapid, and the available water capacity is low. Natural fertility and organic-matter content are low. These soils absorb water rapidly.

Valent soils are better suited to range than to other uses. They are not suited to the commonly grown dryland crops but are suited to irrigation in some places. These soils are suited to trees and shrubs in windbreaks and to production of food and cover for wildlife.

Representative profile of Valent loamy fine sand, in an area of Valent and Dwyer loamy fine sands, 3 to 17 percent slopes, in native grass 2,000 feet north and 50 feet east of the southwest corner of sec. 18, T. 29 N., R. 50 W:

- A—0 to 4 inches, grayish-brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; soft, very friable; mildly alkaline; clear, smooth boundary.
- AC—4 to 14 inches, brown (10YR 5/3) fine sand, brown (10YR 4/3) when moist; weak, medium, subangular blocky structure; loose; mildly alkaline; gradual, smooth boundary.
- C—14 to 60 inches, pale-brown (10YR 6/3) fine sand, brown (10YR 5/3) when moist; single grained; loose; mildly alkaline.

The A horizon ranges from 3 to 9 inches in thickness. It is dark grayish brown to grayish brown. It is dominantly loamy fine sand but in some areas it is fine sand.

Some profiles lack an AC horizon.

The C horizon is loamy sand or fine sand.

Valent soils are near Busher, Jayem, and Dwyer soils on the landscape. They have a thinner A horizon and contain more sand than Busher and Jayem soils. They have lime leached deeper in the profile than Dwyer soils.

VaB—Valent and Dwyer loamy fine sands, 0 to 3 percent slopes. This mapping unit is on uplands and on stream terraces along drainageways. Areas are as much as 200 acres in size. Some areas consist almost entirely of Valent soils, some are almost entirely Dwyer soils, and many areas consist of both soils. Valent soils make up more of the total acreage than Dwyer soils. Slopes are mainly complex because many areas are hummocky.

The Valent soils have a profile similar to the one described as representative for the Valent series. The Dwyer soils have the profile described as representative for the Dwyer series. In some areas the surface layer is dark grayish brown to a depth of 20 inches or more, and a few areas that have pebbles on the surface and throughout the profile.

Included with this unit in mapping were areas of Bankard, Bayard, and Vetral soils on lower elevations, which make up as much as 20 percent of some mapped areas.

Soil blowing is a hazard in cultivated areas. Runoff is slow because nearly all rainfall is absorbed as rapidly as it falls.

Nearly all the acreage of this unit is in native grass and is used for grazing. A low available water capacity and a lack of seasonal rainfall makes these soils unsuited to commonly grown dryland crops. A few small areas of alfalfa are irrigated. Capability units VIe-5, dryland, and IVe-11, irrigated; Sandy range site; windbreak suitability group 3.

VaF—Valent and Dwyer loamy fine sands, 3 to 17 percent slopes. This mapping unit is on uplands. Areas are as much as 1,000 acres in size. Some areas consist almost entirely of Valent soils, some are almost entirely Dwyer soils, and many consist of both soils. Valent soils make up more of the total acreage than Dwyer soils. Most areas have complex slopes and a hummocky landscape.

The Valent soils have the profile described as representative for the Valent series. The Dwyer soils have a profile similar to the one described for the Dwyer series. In some areas the underlying material contains fragments of sandstone, and in other areas sandstone is at a depth of 20 to 40 inches.

Included with this unit in mapping were areas of soils that have a surface layer of sandy loam or loamy very fine sand. Busher and Jayem soils on lower elevations were included, and they make up as much as 15 percent of some mapped areas.

Soil blowing is a very severe hazard if the grass cover is destroyed. Blowouts are common in some areas. Runoff is slow.

Nearly all the acreage of this mapping unit is in native grass, which is used for grazing or for hay. The soils are too erodible and too droughty for most dryland crops. Capability unit VIe-5, dryland; Sands range site; windbreak suitability group 7.

Vetral Series

The Vetral series consists of deep, well-drained soils that formed in sandy alluvium and colluvium on foot slopes in upland swales. Slopes are mostly less than 9 percent but range from 1 to 30 percent.

In a representative profile the surface layer is very friable, grayish-brown and dark-gray loamy very fine sand about 31 inches thick. Next is a transitional layer of pale-brown loamy very fine sand about 7 inches thick. The underlying material is very pale brown loamy very fine sand.

Permeability is moderately rapid, and the available water capacity is moderate. Natural fertility is medium, and organic-matter content is moderate.

Where slopes are less than 9 percent, Vetral soils are suited to both dryfarmed and irrigated crops. These soils are suited to grass for grazing or for hay. They are well suited to trees and shrubs in windbreaks and to habitat for wildlife.

Representative profile of Vetral loamy very fine sand, in an area of Vetral and Bayard soils, 1 to 5 percent slopes, in native grass 750 feet north and 50 feet east of the southeast corner of sec. 19, T. 31 N., R. 50 W:

A11—0 to 15 inches, grayish-brown (10YR 5/2) loamy very fine sand, very dark brown (10YR 2/2) when moist; weak, medium and fine, granular structure; soft, very friable; neutral; clear, smooth boundary.

A12—15 to 31 inches, dark-gray (10YR 4/1) loamy very fine sand, very dark gray (10YR 3/1) when moist; weak, medium and fine, subangular blocky structure parting to weak, medium and fine, granular; soft, very friable; mildly alkaline; clear, smooth boundary.

AC—31 to 38 inches, pale-brown (10YR 6/3) loamy very fine sand, dark brown (10YR 4/3) when moist; weak, medium and coarse, subangular blocky structure; soft, very friable; mildly alkaline; gradual, smooth boundary.

C—38 to 60 inches, very pale brown (10YR 7/3) loamy very fine sand, brown (10YR 5/3) when moist; single grained; loose; moderately alkaline.

Lime is at a depth of 30 to 60 inches or more.

The A horizon ranges from 14 to 40 inches in thickness. It is dark gray to grayish brown. It is mostly loamy very fine sand, but fine sandy loam and sandy loam are also common. It is neutral or mildly alkaline.

The AC horizon ranges from 8 to 20 inches in thickness. It is neutral to mildly alkaline.

The C horizon is mildly alkaline to moderately alkaline.

Vetral soils are near Bayard, Busher, Jayem, and Sarben soils on the landscape. They have a thicker A horizon than Bayard, Busher, Jayem, or Sarben soils. They lack the B horizon that is characteristic of Jayem soils.

VeC—Vetral and Bayard soils, 1 to 5 percent slopes. This mapping unit is on foot slopes and stream terraces. Areas are as much as 300 acres in size. Vetral soils make up 55 to 75 percent of the total acreage, and Bayard soils 25 to 45 percent. An individual area, however, can contain either one or both of the soils.

These soils have a profile similar to the one described as representative for their respective series, but the surface layer includes very fine sandy loam, fine sandy loam, and loamy very fine sand. In some areas the surface layer is less than 7 inches thick and in other areas silty material is below a depth of 2 feet. Buried soils are common.

Included with this unit in mapping were a few areas of soils that are mildly alkaline to moderately alkaline.

Some areas of Bridget, Glenberg, and Tripp soils on low elevations were included and make up as much as 15 percent of some mapped areas.

Soil blowing is a hazard if the soil surface is not protected. Conserving soil moisture is a concern of management where the soils are dryfarmed. Runoff is slow.

About half the acreage of these soils is in crops, and half is in range. Wheat, alfalfa, and oats are the principal crops. Some areas are seeded to tame grasses, which are used for hay. Areas in native grass are used for grazing or the grass is cut for hay. Capability units IIIe-5, dryland, and IIIe-8, irrigated; Sandy range site; windbreak suitability group 3.

Wet Alluvial Land

Wx—Wet alluvial land (0 to 3 percent slopes). This land type consists of deep deposits of alluvium that are mostly in long, narrow areas on bottom lands. A water table fluctuates from a depth of about 2 feet to near the surface, and at times water is on the surface. A few areas are strongly affected by salts or alkali.

The surface layer is fine sandy loam, loamy fine sand, or fine sand. It is dark grayish brown, gray, or grayish brown. The underlying material is stratified and ranges from sand to fine sandy loam. Gravel is below a depth of 24 inches in some places. The surface layer is generally darker than the underlying material, but buried dark-colored layers are common. In most places the underlying material has yellowish-brown to reddish-brown mottles.

In some areas the surface layer and the underlying material are very fine sandy loam, loam, or clay loam. Included in mapping were small areas of Bankard variant soils on the slightly high parts of bottom lands.

Permeability is rapid, but drainage is limited by the high water table. Runoff is very slow.

All the acreage of this land type is in native grass, which is used for range and for hay. Without artificial drainage, this land type is not suited to the commonly grown crops. Capability unit Vw-7, dryland; Wet Land range site; windbreak suitability group 10.

Use and Management of the Soils

This section explains the system of capability classification used by the Soil Conservation Service and describes the management of the soils in Dawes County by capability units. In addition, predicted average acre yields of the principal irrigated and dryland crops grown in the county are given, and management of the soils for range, woodland and windbreaks, wildlife, recreation, and engineering purposes are discussed.

Crops and Pasture³

About 22 percent of the soils in Dawes County are

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well suited to the crops commonly grown in the county. Another 14 percent are suited to crops, but the soils have severe or very severe hazards. Some soils are sandy and are subject to soil blowing. Others are on bottom lands and are subject to occasional flooding. About 6 percent of the soils are fine textured, and preparing a seedbed is difficult, especially during very dry or very wet periods. Soil losses from water erosion, and the subsequent deposit of silt in the valleys, occurs in many places on uplands.

The major dryfarmed crop is winter wheat. Among the other important grain crops are oats, barley, and rye. Small areas of corn and sorghum are grown both for grain and for silage. Almost 5 percent of the acreage of Dawes County is in alfalfa, used for hay for livestock. A large acreage is summer fallowed each year.

Only a minor acreage in Dawes County is used for dryland pastures. Dryland pastures are commonly in small lots near farmsteads and building sites. They are usually planted to cool-season grasses and are grazed during spring and fall. A small acreage that was formerly cultivated is planted to cool-season grasses as part of the early land use programs of the Department of Agriculture. Cattle graze mainly the large areas of native range and a few small areas of irrigated pasture.

In 1972, according to the Nebraska Agricultural Statistics, about 16,800 acres was irrigated in Dawes County. Water for irrigation comes from approximately 36 irrigation wells and from surface water diverted from the White River to be used in the Whitney Irrigation Project. The chief irrigated crops are alfalfa and tame grasses for hay. A small acreage of corn is also irrigated.

In general, the underground water supply of Dawes County is not extensive. Where sufficient underground water is available, there is a potential for increasing the amount of irrigated land.

Capability grouping

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

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

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

Capability Classes, the broadest groups, are designated by Roman numerals I through VIII. The nu-

merals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

- Class I soils have few limitations that restrict their use.
- Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.
- Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.
- Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.
- Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, range, or wildlife habitat.
- Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife habitat.
- Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife habitat.
- Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife habitat, water supply, or esthetic purposes.

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, saline or alkaline, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use.

Capability Units are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-1 or IIIe-6. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass or kind of limitation as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass. The capability unit designation for each soil in the county can be found in the "Guide to Mapping Units."

In the following pages the capability units represented in Dawes County are described, and suggestions for the use and management of the soils are given.

Management of dryfarmed cropland

Conservation practices such as terracing, contour farming, stripcropping, and a cropping system that includes mulch tillage are suited to such soils as the gently sloping and strongly sloping Alliance, Keith, Kadoka variant, and Keota soils. Some gently sloping soils on which wheat is the principal crop are particularly well suited to use of flat channel terraces to conserve soil moisture. The flat channels are about 50 to 80 feet wide and are constructed so that they retain all the runoff from the field and spread it in a shallow layer over the entire channel. Thus, the channel contains an increased amount of moisture that can be used by crops.

Soil blowing on the moderately coarse and coarse soils can be adequately controlled by keeping a mulch of crop residue on the surface. Fields can be arranged in narrow strips of alternate protected and nonprotected areas, and in places narrow belts of trees can be planted for field windbreaks. These practices help to control soil blowing on Busher, Glenberg, Bankard, and Sarben soils.

Cultivated soils in Dawes County should be tested to determine their need for additional plant nutrients, which can be provided by use of commercial fertilizer or barnyard manure. A correlation should be made between the amount of moisture in the soils and the amount of fertilizer applied, particularly for dryfarmed crops. During periods of little rainfall, some soils that have a dry subsoil do not need fertilizer, or they need smaller applications than during periods of normal or above-average rainfall. A light application of nitrogen can increase yields of winter wheat planted on fallow land where extra moisture is stored for the next crop. Mitchell and Keota soils and the Kadoka variant soil generally respond to applications of phosphorus and zinc.

Leaving crop residue on the soil surface during tillage operations helps to reduce soil losses from water erosion and soil blowing. Using mulch tillage and a till-plant system of seedbed preparation helps to reduce runoff and sediment loss on soils planted to row crops. Keeping straw, stalks, or other residue on the soil surface during summer fallow operations also helps to reduce soil blowing. Steep or sandy soils used for pasture need an adequate growth of grass as protection against water erosion. To protect pasture and range, at least 4 inches of grass should be maintained at all times.

The fine-textured soils, such as those in the Buffington, Pierre, and Kyle series, can support a cropping system that keeps grass on the soil most of the time. Maintaining a cover of grass reduces the amount of tillage necessary.

Saline-Alkali land and areas of Slickspots are better suited to grasses than to other uses. Tall wheatgrass and western wheatgrass can be used under dryland conditions. A drainage system of V-ditches helps to prevent flooding of low areas. Washing or leaching

the salts and alkali from the rooting zone of plants is generally difficult because many of the soils are fine textured.

CAPABILITY UNIT IIc-1, DRYLAND

In this unit are deep, well-drained, very gently sloping soils on uplands, stream terraces, and foot slopes (fig. 19). The soils have a surface layer of very fine sandy loam or silt loam, and their subsoil is very fine sandy loam to heavy silty clay loam.

Permeability is moderately slow to moderate, and the available water capacity is high. The organic-matter content is moderate, and the natural fertility is medium. The soils absorb moisture easily and release it readily to plants. Runoff is slow to medium.

If these soils are cultivated, water erosion and soil blowing are the main hazards. A lack of sufficient moisture in many years limits the growth of dry-farmed crops. Maintenance of the organic-matter content is a concern of management.

The soils are suited to wheat, alfalfa, and grass and to such row crops as sorghum and corn. Wheat is the principal crop. Deep-rooted crops, such as alfalfa, benefit from subirrigation where these soils are on low

stream terraces. Stripcropping, stubble mulch tillage, and terracing help to conserve moisture and to control erosion. The soils are especially well suited to terracing. The terraces are mostly of the level type and have either V-shaped or flat channels. Level terraces that have a flat channel distribute rainwater better than those that have a V-shaped or narrow channel. Summer fallow is commonly used on these soils to store extra moisture for the following year's wheat crop. Stubble mulch tillage and summer fallow help to control soil blowing.

CAPABILITY UNIT IIw-3, DRYLAND

In this unit are deep, well-drained, nearly level and very gently sloping soils on bottom lands. The soils have a surface layer of silt loam or silty clay loam, and their underlying material is very fine sandy loam or silt loam.

Permeability is moderately slow or moderate, and the available water capacity is high. The organic-matter content is low, and the natural fertility is medium to low. The soils absorb and store water well. Runoff is slow. Most of the soils are easy to work, but those that have a surface layer of silty clay loam



Figure 19.—An area of Keith silt loam, 1 to 3 percent slopes, capability unit IIc-1, dryland.

puddle easily when too wet and become hard or cloddy if worked when dry.

Occasional flooding is the main limitation to use of the soils. A damaging flood occurs in about 1 year out of 5. In places floods deposit sediment or debris, which damages crops and fences. Conserving soil moisture, increasing the organic-matter content, and improving soil tilth and fertility are concerns of management.

The soils are better suited to alfalfa and grass than to other crops. Where flooding is controlled, some areas are used for such small grain crops as wheat, oats, and barley and for such row crops as corn and sorghum. In some areas flooding is controlled by diversions. In other areas, detention reservoirs constructed upstream help to control flooding.

CAPABILITY UNIT IIw-4, DRYLAND

Only Las Animas soils, 0 to 2 percent slopes, is in this unit. It is a deep, somewhat poorly drained soil on bottom lands. It has a surface layer of fine sandy loam to silt loam, and its underlying material is stratified loamy fine sand and very fine sandy loam to a depth of 48 inches. Below this layer is coarse sand. The water table is at a depth of 2 to 6 feet.

Permeability is moderately rapid, and the available water capacity is moderate. The organic-matter content is moderately low, and the natural fertility is medium to low. The soil absorbs moisture easily and releases it readily to plants. It is generally easy to work. Runoff is slow.

Wetness is the main limitation to use of the soil. During wet periods in spring, tillage is delayed. Soil blowing is a minor hazard. Increasing the organic-matter content and improving soil fertility are concerns of management.

The soil is suited to alfalfa, wheat, corn, and grass. It is better suited to alfalfa, corn, and grass than to other uses. A drainage system of tile drains or open ditches can be used to lower the water table, but suitable outlets are difficult to find. A cropping system that provides for crop residue on the soil surface helps to prevent soil blowing. Applying commercial fertilizer helps to maintain soil fertility.

CAPABILITY UNIT IIe-1, DRYLAND

In this unit are deep, well-drained, nearly level to very gently sloping soils on uplands, foot slopes, stream terraces, and bottom lands. The soils have a surface layer of silt loam, and their subsoil is very fine sandy loam or silt loam. Some areas are rich in lime.

Permeability is moderate, and the available water capacity is high. The organic-matter content is low to moderate, and the natural fertility is medium to low. The soils absorb moisture easily and release it readily to plants. They are easy to work. Runoff is slow.

Conservation of moisture is the main concern of management. Maintaining organic-matter content and soil fertility are also concerns. Soil blowing is a hazard if the soil surface is not protected. Seasonal rainfall is commonly inadequate to meet the needs of all crops.

The soils are well suited to such crops as winter wheat and other small grain and to such row crops as grain sorghum and corn. Wheat is generally planted on soils that have been fallowed the previous year. A

lack of sufficient rainfall limits production of dry-farmed crops. Alfalfa can obtain some moisture from the water table beneath the low stream terraces and high bottom lands.

A cropping system in which wheat is alternated with fallow helps to conserve moisture and to maintain soil fertility. If a longer cropping system is used, a suitable sequence is 1 year each of wheat, fallow, and other small grains or grain sorghum. Crop residue should be left on the soil surface during tillage operations. Stubble mulch tillage during fallow operations helps to conserve water, to add organic matter, and to prevent soil blowing.

CAPABILITY UNIT IIIe-1, DRYLAND

In this unit are deep and moderately deep, well-drained, very gently sloping to strongly sloping soils on uplands, foot slopes, and stream terraces. The soils have a surface layer of silt loam, loam, or silty clay loam, and their subsoil is very fine sandy loam to silty clay. Some areas are moderately eroded.

Permeability is slow to moderate, and the available water capacity is low to high. The organic-matter content is low to moderate, and the natural fertility is medium to low. Except for the silty clay loams, which are droughty, the soils absorb moisture easily and release it readily to plants. Most of the soils are easy to work, but the silty clay loams lack good tilth, and they puddle if worked or grazed when too wet. Runoff is slow to medium.

Water erosion is the main hazard to use of these soils. Soil blowing is a hazard in some areas. Conserving soil moisture is a major concern of management because adequate seasonal rainfall is lacking in most years. Increasing organic-matter content and improving soil fertility are also concerns.

The soils are suited to wheat, corn, sorghum, and grasses. Dryfarmed row crops should not be grown more than 2 years in succession. Cover crops and emergency tillage help to protect the soils from blowing in dry years when crops fail to produce enough residue. Contour stripcropping, stubble mulch tillage, terracing (fig. 20), and contour farming help to control water erosion. In some areas terracing and contour farming are difficult. A cropping system of close-drilled grasses and hay crops helps to control water erosion in these areas. Leaving most crop residue on the surface also reduces water erosion and soil blowing.

CAPABILITY UNIT IIIe-3, DRYLAND

Only Sarben fine sandy loam, 1 to 5 percent slopes, is in this unit. It is a deep, well-drained soil on uplands. It has a surface layer and underlying material of fine sandy loam.

Permeability is moderately rapid, and the available water capacity is moderate. The organic-matter content is low, and natural fertility is medium to low. The soil absorbs moisture easily and releases it readily to plants. It is easy to work and can be tilled relatively early after rains. Runoff is slow.

Soil blowing is the main hazard on this soil. Conserving soil moisture is a major concern of management because rainfall is inadequate for crops in most



Figure 20.—Terraces and stripcropping on an area of Kadoka silt loam, deep variant, 3 to 9 percent slopes, eroded.

years. Increasing the organic-matter content and improving soil fertility are also concerns.

The soil is suited to corn, alfalfa, wheat, other small grains, and grass. Row crops can be safely grown 1 year to 2 years in succession. Stripcropping, field windbreaks, cover crops, and stubble mulch tillage help to control soil blowing and to reduce water erosion.

A suitable cropping system consists of crops that provide a protective cover most of the year, especially in fall and in winter. Cover crops are needed to protect the soil, especially where soil blowing is a hazard. If soil fertility is maintained, crops generally produce sufficient residue to protect the areas against soil blowing. In some dryfarmed areas that are exposed to wind, most of the organic matter and the fine soil particles have been lost through soil blowing. In these areas, working stubble and other residue into the soil helps to increase the organic-matter content and to hold the soil in place.

CAPABILITY UNIT III₆-5, DRYLAND

In this unit are deep, well-drained to somewhat excessively drained, nearly level to gently sloping soils on uplands, foot slopes, and stream terraces. The soils have a surface layer and underlying material of loamy very fine sand. Some soils are moderately eroded.

Permeability is moderately rapid, and the available water capacity is moderate. The organic-matter content is low to moderate, and the natural fertility is medium to low. The soils absorb moisture easily and release it readily to plants. Runoff is slow.

Soil blowing and water erosion are severe hazards if the soils are cultivated. A lack of adequate soil moisture in most years limits the growth of dryfarmed crops. Conserving soil moisture, increasing organic-matter content, and improving fertility are concerns of management.

The soils are suited to wheat, rye, and alfalfa. They are better suited to grasses and to other close-growing crops than to other crops.

Keeping the surface of the soils covered by growing

crops, grass, or residue helps to reduce soil blowing. All residue should be returned to the soil. Wind stripcropping or planting crops in narrow strips helps to protect wide areas from severe soil blowing. A cover of crop residue on the surface of the soils also helps to reduce water erosion. In some areas tree windbreaks help to reduce soil blowing.

CAPABILITY UNIT III₆-2, DRYLAND

In this unit are deep, well-drained, nearly level soils on uplands and stream terraces. The soils have a surface layer of silty clay loam or silty clay, and their subsoil is light silty clay loam or heavy silty clay loam. They are rich in lime.

Permeability is slow or moderately slow, and the available water capacity is high. The organic-matter content is moderately low, and the natural fertility is medium to low. The soils absorb moisture slowly and release it slowly to plants. They are difficult to work because they puddle if worked when too wet and are cloddy and hard when dry. Runoff is slow.

These fine textured and moderately fine textured soils are droughty and difficult to cultivate, which are the main limitations to use. Dryfarmed areas lack adequate moisture in most years, and conserving moisture is a major concern of management. Increasing the organic-matter content and improving soil tilth and fertility are also concerns if the soils are cultivated.

The soils are suited to wheat, to other close-growing small grain, and to grasses or trees. The fine-textured soils are better suited to grasses and to alfalfa than to other crops because they are difficult to work, and preparing a seedbed on these soils is difficult. Alternating strips of crops and strips of stubble-mulched fallow helps to conserve water and to reduce soil blowing in dryfarmed areas. Fields should be farmed in strips that are perpendicular to the prevailing wind direction. Leaving organic matter, such as crop residue, on the surface helps to increase the intake of water.

CAPABILITY UNIT IIIw-6, DRYLAND

Only Glenberg loamy very fine sand, occasionally flooded, 0 to 3 percent slopes, is in this unit. It is a deep, well-drained soil on bottom lands. It has a surface layer of loamy very fine sand. The underlying material is loamy very fine sand to a depth of about 48 inches and is coarse sand and gravel below this depth.

Permeability is moderately rapid, and the available water capacity is moderate. The organic-matter content is low, and the natural fertility is medium to low. The soil absorbs moisture easily and releases it readily to plants. It is easy to work. Runoff is slow.

Occasional flooding is the principal limitation to use of this soil. Floods deposit sediment and debris, which damage crops and fences. Soil blowing is a minor hazard. Dryfarmed areas lack adequate moisture in most years. Conserving soil moisture is a major concern of management. Increasing organic-matter content and improving soil fertility are also concerns.

The soil is suited to most of the commonly grown crops. It is better suited to crops such as sorghum, which can be planted late in spring, or to wheat, which can be planted early in fall, than to other crops. Many areas of this soil are in native grass, which is cut for hay. Alfalfa can also be grown. Leaving crop residue on the surface during fall and winter helps to control soil blowing. A cropping system that includes mulch planting helps to keep the soil productive. Commercial fertilizer is needed in places to add phosphorus to the soil. Iron and zinc are also needed in places.

CAPABILITY UNIT IVe-1, DRYLAND

In this unit are mainly deep or moderately deep, well-drained, gently sloping to strongly sloping soils on uplands. A few soils are shallow to bedrock. The soils have a surface layer of loam to silty clay loam, and their underlying material is loam to silty clay.

Permeability is moderately slow to moderate, and the available water capacity is low to high. The organic-matter content is low to moderate, and the natural fertility is medium to low. Most of the soils absorb moisture easily and are easy to work, but the soils that have a surface layer of silty clay loam absorb moisture slowly, puddle if worked when too wet, and are hard and cloddy if worked when dry. Runoff is medium to rapid.

Water erosion is the principal hazard on the soils. Soil blowing is also a hazard in some areas. A lack of adequate seasonal rainfall in most years makes conserving soil moisture an important concern of management. Increasing the organic-matter content and improving soil tilth and fertility are also concerns.

The soils are suited to wheat, alfalfa, and grass. They are better suited to grasses grown for hay than to other crops. A suitable cropping sequence limits row crops to no more than 1 year in succession. Summer fallow and stubble mulch tillage help to insure an adequate supply of moisture for the succeeding year's wheat crop. The terrain in some cultivated areas makes terracing difficult. Such areas can be reseeded to native grasses for hay or used for grazing.

CAPABILITY UNIT IVe-3, DRYLAND

Only Sarben fine sandy loam, 5 to 9 percent slopes,

is in this unit. It is a deep, well-drained soil on uplands. It has a surface layer and underlying material of fine sandy loam.

Permeability is moderately rapid, and the available water capacity is moderate. The organic-matter content is low, and the natural fertility is medium to low. The soil absorbs moisture easily and releases it readily to plants. It is easy to work and can be tilled relatively early after rains. Runoff is medium.

Water erosion and soil blowing are the major hazards. Increasing organic-matter content, improving soil fertility, and conserving soil moisture are concerns of management. Seasonal rainfall is inadequate for crops in most years.

The soil is suited to most of the commonly grown crops. It is better suited to such small grains as wheat and to such spring-sown small grains as wheat, oats, and barley than to other crops. Grasses or other close-growing crops help to control water erosion and soil blowing. Conservation practices to control both soil blowing and water erosion include stubble mulch tillage, stripcropping on the contour, and using terraces where slopes are long. Returning all crop residue to the soil also helps to control erosion.

CAPABILITY UNIT IVe-4, DRYLAND

In this unit are deep and moderately deep, well-drained, very gently sloping and gently sloping soils on uplands and stream terraces. The soils have a surface layer of silty clay, and their underlying material is clay. Clay shale is at a depth of 20 to 40 inches in most areas.

Permeability is very slow, and the available water capacity is low to moderate. The organic-matter content is moderately low, and the natural fertility is medium to low. The soils absorb moisture slowly and release it slowly to plants. They are difficult to work because they are very hard when dry and puddle if worked or grazed when too wet. Runoff is medium.

Water erosion and soil blowing are the major hazards in cultivated areas. Conserving soil moisture is the main concern of management because of the lack of seasonal rainfall and the droughty condition of the soils. Improving soil fertility and increasing organic-matter content are also concerns.

Most of the area of the soils are used for range, and they are better suited to this purpose than to other uses. Wheat grown under summer fallow operations helps to store additional moisture for the next season's crop. Terracing, contour farming, stubble mulch tillage, and returning crop residue to the soil help to control water erosion and to increase the moisture intake. A cropping system that alternates fallow and wheat is suitable. A year or two of grass is also beneficial. Areas now in crops can be seeded to a suitable mixture of grasses and used for grazing. The droughty condition of the soils makes them poorly suited to alfalfa.

CAPABILITY UNIT IVe-5, DRYLAND

In this unit are deep, well-drained or somewhat excessively drained, nearly level to strongly sloping soils on uplands, foot slopes, and bottom lands. The soils have a surface layer of loamy very fine sand or loamy fine sand, and their underlying material is fine sand

to loamy very fine sand. Some areas on uplands are eroded.

Permeability is moderately rapid to rapid, and the available water capacity is low to moderate. The organic-matter content is low to moderate, and the natural fertility is medium to low. The soils absorb moisture easily and release it readily to plants. They are easy to work. Runoff is slow to medium.

Soil blowing is a very severe hazard on these soils. Water erosion is a hazard on the steeper soils. The soils are droughty. Dryfarmed areas lack adequate moisture in most years, and conserving moisture is an important concern of management. Increasing the organic-matter content and improving soil fertility are also concerns.

The soils are better suited to grasses and to other close-growing crops, which help to control soil blowing, than to other uses. They are well suited to wheat, rye, oats, and barley. Returning all crop residue to the soil helps to increase water intake and to control water erosion. Summer fallow can be accompanied by stubble mulching. Planting crops in narrow strips helps to protect wide areas from severe soil blowing. Terracing and contour farming are not practical, because the soils have a loose, sandy surface layer.

CAPABILITY UNIT IV_s-9, DRYLAND

Only Minnequa silty clay loam, 1 to 5 percent slopes, is in this unit. It is a moderately deep, well-drained soil on uplands. It has a surface layer of silty clay loam, and its underlying material is light silty clay loam. Chalky shale is at a depth of 20 to 40 inches.

Permeability is moderately slow, and the available water capacity is moderate. The organic-matter content and natural fertility are low. The soil absorbs moisture slowly and releases it slowly to plants. It is difficult to work because it puddles if worked when too wet and is hard and cloddy if worked when dry. Runoff is medium.

Water erosion is the major hazard on this soil. Soil blowing is a minor hazard. Seasonal rainfall is generally inadequate to meet the needs of crops, so conserving soil moisture is a major concern of management. Increasing the organic-matter content and improving soil tilth and fertility are also concerns.

Most of the acreage of the soil is in native grass and is used for grazing. The soil is better suited to range than to other uses. Small areas of this soil that are presently cultivated should be seeded to a mixture of range grasses and used for grazing to help reduce water erosion. An adequate cover of grass should be kept on the surface of the soil at all times.

CAPABILITY UNIT IV_w-5, DRYLAND

Only Bankard loamy fine sand, wet variant, 0 to 2 percent slopes, is in this unit. It is a deep, somewhat poorly drained soil on bottom lands. It has a surface layer of loamy fine sand, and its underlying material is loamy fine sand, fine sand, and coarse sand. The water table is at a depth of 2 to 6 feet.

Permeability is rapid, and the available water capacity is low. The organic-matter content is low, and the natural fertility is medium to low. The soil absorbs moisture easily and releases it readily to plants. Runoff is slow.

Soil blowing and wetness are the principal limitations to use of this soil. The moderately high water table causes wetness early in spring, but in dry seasons plants benefit from the subirrigation. Increasing the organic-matter content and improving soil fertility are important concerns of management.

Most areas of the soil are in native grass, which is cut for hay. The soil is better suited to this use than to other purposes. Small areas are presently cultivated, but this soil is marginal for crops. These areas should be reseeded to grass for hay.

CAPABILITY UNIT IV_s-1, DRYLAND

Only Tripp silt loam, saline-alkali, 0 to 2 percent slopes, is in this unit. It is a deep, well-drained soil on stream terraces that is affected by moderate amounts of soluble salts and alkali. It has a surface layer and subsoil of silt loam.

Permeability is moderate, and the available water capacity is high. The organic-matter content is moderate, and the natural fertility is medium. The saline and alkaline condition is not uniform throughout the soil. The soil absorbs moisture easily and releases it readily to plants except in the spots strongly affected by salts and alkali. It is easy to work, but the surface layer puddles easily in some places. Runoff is slow, and water ponds in small depressions.

Salinity and alkalinity are the principal limitations to use of this soil. Soil blowing is a hazard if the soil surface is not protected. Conserving soil moisture is a concern of management because adequate seasonal rainfall is lacking in most years. Increasing organic-matter content and balancing soil fertility are also concerns.

The soil is suited to such crops as tall wheatgrass and barley that are tolerant of salt and alkali. Chemical amendments are commonly not satisfactory in lowering the salt and alkali content. Under dryland conditions, it is nearly impossible for the normal amount of rainfall to wash the excess salts out of the soil. Stubble mulching, wind stripcropping, and returning all crop residue to the soil are suitable practices. Adding organic matter, such as barnyard manure, to the severely affected areas helps to improve soil tilth, structure, and permeability.

CAPABILITY UNIT IV_s-2, DRYLAND

Only Kyle silty clay, 0 to 1 percent slopes, is in this unit. It is a deep, well-drained soil on stream terraces. It has a surface layer of silty clay, and its subsoil is clay.

Permeability is very slow, and the available water capacity is moderate. The organic-matter content is moderately low, and the natural fertility is medium to low. The soil absorbs moisture slowly and releases it slowly to plants. It is difficult to work because it is very sticky when wet and very hard when dry. Runoff is slow.

The clayey texture and the very slow permeability of the subsoil make this soil droughty. Soil blowing is a minor hazard. On dryfarmed areas there is a shortage of moisture in most years, and conserving moisture is a major concern of management. Increasing the organic-matter content and improving soil tilth and fertility are also concerns.

The soil is better suited to small grains, such as wheat and barley, than to other uses. It is poorly suited to alfalfa because it is droughty. A cropping system that includes stubble mulching and returning all crop residue to the soil helps to conserve soil moisture. Summer fallow allows additional soil moisture to accumulate for the next season's wheat crop.

CAPABILITY UNIT Vw-7, DRYLAND

Only Wet alluvial land is in this unit. It consists of deep, poorly drained alluvial material on bottom lands. It has a surface layer of fine sandy loam to very fine sandy loam that is underlain by stratified fine sand to silt loam. Coarse gravel is common in places. The water table is at a depth of 0 to 2 feet.

Permeability is rapid, but drainage is limited by the high water table. Most areas stay wet during most of the year. Runoff is slow.

Wetness is the principal limitation to use of this land type. Without artificial drainage, wet alluvial land is not suited to cultivated crops. Suitable outlets for drainage are difficult to find. A few areas are affected by excess alkali.

The areas of this land type are in grass, which is used for hay. The areas are well suited to habitat for wildlife.

CAPABILITY UNIT VIe-1, DRYLAND

In this unit are mainly deep and moderately deep, well-drained, moderately steep to steep soils on uplands and foot slopes. The soils have a surface layer of loam, silt loam, or silty clay loam, and their subsoil is loam to silty clay. In a few areas the soils are shallow to siltstone or sandstone bedrock.

Permeability is slow to moderate, and the available water capacity is low to high. The organic-matter content is low to moderate, and the natural fertility is medium to low. Most of the soils absorb moisture easily, but the silty clay loams absorb moisture at a moderately low rate. Runoff is slow to rapid.

Water erosion and soil blowing are the principal hazards on these soils. The soils are too steep and too eroded for cultivated crops. There is a shortage of seasonal rainfall in most years, and conserving soil moisture is a major concern of management. Increasing the organic-matter content, improving soil tilth, and balancing fertility are also concerns.

The soils are better suited to native grass used for grazing than to other uses. They can be used as habitat for wildlife and for recreation. Leaving sufficient vegetation on rangeland helps to control erosion and to conserve moisture.

CAPABILITY UNIT VIe-3, DRYLAND

Only Sarben fine sandy loam, 9 to 30 percent slopes, is in this unit. It is a deep, well-drained soil on uplands. Its surface layer and underlying material are fine sandy loam.

Permeability is moderately rapid, and the available water capacity is moderate. The organic-matter content is low, and the natural fertility is medium to low. The soil absorbs moisture easily and releases it readily to plants.

Soil blowing and water erosion are very serious hazards if the soil is cultivated. The few cultivated areas

are severely eroded. In most years, seasonal rainfall is inadequate to meet the needs of crops.

The soil is not suited to cultivated crops. It is better suited to native grasses grown for hay or for grazing than to other uses. Idle and cultivated areas should be seeded to native grass for use as range. A planned grazing system to control and maintain healthy stands of grass helps to prevent soil blowing and water erosion.

CAPABILITY UNIT VIe-4, DRYLAND

Only Pierre silty clay, 5 to 30 percent slopes, is in this unit. It is a moderately deep, well-drained soil on uplands. It has a surface layer of silty clay, and its underlying material is clay. Clayey shale is at a depth of 20 to 40 inches.

Permeability is very slow, and the available water capacity is low. The organic-matter content is moderately low, and the natural fertility is medium to low. The soil absorbs water slowly and releases it slowly to plants. Runoff is medium to rapid.

Water erosion is a very serious hazard if the grass cover is destroyed. The soil is too steep and too erodible for crops. It is droughty. In most years seasonal rainfall is inadequate to meet the needs of grasses.

The soil is better suited to native grass used for hay or for grazing than to other purposes. Proper range use and a planned grazing system that maintain healthy stands of grass help to protect the soil against erosion.

CAPABILITY UNIT VIe-5, DRYLAND

In this unit are mainly deep, well drained to excessively drained, nearly level to steep soils on uplands and stream terraces. In a few areas soils are shallow to sandstone bedrock. The soils have a surface layer and a subsoil of loamy fine sand or loamy very fine sand.

Permeability is moderately rapid or rapid, and the available water capacity is low to moderate. The organic-matter content is low to moderate, and the natural fertility is medium to low. The soils absorb moisture easily and release it readily to plants. Runoff is slow to rapid.

Soil blowing is a serious hazard if the grass cover is destroyed. Water erosion is also a hazard, if a good grass cover is not maintained. The soils are somewhat droughty, and seasonal rainfall is commonly inadequate to meet the needs of crops.

The soils are too sandy, too droughty, and too erodible for cultivated crops. They are better suited to grass than to other uses. Small areas that are presently cultivated should be reseeded to grass, which can be cut for hay or used for grazing. Proper range use and deferred grazing are needed to maintain a protective cover of grass on the surface of the soils at all times.

CAPABILITY UNIT VIe-7, DRYLAND

Only Breaks-Alluvial land complex is in this unit. This land type is in very steep areas that border narrow drainageways and the associated nearly level bottom lands. The sides of the drainageways consist of calcareous loamy soil material. The bottom lands consist of calcareous loamy alluvial sediment washed from

the surrounding uplands and are occasionally flooded.

Water erosion is the principal hazard on the Breaks part of the complex. Flooding is a common hazard on the Alluvial land part.

The land type is too steep for cultivated crops. The very steep slopes support fair to good stands of grasses. On the narrow bottom lands of the drainageways are mostly sparse grasses and weeds. Some areas have a cover of deciduous trees or shrubs. These areas provide good food and cover for wildlife. The land type is better suited to habitat for wildlife and to recreation than to other uses. It supports some grazing. The grazing should be carefully regulated to prevent destruction of vegetation, particularly on the very steep Breaks.

CAPABILITY UNIT VI_c-9, DRYLAND

Only Minnequa silty clay loam, 5 to 12 percent slopes, is in this unit. It is a moderately deep, well-drained soil on uplands. It has a surface layer of silty clay loam, and its underlying material is light silty clay loam. Chalky shale is below a depth of about 38 inches. This soil is rich in lime.

Permeability is moderately slow, and the available

water capacity is moderate. The organic-matter content and the natural fertility are low. The soil absorbs moisture slowly and releases it slowly to plants. Run-off is medium.

Water erosion is a very severe hazard, particularly if the grass cover is destroyed. Soil blowing is a minor hazard. The soil is not suited to cultivated crops. It is droughty, and in most years seasonal rainfall is inadequate to meet the needs of crops.

Most of the areas of the soil are in native grass and is used for grazing. The soil is better suited to this purpose than to other uses. Proper management of the grassland and a planned grazing system insure a vigorous growth of grasses that help to control soil erosion.

CAPABILITY UNIT VI_s-1, DRYLAND

In this unit are deep and moderately deep, well-drained, nearly level to strongly sloping soils and land types on uplands, foot slopes, and stream terraces. All are strongly affected by soluble salts and alkali. The soils have a surface layer of silty clay loam to silty clay, and their subsoil is heavy silty clay loam to clay (fig. 21).

Permeability is moderately slow to very slow, and



Figure 21.—An area of Kyle-Slickspots complex, 0 to 2 percent slopes, in capability unit VI_s-1, dryland. The light-colored areas are Slickspots that are strongly affected by alkali.

the available water capacity is low to high. The organic-matter content is moderately low, and the natural fertility is medium to low. The soils absorb moisture slowly and release it slowly to plants. Some runoff water ponds in small depressions on the surface. Salts and alkali are severe in the depressions.

The soils are too strongly saline and too alkaline for most cultivated crops, and this is the principal limitation to their use. Many of the small depressions are barren of vegetation.

The areas are better suited to range than to other uses. Chemical amendments are generally not satisfactory in lowering the saline and alkaline content. Proper range use and a planned grazing system that maintain an adequate growth of natural vegetation at all times help to control soil blowing and water erosion.

CAPABILITY UNIT VI₆-4, DRYLAND

In this unit are shallow, well drained to somewhat excessively drained soils on uplands. The soils are mainly nearly level to steep, but in a few small areas they are moderately deep. The soils have a surface layer and a subsoil of gravelly sandy loam to silty clay. The underlying material is gravel, sandstone, siltstone, or shale, and these materials outcrop in many areas.

Permeability is slow to rapid, and the available water capacity is very low to moderate. The organic-matter content and the natural fertility are low. The clayey soils absorb moisture slowly and release it slowly to plants. The silty and loamy soils absorb moisture easily and release it readily to plants. Runoff is slow to rapid, depending on the degree of slope, vegetation, and texture of the surface layer.

The soils are too steep and too shallow for cultivated crops. Conserving soil moisture is the major concern of management because of the droughty condition of the soils and a lack of adequate seasonal rainfall.

Nearly all the acreage of the soils is in grass and is used for grazing. The soils are better suited to this purpose than to other uses. Suitable management practices include deferred grazing and a planned grazing system. The total annual production of grass on this site is generally smaller than on areas of deeper soils.

CAPABILITY UNIT VI₆-1, DRYLAND

Only Clayey alluvial land is in this unit. This land type consists of deep alluvial material on low bottom lands adjacent to meandering streams and channels. These streams overflow following heavy rains and flood the adjacent areas. The soil material consists of stratified sediments of silty clay loam to clay that washed from the surrounding uplands.

The areas are flooded only for short periods, but crops are subject to damage. Most areas are not suited to cultivation because they are dissected into small isolated areas by meandering stream channels.

Clayey alluvial land supports a fair to good stand of grasses and annual reeds and can be grazed during most of the year. It is better suited to grasses and trees than to other uses. Areas that are presently cultivated should be reseeded to adapted native grasses and used for grazing. Proper grazing and manage-

ment that develop a better growth of grass help to protect the soil surface.

CAPABILITY UNIT VI₆-3, DRYLAND

Only Loamy alluvial land is in this unit. This land type consists of deep, well-drained alluvial sediment on low bottom lands that are subject to flooding following heavy rains. The soil material is made up of stratified very fine sandy loam to silty clay loam.

Flood waters generally cover this land type only for short periods but long enough to prevent use of the areas for crops. Most areas are not suited to cultivation because they are dissected into small isolated areas by meandering stream channels.

Most areas of this land type support fair to good stands of grasses and annual weeds and can be grazed during most of the year. Trees are common. The land type is better suited to range than to other uses. A planned grazing system that maintains an adequate cover of grasses helps to protect the areas. Areas presently cultivated should be reseeded to a mixture of suited native grasses and used for range.

CAPABILITY UNIT VI₆-6, DRYLAND

Only Sandy alluvial land is in this unit. This land type consists of deep, somewhat excessively drained alluvial material on bottom lands that are subject to flooding following heavy rains. The soil material consists of a surface layer of fine sandy loam or very fine sandy loam underlain by stratified material of fine sand to silt loam. Pebbles are common throughout the soil material.

Flood waters generally cover this land type only for short periods but long enough to prevent use of the areas for crops. A few areas are cultivated, but most are not suited to cultivation because of flooding too frequently or because they are dissected into small isolated areas by meandering stream channels.

Most areas of the land support a fair to good growth of grasses and annual weeds and can be grazed during most of the year. The land is better suited to grass and trees than to other uses. Proper range use that provides for a good growth of grass cover helps to protect the soil surface. Cultivated areas should be reseeded to a mixture of suited native grasses and used for grazing.

CAPABILITY UNIT VII₆-3, DRYLAND

In this unit are shallow and very shallow, well-drained, nearly level to very steep soils and soil material on uplands and bottom lands. Most of the soils have a surface layer and underlying material of loam to silty clay, but a few areas have loamy sand or mixed sand and gravel. The soils are underlain by gravel, sandstone, or shale, and these materials are exposed at the surface in many areas.

Permeability is slow to very rapid, and the available water capacity is very low. The organic-matter content and the natural fertility are low. The clayey soils absorb moisture slowly and release it slowly to plants. The silty soils absorb moisture easily and release it readily to plants. Runoff is rapid to very rapid on most soils, but it is very slow on the gravelly soils.

The soils are too shallow, too rocky, or too steep for cultivation. They are better suited to grasses than to

other uses. Most areas are not suited to trees. Vegetation is sparse because of droughtiness and outcrops of bedrock and gravel. Areas can be used for limited grazing. The number of livestock should be balanced against the generally low productivity of the soils.

CAPABILITY UNIT VII_s-4, DRYLAND

In this unit are steep to very steep, well-drained, shallow to deep soils and land types on uplands. The areas are characterized by many canyons and their associated drainageways. The surface layer is mainly loam and silt loam, and the underlying material is mainly very fine sandy loam. An important area in this unit is the Pine Ridge. About 10 to 30 percent of the area is rock outcrop, consisting of scenic sandstone buttes and outcrops of sandstone.

Permeability is moderate, and the available water capacity is low to high, depending on depth to sandstone bedrock. The organic-matter content is low to moderate, and the natural fertility is medium to low. In the Pine Ridge area, the deep, darker colored soils are mainly on north- and east-facing exposures, and the shallow, lighter colored soils are mainly on south- and west-facing exposures. Runoff is medium to very rapid, depending on the degree of slope and the amount of vegetation.

The soils are too steep or too shallow for cultivation. They are better suited to grasses and to trees than to other uses. They provide excellent food and cover for woodland wildlife. The soils are also suited to livestock production if a planned grazing system is used. Some areas support good stands of ponderosa pine trees, and the large, mature trees can be selectively cut for lumber.

CAPABILITY UNIT VIII_s-8, DRYLAND

Only Badland is in this unit. This land type consists of steep to very steep, eroded, barren exposures of siltstone and shale. Except in some areas on the lowest part of the landscape, it supports little or no vegetation. Badland is suitable for recreation, and the areas provide cover for wildlife.

Management of irrigated soils

Most of the acreage of irrigated soils in Dawes County is in the valleys of the White and Niobrara Rivers and their tributary streams. Water for irrigation comes from surface water that is supplied by canals operated by irrigation companies and from a few irrigation wells.

The principal irrigated crops are small grains, alfalfa, and grasses. A small acreage of row crops is used mostly for ensilage.

The kind of irrigation system used depends on the crop. Row crops are not commonly irrigated in Dawes County. Where they are irrigated, the most common method is furrow irrigation. The water is applied to furrows between the plant rows by gated pipes or siphon tubes. Furrow irrigation works well on the very gently sloping soils. Where slope is greater than 1.5 percent, soil erosion is likely to be excessive and another system should be considered.

Hay crops and small grain can be irrigated by the

border method, in which flooding is controlled by borders or small dikes along the sides of narrow strips in the field. Irrigation water flows as a thin uniform sheet and is absorbed by the soil as it advances across the strip. The strips should be level and of uniform grade. Such soils as the nearly level Bridget silt loam, Mitchell silt loam, and Tripp silt loam are well suited to border irrigation.

The sprinkler method consists of the use of a series of small sprinklers spaced along distribution pipes. The sprinklers apply water at a rate that the soil can absorb without runoff. Sprinklers can be used on the more sloping soils, as well as on the nearly level soils. They are also useful on sandy soils where the intake rate is so high that a furrow system is not practical. Soils such as Glenberg loamy very fine sand, 0 to 3 percent slopes, are well suited to the sprinkler method. Because the water can be carefully controlled, a sprinkler system has special uses in conservation farming, such as for establishing new pastures on moderately steep soils and irrigating sandy or steep soils not suited to other systems. In summer, however, some water is lost through evaporation and wind drift and can cause an uneven application of water at times.

Sprinkler systems are of two general types. One type is set at certain locations and operates at those locations until a specified amount of water is applied. The other type has a moving system that revolves around a center pivot.

A soil can hold only a limited amount of water. Irrigation water, therefore, should be applied at intervals to keep the soil moist at all times. The intervals vary according to the crop and the time of year. Water should be applied at the rate it can be absorbed by the soil. A deep soil such as Keith silt loam, 1 to 3 percent slopes, holds about 2 inches of available water per foot of soil depth. Thus, if the soil is 4 feet deep and is planted to a crop that sends its roots to that depth, it can hold about 8 inches of available water for that crop. Greatest efficiency is obtained if irrigation is begun at about the time when the crop has used half the stored water. If a soil holds 8 inches of available water, irrigation should generally be started when about 4 inches has been removed by the crop. Irrigation sets or systems should be planned to replace the amount of water the crop uses at the rate that the crop uses it.

Management of irrigated fields should regulate the application of water so that good crop growth is achieved without wasting water or eroding the soil. The furrow streams or sprinkler rate should be adjusted so that the water applied thoroughly moistens the soil without excessive runoff or erosion. An irrigation reuse system recycles runoff water back into the system to reirrigate the same fields or other fields nearby.

Assistance in planning and layout of an irrigation system is available through the local office of the Soil Conservation Service or through the County Extension Service. Estimates of the cost of equipment can be obtained from local dealers and manufacturers of irrigation equipment.

Irrigated soils generally produce higher yields than dryfarmed soils. Most plant nutrients, especially nitrogen and phosphorus, are removed when irrigated

crops are harvested. Returning all crop residue to the soil and adding manure and commercial fertilizers helps supply needed plant nutrients. An adequate supply of nitrogen should be supplied. Soils disturbed by land leveling, particularly if topsoil has been removed, generally respond to applications of phosphorus, zinc, and iron. The kinds and amounts of fertilizer needed for specified irrigated crops should be determined by a soil test.

The following paragraphs describe the capability units for irrigated soils. Each unit includes soils that have similar management requirements, soil hazards, limitations, and concerns of management. Suitable practices to help overcome the soil limitations are given. The names of all the soils in each capability unit are given in the "Guide to Mapping Units."

All soils in Nebraska are placed in Irrigation Design Groups, described in the Irrigation Guide for Nebraska. Arabic numbers in the irrigation capability unit indicate the design group to which the soils in the unit belong. For example, capability unit IIe-6, irrigated, indicates that the soils are in design group 6 in the Irrigation Guide. A copy of the Guide is in each field office of the Soil Conservation Service in Nebraska.

CAPABILITY UNIT I-6, IRRIGATED

In this unit are deep, well-drained, nearly level and very gently sloping soils on foot slopes, stream terraces, and bottom lands. The soils have a surface layer of silt loam, and their subsoil is very fine sandy loam or silt loam.

Permeability is moderate, and the available water capacity is high. The organic-matter content is low to moderate, and the natural fertility is medium to low. The soils absorb moisture easily and release it readily to plants. They are easy to work. In places they receive runoff from higher lying soils. Runoff is slow.

The soils are subject to soil blowing if the soil surface is not protected. Increasing the organic-matter content and maintaining soil fertility are concerns of management. Proper management of irrigation water is also important. Some land leveling is needed to prepare the soils for gravity irrigation, but deep cuts generally are not needed.

The soils are suited to all crops commonly grown in the county and to all irrigation systems commonly used. Runoff from irrigated areas should be kept to a minimum. Excess runoff water can be recycled by a reuse system.

CAPABILITY UNIT IIe-4, IRRIGATED

In this unit are deep, well-drained, very gently sloping soils on uplands. The soils have a surface layer of silt loam, and their subsoil is silty clay loam.

Permeability is moderately slow, and the available water capacity is high. The organic-matter content is moderate, and the natural fertility is medium. The soils absorb moisture easily and release it readily to plants. They are easy to work. Runoff is slow.

Soil blowing is a hazard if the soil surface is not protected. Controlling water erosion and efficiently using irrigation water are the principal concerns of management if the soils are irrigated. Maintaining soil fertility is also a concern. Land leveling is needed

to prepare some areas of the soils for gravity irrigation, but deep cuts are generally not needed.

The soils are suited to all crops commonly grown in the county. Planting alfalfa or an alfalfa-grass mixture helps to reduce erosion on long slopes. A mulch tillage operation that leaves crop residue on the soil surface during seedbed preparation and planting helps to reduce water erosion on the steeper soils. Applying commercial fertilizers helps to maintain fertility, and returning crop residue to the soil helps to maintain organic-matter content.

The water intake rate is moderately low. Water application rates should be adjusted to prevent excessive runoff. Relatively long irrigation runs are possible in many areas. All of the commonly used irrigation systems are suitable for use on these soils.

CAPABILITY UNIT IIe-6, IRRIGATED

In this unit are deep, well-drained, very gently sloping soils on uplands, foot slopes, and stream terraces. The soils have a surface layer and subsoil of very fine sandy loam or silt loam.

Permeability is moderate, and the available water capacity is high. The organic-matter content is moderate, and the natural fertility is medium. The soils absorb moisture easily and release it readily to plants. They are easy to work. Runoff is slow or medium.

Water erosion is a hazard in areas where runoff from adjacent slopes causes gullying. Soil blowing is also a hazard if the soil surface is unprotected. Maintaining soil fertility, increasing organic-matter content, and efficiently using irrigation water are concerns of management. In most places some land leveling is needed to prepare the soils for gravity irrigation. In some areas bench leveling is more practical.

The soils are suited to all crops commonly grown in the county, including small grains, hay crops and grasses. Including in the cropping system crops that leave residue on the soil surface during seedbed preparation and planting helps to control water erosion and soil blowing and to increase the organic-matter content. Applying barnyard manure and commercial fertilizers helps to maintain soil fertility.

The water intake rate is moderate. A sprinkler irrigation system is suitable for use on these soils. The application rate of irrigation water should be controlled to prevent excessive runoff. A gravity irrigation system that includes contour ditches is suitable for small grains and hay crops. Some of the soils are too steep for efficient use of furrow and border irrigation. Using contour furrows greatly reduces erosion. Land leveling can be used to provide nearly level benches across the steeper slopes for both gravity and border irrigation systems. Diversion terraces help to control runoff from adjacent steeper soils. Trapping excess runoff water in reuse pits provides additional water for irrigation and protects the ends of fields and roadside ditches from erosion.

CAPABILITY UNIT IIe-8, IRRIGATED

Only Glenberg loamy very fine sand, 0 to 3 percent slopes, is in this unit. It is a deep, well-drained soil on bottom lands. It has a surface layer and underlying material of loamy very fine sand.

Permeability is moderately rapid, and the available water capacity is moderate. The organic-matter content is low, and the natural fertility is medium to low. The soil absorbs moisture easily and releases it readily to plants. Runoff is slow.

Soil blowing is the principal hazard on this soil. Efficiently using irrigation water, maintaining soil fertility, and increasing the organic-matter content are important concerns of management. Some land grading is generally needed to prepare this soil for gravity irrigation.

The soil is suited to all the irrigated crops commonly grown in the county. Maintaining a cover of vegetation helps to control soil blowing. Stripcropping helps to reduce soil blowing on larger areas. Applying commercial fertilizers helps to maintain soil fertility.

The water intake rate is moderately high. Irrigation runs should be relatively short for furrow and border gravity systems. Because available water capacity is only moderate, the soil needs to be irrigated more often than finer textured soils.

CAPABILITY UNIT IIw-3, IRRIGATED

Only Haverson silty clay loam, occasionally flooded, 0 to 3 percent slopes, is in this unit. It is a deep, well-drained soil on bottom lands. It has a surface layer of silty clay loam over very fine sandy loam to silt loam.

Permeability is moderately slow, and the available water capacity is high. The organic-matter content is low, and the natural fertility is medium to low. The soil absorbs water slowly. Because of its clayey surface layer, this soil cracks upon drying and is sticky when wet. The soil is difficult to work because it is hard and cloddy if worked when dry and puddles if worked when wet. Runoff is slow.

Flooding is a major hazard if this soil is irrigated. Maintaining soil fertility, improving organic-matter content and soil tilth, and efficiently using irrigation water are concerns of management. Only a small amount of leveling is needed to prepare this soil for gravity irrigation.

The soil is suited to grasses and legumes used for hay. The hazard of flooding limits its suitability for small grains and other crops. Applying commercial fertilizers helps to maintain soil fertility, and leaving crop residue on the surface helps to improve the organic-matter content.

The water intake rate is low. Slightly longer irrigation runs can be used on this soil than on coarser textured soils. Irrigation reuse pits at the lower end of the field trap excess runoff water from the irrigation system for reuse on the same field or on nearby fields.

CAPABILITY UNIT IIw-6, IRRIGATED

Only Haverson silt loam, occasionally flooded, 0 to 3 percent slopes, is in this unit. It is a deep, well-drained soil on bottom lands. It has a surface layer of silt loam over very fine sandy loam or silt loam.

Permeability is moderate, and the available water capacity is high. The organic-matter content is low, and the natural fertility is medium to low. The soil absorbs moisture easily and releases it readily to plants. It is easy to work. Runoff is slow.

Flooding is the major hazard if this soil is irrigated.

Maintaining soil fertility, increasing organic-matter content, and efficiently using irrigation water are concerns of management. Little land leveling is needed to prepare this soil for gravity irrigation.

The soil is suited to most crops commonly grown in the county. It is better suited to grasses and alfalfa used for hay and pasture than to other crops. Flooding delays the harvesting of small grain in some years. Applying commercial fertilizers and returning crop residue to the soil help to maintain soil fertility.

The water intake rate is moderate, and the soil is easy to irrigate. Water should be applied at a rate that it can be absorbed by the soil without excessive runoff. A reuse system at the lower end of the field should be used with gravity irrigation systems.

CAPABILITY UNIT IIw-8, IRRIGATED

Only Las Animas soils, 0 to 2 percent slopes, are in this unit. They are deep, somewhat poorly drained soils on bottom lands. They have a surface layer of fine sandy loam to silt loam, and their underlying material is stratified loamy fine sand and very fine sandy loam. The water table is at a depth of 3 to 6 feet.

Permeability is moderately rapid, and the available water capacity is moderate. The organic-matter content is moderately low, and the natural fertility is medium to low. The soils absorb moisture easily and release it readily to plants. They are easy to work. Runoff is slow.

The moderately high water table is the main limitation, and artificial drainage is needed if these soils are irrigated. Soil blowing is a minor hazard if the soil surface is not protected. Preparation of the seedbed is delayed in spring because these soils do not warm up as rapidly as well-drained soils. Maintaining soil fertility and efficiently using irrigation water are concerns of management. Only a small amount of land leveling is needed to prepare the soils for gravity irrigation. Care should be taken that deep cuts do not expose coarse-textured material.

The soils are suited to all crops commonly grown in the county. Because they warm slowly in the spring, the soils are well suited to hay and pasture crops, such as alfalfa and irrigated grass. Soil wetness can be reduced by use of open V-ditches or tile drains in areas where a suitable outlet is available. Applying commercial fertilizers helps to maintain soil fertility, and leaving crop residue on the soil surface during seedbed preparation and planting helps to control soil blowing.

All irrigation systems commonly used in the county are suitable for use on these soils. The water intake rate of these soils is moderate, and large irrigation, streams and short runs are needed if the furrow and border irrigation systems are used.

CAPABILITY UNIT IIIe-3, IRRIGATED

In this unit are deep and moderately deep, well-drained, very gently sloping soils on uplands and stream terraces. The soils have a surface layer of silty clay loam, and their subsoil is heavy silty clay loam or light silty clay. Many areas are underlain by shale at a depth of 20 to 40 inches.

Permeability is slow to moderately slow, and the available water capacity is low to high. The organic-matter content is moderately low, and the natural

fertility is low. The soils absorb water slowly and release it slowly to plants. They are sticky when wet and crack upon drying. They are difficult to work because they tend to clod if worked when dry and to puddle if worked when too wet. Runoff is slow to medium.

Water erosion is a hazard if these soils are irrigated. Soil blowing is a hazard if the soil surface is unprotected. Efficiently used irrigation water, improving soil tilth, and maintaining soil fertility are concerns of management. Generally some land leveling is needed to prepare these soils for gravity irrigation. In some areas, deep cuts expose the claypan subsoil.

The soils are suited to all the crops commonly grown in the county, but they are better suited to alfalfa and grasses used for hay than to other crops. Where the soils are in hay crops, water erosion and soil blowing are easier to control. Applying barnyard manure and commercial fertilizers helps to improve soil fertility.

The water intake rate is low. The sprinkler irrigation system is suited to these soils.

CAPABILITY UNIT IIIe-4, IRRIGATED

In this unit are deep, well-drained, gently sloping to strongly sloping soils on uplands. The soils have a surface layer of silt loam, and their subsoil is silty clay loam. Some soils are eroded.

Permeability is moderately slow, and the available water capacity is high. The organic-matter content and natural fertility are medium. In most places the soils are easy to work. Runoff is medium.

Soil blowing and water erosion are hazards if these soils are irrigated. Maintaining soil fertility, improving

the organic-matter content and efficiently using irrigation water are concerns of management. Except where sprinkler irrigation is used, extensive land leveling is generally needed. Bench leveling is more suitable in some places.

These soils are well suited to alfalfa or to grasses used for irrigated pasture. Row crops can be grown, but irrigation methods must be altered to prevent erosion.

Applying commercial fertilizer and barnyard manure helps to improve soil fertility and organic-matter content.

The water intake rate is moderately low. Application rates should be regulated to avoid erosion and loss of water by runoff. Where row crops are irrigated by the gravity system, the area should be reshaped by land leveling so that contour bench irrigation can be used. A sprinkler system is well suited to use on these soils, provided suitable devices can be installed to prevent runoff from excessive irrigation and rainfall (fig. 22).

CAPABILITY UNIT IIIe-6, IRRIGATED

In this unit are deep, well-drained, very gently sloping to strongly sloping soils on uplands and foot slopes. The soils have a surface layer of silt loam, and their subsoil is very fine sandy loam to light silty clay loam.

Permeability is moderate and the available water capacity is high. The organic-matter content is low or moderate, and the natural fertility is medium or low. The soils absorb water easily and release it readily to plants. They are easy to work. Runoff is slow to medium, depending on the degree of slope.

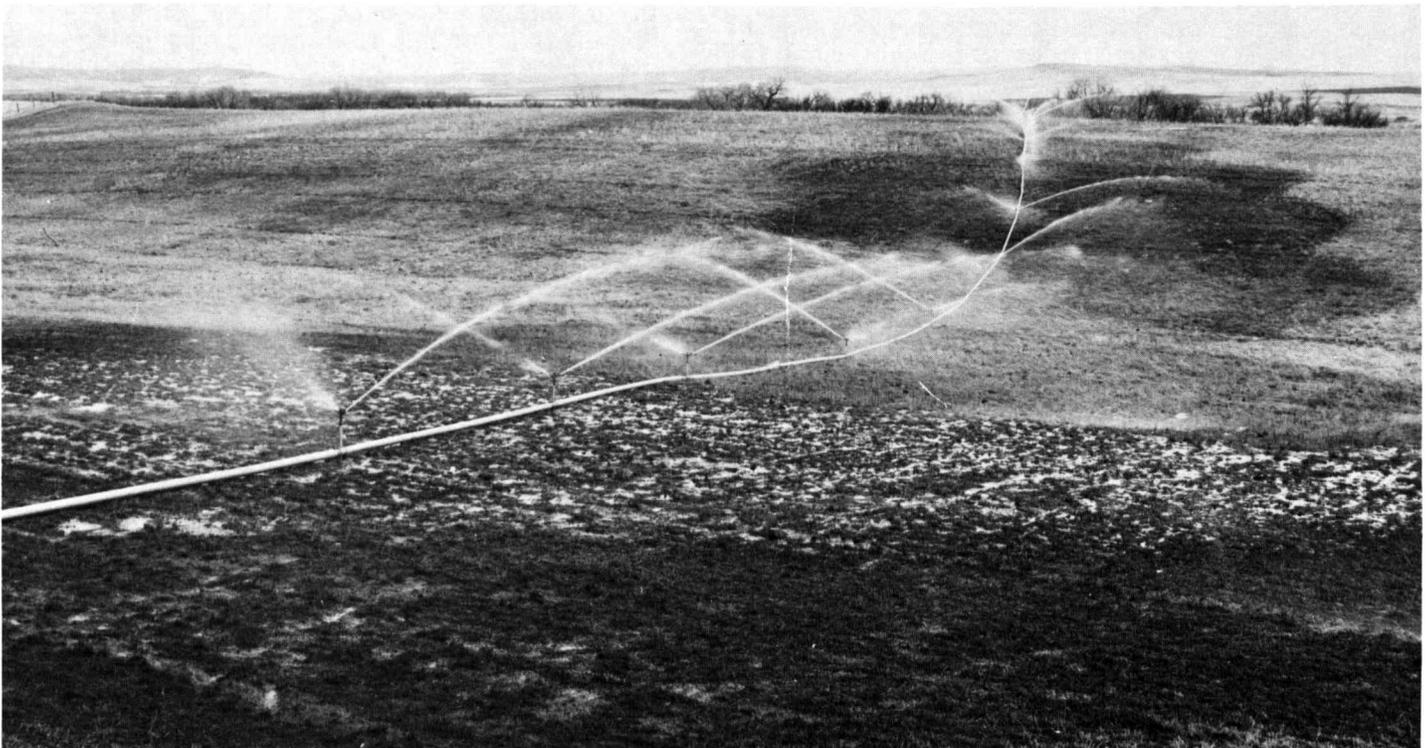


Figure 22.—Applying water to alfalfa by means of sprinkler system; soil is in capability unit IIIe-4, irrigated.

Water erosion is a serious hazard if these soils are irrigated. Soil blowing is a hazard if the soil surface is unprotected. Efficiently using irrigation water and maintaining soil fertility are major concerns of management. The organic-matter content needs to be increased, especially where the soils are light colored. Extensive land leveling is needed to prepare these soils for gravity irrigation. Bench leveling is more suitable in places.

The soils are better suited to small grains or to hay and pasture crops than to other uses. Applying barnyard manure and commercial fertilizers helps to maintain soil fertility. Including in the cropping system crops that return residue to the soil helps to reduce soil erosion and to increase the organic-matter content.

The water intake rate is moderate. Application rates should be controlled to prevent excessive runoff. A sprinkler irrigation system is well suited to use on these soils. A gravity irrigation system that includes contour ditches is suitable for small grain and hay crops.

CAPABILITY UNIT III₆-7, IRRIGATED

In this unit are moderately deep, well-drained, very gently sloping soils on uplands. The soils have a surface layer of silt loam, and their subsoil is silt loam to heavy silty clay loam. They are underlain by siltstone or sandstone at a depth of 20 to 40 inches.

Permeability is moderately slow or moderate, and the available water capacity is moderate. The organic-matter content is low or moderate, and the natural fertility is medium or low. The soils absorb moisture well and release it readily to plants. They are easy to work. Runoff is slow.

Soil blowing and water erosion are hazards. Efficiently using irrigation water and maintaining soil fertility are the major concerns of management. The organic-matter content needs to be increased, especially where the soils are light colored. In most places, some land leveling is needed to prepare these soils for gravity irrigation. Deep cuts can expose the moderately deep bedrock.

The soils are suited to all crops commonly grown in the county. Leaving a protective cover of crops or residue on the soil surface most of the time helps to control soil blowing and water erosion. Leaving crop residue on the soil also helps to maintain the organic-matter content. Commercial fertilizers help to maintain soil fertility if the soils are irrigated.

The water intake rate is moderate. The type of irrigation system that is suited to these soils depends on the kind of crop. A sprinkler system is generally well suited to use on these soils, but a gravity system that includes borders or contour ditches can be used for small grain and hay crops.

CAPABILITY UNIT III₆-8, IRRIGATED

In this unit are deep, well-drained and somewhat excessively drained, very gently sloping and gently sloping soils on uplands, foot slopes, and stream terraces. The soils have a surface layer and subsoil of loamy very fine sand or fine sandy loam. Some soils are eroded.

Permeability is moderately rapid, and the available

water capacity is moderate. The organic-matter content is low to moderate, and the natural fertility is medium to low. The soils absorb moisture easily and release it readily to plants. They are easy to work. Runoff is slow.

Soil blowing and water erosion are hazards if these soils are irrigated. Efficient use of irrigation water is needed to prevent excessive leaching of plant nutrients from the soils. Maintaining soil fertility and improving the organic-matter content are also concerns of management.

The soils are suited to all the crops commonly grown in the county, particularly alfalfa and grasses used for hay and pasture. Leaving residue on the soil surface and using narrow fields or stripcropping help to control soil blowing. Mulch planting keeps crop residue on the soil surface. Applying barnyard manure and leaving all residue on the soil surface during seedbed preparation and planting help to improve the organic-matter content.

The water intake rate is moderately high. A sprinkler system is well suited to use on these soils. The center-pivot system provides for light, frequent applications and is suitable for use on irrigated hay and pasture crops.

CAPABILITY UNIT III₆-1, IRRIGATED

Only Buffington silty clay, 0 to 1 percent slopes, is in this unit. It is a deep, well-drained soil on stream terraces. It has a surface layer of silty clay, and its subsoil is light silty clay loam.

Permeability is slow, and the available water capacity is high. The organic-matter content is low, and the natural fertility is medium to low. The soil puddles easily if worked when too wet. Runoff is slow.

Soil blowing is a hazard. Efficiently using irrigation water, maintaining soil fertility, increasing the organic-matter content, and improving soil tilth are concerns of management. Only a small amount of land leveling is needed to prepare this soil for gravity irrigation.

The soil is suited to all crops commonly grown in the county, particularly grasses and legumes for hay and pasture. Including in the cropping systems crops that produce residue that can be left on the soil surface during seedbed preparation helps to maintain organic-matter content and soil fertility.

The water intake rate is very low. A gravity system is difficult to use on this soil because water applied in a long irrigation run needs a long time to enter the soil. A sprinkler system of the set type is better suited to use on this soil. A center-pivot system does not provide for a sufficiently long application period to permit irrigation water to enter the soil.

CAPABILITY UNIT III₆-3, IRRIGATED

Only Bufton silty clay loam, 0 to 1 percent slopes, is in this unit. It is a deep, well-drained soil on uplands and stream terraces. It has a surface layer of silty clay loam, and its subsoil is heavy silty clay loam.

Permeability is slow to moderately slow, and the available water capacity is high. The organic-matter content is moderately low, and the natural fertility is low. The soil puddles easily if worked when wet. Runoff is slow.

Soil blowing is a hazard. Efficiently using irrigation

water, maintaining soil fertility, increasing organic-matter content, and improving soil tilth are concerns of management. Only a small amount of land leveling is needed to prepare this soil for gravity irrigation.

The soil is suited to all crops commonly grown in the county. Including crops in the cropping system that produce residue that can be left on the surface of the soil is needed. Applying commercial fertilizers and barnyard manure helps to improve soil fertility.

The water intake rate is low. Irrigation systems should provide for slow application of irrigation water. Irrigation runs can be long, and the time interval of irrigation can be longer than on more silty soils. A gravity system can be used on this soil, but a sprinkler system is better suited.

CAPABILITY UNIT III_s-6, IRRIGATED

Only Tripp silt loam, saline-alkali, 0 to 2 percent slopes, is in this unit. It is a deep, well-drained soil on stream terraces. It is moderately affected by salts and alkali. It has a surface layer and subsoil of silt loam.

Permeability is moderate, and the available water capacity is high. The organic-matter content is moderate, and the natural fertility is medium. The soil absorbs moisture easily and releases it readily to plants. Runoff is slow.

The moderately saline and alkaline condition of this soil is the major limitation to use. In some areas, the surface layer is affected by soluble salts and alkali, and in other areas, only the subsoil and underlying material are affected. The effect of the salts and alkali is more apparent in deep-rooted crops than in other crops. Where the salts and alkali are at the surface, tillage is more difficult, less water is taken in, and stands of crops are spotty. Permanent improvement of this soil is difficult. Maintaining soil fertility and efficiently using irrigation water are concerns of management. Some land leveling is generally needed to prepare this soil for gravity irrigation.

The soil is suited to plants that are tolerant of the saline-alkali condition, such as tall wheatgrass and native western wheatgrass. Some areas where the concentrations of salinity and alkalinity are not excessive are suited to spring-sown small grain.

The water intake rate is moderate. Applications of water should be controlled to prevent excessive runoff. All the common methods of irrigation are suitable for use on this soil. Excessive applications of irrigation water can be used to wash salts from the soil, provided a suitable method of surface drainage is used.

CAPABILITY UNIT III_w-8, IRRIGATED

Only Glenberg loamy very fine sand, occasionally flooded, 0 to 3 percent slopes, is in this unit. It is a deep, well-drained soil on bottom lands. It has a surface layer and underlying material of loamy very fine sand.

Permeability is moderately rapid, and the available water capacity is moderate. The organic-matter content and natural fertility are low. Runoff is slow.

Flooding is a major hazard if this soil is irrigated. Floods deposit silt and debris and erode leveled fields. Soil blowing is a hazard if the soil surface is not protected. Maintaining soil fertility, increasing organic-matter content, and efficiently using irrigation water

are concerns of management. Little land leveling is needed to prepare this soil for gravity irrigation.

The soil is suited to grasses and alfalfa used for hay and pasture. Periodic flooding is less likely to damage hay crops than cultivated crops. In some areas, diversion channels can be used to direct flood waters to outlets, such as streams.

The water intake rate is moderately high. Applications of water should be light but frequent. A sprinkler irrigation system is suitable for use on this soil.

CAPABILITY UNIT IV_s-3, IRRIGATED

In this unit are deep and moderately deep, very gently sloping to strongly sloping soils on uplands and foot slopes. The soils have a surface layer of silty clay loam, and their subsoil is light silty clay or heavy silty clay loam. Many areas are underlain by shale at a depth of 20 to 40 inches.

Permeability is slow or moderately slow, and the available water capacity is low to high. The organic-matter content is low to moderately low, and the natural fertility is low. The soils absorb moisture slowly and release it slowly to plants. They are difficult to work because they tend to clod if worked when dry and puddle if worked when too wet. Runoff is medium to rapid.

Water erosion is the principal hazard if these soils are irrigated. Efficiently using irrigation water is the main concern of management. Increasing the organic-matter content, improving soil tilth, and maintaining soil fertility are also concerns. Extensive land leveling is needed to prepare these soils for gravity irrigation. Bench leveling is more suitable in places.

The soils are suited to close-sown small grain, irrigated grasses, and alfalfa. If a furrow irrigation system is used, extensive land leveling is needed to reduce soil slope. This practice prevents soil erosion and excessive runoff of irrigation water.

The water intake rate is low. Irrigation water should be applied at a rate that the water can be absorbed by the soils. A sprinkler irrigation system is well suited to use on these soils. Erosion in wheel tracks can be a concern if a center-pivot system is used.

CAPABILITY UNIT IV_w-6, IRRIGATED

Only Mitchell silt loam, 5 to 9 percent slopes, is in this unit. It is a deep, well-drained soil on uplands. It has a surface layer and underlying material of calcareous silt loam.

Permeability is moderate, and the available water capacity is high. The organic-matter content is low, and the natural fertility is medium to low. The soil absorbs moisture easily and releases it readily to plants. It is easy to work. Runoff is medium.

Water erosion is the principal hazard if this soil is irrigated. Controlling erosion, maintaining balanced soil fertility, and increasing the organic-matter content are important concerns of management. Efficiently using irrigation water is also a concern. Phosphorus is likely to be lacking in this soil. Extensive land leveling is needed to prepare this soil for gravity irrigation. Bench leveling is more suitable in places.

The soil is suited to grasses and other hay crops. Where these crops are grown, water erosion is easier to control. Leaving crop residue on the soil surface

helps to reduce erosion. Applying commercial fertilizers generally increases forage production, which helps to reduce erosion.

The water intake rate is moderate. Water should be applied at a rate that it can be absorbed by the soil. A sprinkler system is suitable for use on this soil. A center-pivot sprinkler system can be used, but there is a risk of making deep wheel ruts when the system operates up and down the slope, especially if irrigation water is applied too fast for the soil to absorb it.

CAPABILITY UNIT IV_e-7, IRRIGATED

In this unit are mainly moderately deep, well-drained, gently sloping to strongly sloping soils on uplands. The soils have a surface layer of loam or silt loam, and their subsoil is loam to heavy silty clay loam. The moderately deep soils are underlain by siltstone or sandstone at a depth of 20 to 40 inches. Many areas of shallow soils are underlain by sandstone or siltstone at a depth of 10 to 20 inches.

Permeability is moderate, and the available water capacity is low to moderate. The organic-matter content is low to moderate, and the natural fertility is medium to low. Runoff is slow to medium.

Soil blowing and water erosion are the principal hazards if these soils are irrigated. Maintaining balanced soil fertility and efficiently using irrigation water are concerns of management. Increasing the organic-matter content and improving soil tilth are also concerns. Phosphorus is likely to be lacking in the light-colored, calcareous soils. Some land leveling is generally needed in preparing the soils for gravity irrigation.

The soils are suited to irrigated small grains, alfalfa and grass. Contour farming helps to control water erosion. Returning all crop residue to the soil and growing grass and legumes help to increase the organic-matter content and to maintain soil fertility. Commercial fertilizer can supply the needed nitrogen and phosphorus.

The water intake rate is moderate. Water should be applied at a rate that it can be absorbed by the soil. Only a sprinkler system is suitable for use on these soils. Erosion in wheel tracks can be a concern if a center-pivot system is used.

CAPABILITY UNIT IV_e-8, IRRIGATED

In this unit are deep, well-drained to somewhat excessively drained, strongly sloping soils on uplands and foot slopes. The soils have a surface layer and subsoil of loamy very fine sand or fine sandy loam.

Permeability is moderately rapid, and the available water capacity is moderate. The organic-matter content is low to moderate, and the natural fertility is medium to low. The soils absorb water easily and release it readily to plants. They are easy to work. Runoff is slow or medium.

Soil blowing and water erosion are hazards if these soils are irrigated. Efficient use of irrigation water is needed to prevent excessive leaching of nutrients. Controlling erosion and maintaining soil fertility are also concerns of management.

The soils are suited to close-sown crops, such as oats, barley, alfalfa, and grass. Soil blowing can be controlled

by including in the cropping system crops that leave residue on the soil surface, especially early in spring when high winds are most common. Planting hay and pasture crops helps to control water erosion. Applying commercial fertilizers and barnyard manure helps to maintain soil fertility and organic-matter content.

The water intake rate is moderately high. A sprinkler irrigation system is well suited to use on these soils. Applications of water should be light and frequent because of the moderately coarse and coarse texture of the soils.

CAPABILITY UNIT IV_e-11, IRRIGATED

In this unit are deep, well-drained to excessively drained, nearly level and very gently sloping soils on stream terraces and bottom lands. The soils have a surface layer of loamy fine sand, and their underlying material is fine sand.

Permeability is rapid, and the available water capacity is low. The organic-matter content is low, and the natural fertility is medium to low. The soils absorb moisture rapidly and release it readily to plants. Runoff is slow because most moisture is absorbed by the soil.

Soil blowing is the principal hazard on these soils. Maintaining fertility and increasing the organic-matter content are concerns of management. Efficient use of irrigation water is needed to prevent leaching of plant nutrients through these coarse-textured soils.

The soils are suited to most irrigated crops commonly grown in the county, but they are better suited to grasses and hay crops. The coarse texture, low fertility, and low organic-matter content of the soils are severe limitations. Using small narrow fields or strips when preparing a seedbed for grass and hay crops helps to reduce soil blowing.

The water intake rate is very high. Irrigation water should be applied at the rate that it can be absorbed by the soil. A sprinkler irrigation system, especially the center-pivot type, is well suited to use on these soils.

CAPABILITY UNIT IV_s-1, IRRIGATED

Only Kyle silty clay, 0 to 1 percent slopes, is in this unit. It is a deep, well-drained soil on stream terraces. It has a surface layer of silty clay, and its subsoil is clay.

Permeability is very slow, and the available water capacity is moderate. The organic-matter content is moderately low, and the natural fertility is medium to low. The soil absorbs water slowly and releases it slowly to plants. It is difficult to work because it is very hard when dry and very sticky when wet. Runoff is slow.

The clayey texture, which makes this soil difficult to work, is the main limitation. Maintaining soil fertility, increasing the organic-matter content, and efficiently using irrigation water are concerns of management. Only a small amount of land leveling is needed to prepare this soil for gravity irrigation.

The soil is suited to grasses and alfalfa used for hay or pasture. Keeping the soil in hay crops eliminates the yearly cultivation needed for annual crops. Applying commercial fertilizers helps to maintain soil fertility.

The water intake rate is very low, and irrigation

water is difficult to apply. The high content of expansive clay causes the soil to crack widely when it dries. Irrigation mainly places water in the crack, thus limiting the supply of water to most of the plants. A gravity irrigation system that includes borders is suitable for use on this soil. A sprinkler system is also suitable, but the application rate must be adjusted to correspond to the very low water intake rate. Center-pivot irrigation systems generally are not suitable because their lowest rate of application is commonly higher than the intake rate of the soil.

CAPABILITY UNIT IVw-11, IRRIGATED

Only Bankard loamy fine sand, wet variant, 0 to 2 percent slopes, is in this unit. It is a deep, somewhat poorly drained soil on bottom lands. It has a surface layer of loamy fine sand, and its underlying material is fine sand. The water table is at a depth of 2 to 6 feet.

Permeability is rapid, and the available water capacity is low. The organic-matter content is low, and the natural fertility is medium to low. The soil absorbs moisture easily and releases it readily to plants. It is loose and difficult to work. Runoff is slow because most rainfall is absorbed as rapidly as it falls.

Soil blowing is a hazard if the soil surface is not protected. The soil is commonly too wet for seedbed preparation early in spring. Artificial drainage is needed in places before the soil can be irrigated. Efficiently using irrigation water, maintaining soil fertility, and increasing the organic-matter content are concerns of management.

The soil is suited to all the irrigated crops commonly grown in the county, particularly to those that can be planted late in the spring, such as alfalfa and grasses. A suitable cropping system should include high-residue crops or should permit leaving most of the crop residue on the soil surface during and after seedbed preparation. Suitable outlets for a drainage system to remove excess water are commonly unavailable.

The water intake rate is very high. Only a sprinkler irrigation system is suitable for use on this soil. Irrigation is supplemental in most years, because early in spring and in summer the water table is commonly high enough to cause excessive soil wetness. Irrigation is needed mostly in the middle part of summer and late in summer.

Predicted yields

Predictions of crop yields are an important interpretation that can be made from a soil survey. The predicted yields per acre of the principal crops grown on soils of Dawes County are given in table 2. These predictions are based on average yields for seeded acres during the most recent 5-year period. They do not represent anticipated yields that might be obtained in the future under new and possible different technology.

Yield data for various crops were derived from information obtained from interviews with farmers, directors of the Natural Resource Districts, representatives of the Soil Conservation Service, and Dawes County Agricultural Extension Service, and others familiar with the soils and farming of the county. Yield information from the Agriculture Stabilization and Conservation Service and research data from

Agricultural Experiment Stations were also used. Yield records, trends, research, and experience were taken into consideration.

Crop yields are influenced by many factors. Some of the most influential soil features are soil depth, texture, slope, and drainage. Also important are erosion, available water capacity, permeability, and fertility. Management practices, such as the cropping pattern, timeliness of operations, plant population, and crop variety, effect crop yields. Last, but certainly not least, weather is significant both on a day-to-day basis, and for longer seasonal or yearly fluctuations. All of these practices were taken into account in preparing table 2.

The yields listed are those predicted where a high level of management is used. Under this level of management, fertility is maintained and fertilizer or lime is applied at rates indicated by soil tests and field experiments. Crop residue is returned to the soil to improve tilth and to maintain or increase the organic-matter content of the soil. Suited varieties of seed are used and plant populations are optimum. Weeds, insects, and diseases are well controlled. Irrigation water is applied in a timely manner and in the proper amounts. Water erosion and soil blowing are controlled. The soils are drained as needed for crop production. Tillage and seeding practices are adequate and are performed at the proper time. The soil is protected from deterioration and used according to its capacity.

The yield table is useful in comparing the productivity of one soil with that of other soils in the county. The table does not give management recommendations, and the yields given do not apply to specific farms or farmers.

Yields in any one year on a particular soil can vary considerably from the figures given in the table because of the effect of weather, sudden infestations of diseases, insects, or other unpredictable hazards. By using long-time averages, it is possible to consider such hazards in predicting crop yields.

Improved technology may make predictions in the table obsolete in a few years. Yield data will then need to be updated as knowledge is gained and improvements in technology show the need.

Range⁴

Rangeland makes up about 69 percent of the total farm acreage in Dawes County. It is scattered throughout the county. About 14,047 acres is in the Oglala National Grasslands, and 26,182 acres is in the Nebraska National Forest. The rangeland is generally not suited to cultivation. The major soil associations in range are Pierre-Samsil-Kyle, Canyon-Bridget-Oglala, and Busher-Tassel-Vetal associations.

Raising livestock, mainly cattle, and selling the calves in the fall as feeders is the largest farm enterprise in the county. The range is grazed 8 to 10 months per year, and hay is fed to livestock the rest of the year.

Management practices that maintain or improve the range condition are needed on all rangeland. Suitable management practices are: (a) *proper grazing use,*

⁴ By PETER N. JENSEN, range conservationist, Soil Conservation Service.

TABLE 2.—*Predicted average yields of principal crops*

[Dashes indicate that the soil is not suited to the specific crop, that the crop is grown in very small amounts, or that irrigation is not practical]

Soil	Wheat ¹	Oats	Alfalfa	
	Dryland	Dryland	Dryland	Irrigated
	Bu	Bu	Tons	Tons
Alliance silt loam, 1 to 3 percent slopes -----	37	43	2.0	5.0
Alliance silt loam, 3 to 9 percent slopes -----	34	40	1.6	4.5
Alliance silt loam, 3 to 9 percent slopes, eroded -----	32	35	1.4	4.3
Badland -----				
Bankard loamy fine sand, 0 to 2 percent slopes -----	19	24	1.1	3.0
Bankard loamy fine sand, wet variant, 0 to 2 percent slopes -----			1.5	2.8
Breaks-Alluvial land complex -----				
Bridget silt loam, 0 to 1 percent slopes -----	39	46	2.2	5.5
Bridget silt loam, 1 to 3 percent slopes -----	37	43	2.1	5.3
Bridget silt loam, 3 to 9 percent slopes -----	34	36	2.0	5.0
Bridget silt loam, 9 to 20 percent slopes -----				
Buffington silty clay, 0 to 1 percent slopes -----	25	30	1.6	4.2
Buften silty clay loam, 0 to 1 percent slopes -----	28	34	1.8	4.5
Buften silty clay loam, 1 to 3 percent slopes -----	26	31	1.5	4.3
Buften silty clay loam, 3 to 9 percent slopes -----	23	25	1.5	3.8
Buften silty clay loam, 9 to 20 percent slopes -----				
Buften-Slickspots complex, 0 to 9 percent slopes -----				
Busher loamy very fine sand, 1 to 5 percent slopes -----	30	34	1.3	4.3
Busher loamy very fine sand, 1 to 5 percent slopes, eroded -----	28	32	1.2	4.2
Busher loamy very fine sand, 5 to 9 percent slopes -----	27	30	1.1	4.0
Busher loamy very fine sand, 5 to 9 percent slopes, eroded -----	24	27	.9	3.8
Busher loamy very fine sand, 9 to 20 percent slopes -----				
Busher and Tassel loamy very fine sands, 5 to 20 percent slopes -----				
Canyon-Bridget-Rock outcrop association, steep -----				
Canyon soils, 3 to 30 percent slopes -----				
Canyon soils, 30 to 50 percent slopes -----				
Clayey alluvial land -----				
Duroc very fine sandy loam, 1 to 3 percent slopes -----	40	46	2.5	5.4
Epping silt loam, 3 to 30 percent slopes -----				
Epping-Badland complex, 3 to 50 percent slopes -----				
Glenberg loamy very fine sand, 0 to 3 percent slopes -----	32	40	2.1	4.8
Glenberg loamy very fine sand, occasionally flooded, 0 to 3 percent slopes -----	28	37	2.0	4.4
Gravelly alluvial land -----				
Haverson silt loam, 0 to 3 percent slopes -----	39	46	2.5	5.7
Haverson silt loam, occasionally flooded, 0 to 3 percent slopes -----	34	40	2.2	4.9
Haverson silty clay loam, occasionally flooded, 0 to 3 percent slopes -----	30	37	2.1	4.9
Jayem loamy very fine sand, 1 to 5 percent slopes -----	31	35	1.4	4.3
Jayem loamy very fine sand, 5 to 9 percent slopes -----	29	32	1.2	4.0
Jayem and Vetal loamy very fine sands, 5 to 9 percent slopes -----	30	33	1.3	4.0
Kadoka silt loam, deep variant, 1 to 3 percent slopes -----	38	44	2.0	5.0
Kadoka silt loam, deep variant, 3 to 9 percent slopes -----	34	41	1.8	4.6
Kadoka silt loam, deep variant, 3 to 9 percent slopes, eroded -----	32	35	1.6	4.4
Keith silt loam, 1 to 3 percent slopes -----	38	44	2.0	5.0
Keith silt loam, 3 to 9 percent slopes -----	34	41	1.8	4.6
Keith and Ulysses silt loams, 3 to 9 percent slopes -----	32	35	1.7	4.4
Keota silt loam, 1 to 3 percent slopes -----	34	39	1.5	4.4
Keota-Epping silt loams, 3 to 9 percent slopes -----	28	30	1.3	4.0
Kyle silty clay, 0 to 1 percent slopes -----	24	29	1.2	4.0
Kyle silty clay, 1 to 5 percent slopes -----	22	26	1.1	3.8
Kyle-Slickspots complex, 0 to 2 percent slopes -----				
Las Animas soils, 0 to 2 percent slopes -----			2.0	4.2
Loamy alluvial land -----				
Minnequa silty clay loam, 1 to 5 percent slopes -----				
Minnequa silty clay loam, 5 to 12 percent slopes -----				
Mitchell silt loam, 0 to 1 percent slopes -----	35	42	2.2	5.4
Mitchell silt loam, 1 to 5 percent slopes -----	33	36	2.0	4.6
Mitchell silt loam, 5 to 9 percent slopes -----	30	33	1.8	4.4
Mitchell silt loam, 9 to 20 percent slopes -----				
Mitchell-Epping silt loams, 9 to 30 percent slopes -----				
Norrest silty clay loam, 1 to 3 percent slopes -----	26	34	1.2	4.2
Norrest silty clay loam, 3 to 9 percent slopes -----	24	32	1.1	3.9
Norrest silty clay loam, 9 to 20 percent slopes -----				
Oglala loam, 9 to 30 percent slopes -----				
Oglala-Canyon loams, 9 to 20 percent slopes -----				
Orella silty clay loam, 3 to 30 percent slopes -----				
Orella-Badland complex, 3 to 50 percent slopes -----				
Penrose-Shale outcrop complex, 10 to 50 percent slopes -----				

TABLE 2.—Predicted average yields of principal crops—Continued

Soil	Wheat ¹	Oats	Alfalfa	
	Dryland	Dryland	Dryland	Irrigated
	Bu	Bu	Tons	Tons
Penrose and Minnequa silty clay loams, 5 to 20 percent slopes	20	24	0.8	3.7
Pierre silty clay, 1 to 5 percent slopes				
Pierre silty clay, 5 to 30 percent slopes				
Pierre-Slickspots complex, 3 to 9 percent slopes				
Richfield silt loam, 1 to 3 percent slopes	38	44	2.0	5.0
Rock outcrop-Canyon complex, 30 to 60 percent slopes				
Rosebud silt loam, 1 to 3 percent slopes	35	40	1.6	4.5
Rosebud-Canyon loams, 3 to 9 percent slopes	26	30	.9	3.8
Saline-Alkali land				
Samsil silty clay, 3 to 30 percent slopes				
Samsil-Shale outcrop complex, 9 to 50 percent slopes				
Sandy alluvial land				
Sarben fine sandy loam, 1 to 5 percent slopes	32	36	1.5	4.5
Sarben fine sandy loam, 5 to 9 percent slopes	27	32	1.2	4.1
Sarben fine sandy loam, 9 to 30 percent slopes				
Sarben and Vetal loamy very fine sands, 9 to 30 percent slopes				
Schamber soils, 3 to 30 percent slopes				
Tassel soils, 3 to 30 percent slopes				
Tripp silt loam, 0 to 1 percent slopes	38	43	2.2	5.5
Tripp silt loam, 1 to 3 percent slopes	36	41	2.1	5.3
Tripp silt loam, saline-alkali, 0 to 2 percent slopes	23	27	1.6	4.2
Ulysses silt loam, 9 to 20 percent slopes				
Valent and Dwyer loamy fine sands, 0 to 3 percent slopes				
Valent and Dwyer loamy fine sands, 3 to 17 percent slopes				
Vetal and Bayard soils, 1 to 5 percent slopes	32	36	1.6	4.3
Wet alluvial land				

¹ Wheat is grown under a summer fallow system of management, and the predicted yields can be expected only in alternate years.

grazing at an intensity that will maintain enough cover to protect the soil and to maintain or improve the quantity and quality of desirable vegetation; (b) *deferred grazing*, postponing grazing or resting grazing land for a prescribed period; and (c) *a planned grazing system*, in which two or more grazing units are alternately rested in a planned sequence over a period of years. The rest period can be throughout the year or during the growing season of the key plants. The distribution of livestock in a pasture can be improved by the correct location of fences, salting facilities, and livestock water developments (fig. 23).

One practice that improves range condition is range seeding. Native grasses, either wild harvest or improved strains, are established by seeding or reseeding on land suitable for use as range. Soils such as Mitchell silt loam, 9 to 20 percent slopes, and Ulysses silt loam, 9 to 20 percent slopes, that are still being used for crops should be range seeded. The important grasses used in the seed mixture include little bluestem, big bluestem, side-oats grama, blue grama, and western wheatgrass. Little care other than management of grazing is needed to maintain forage production.

Range sites and condition classes

Different kinds of rangeland produce different kinds and amounts of native grass. For proper range management, an operator should know the kinds of range sites in his holding and the native plants each site can grow. Management can then be used that will favor the growth of the best forage plants on each site.

Range condition is classified according to the percentage of original or climax vegetation on the site. This classification compares the kind and amount of vegetation presently on the site with that which the site can produce. Changes in range condition are caused mainly by the intensity of grazing and by drought.

Climax vegetation can be altered by intensive grazing. Livestock graze selectively. They constantly seek the more palatable and nutritious plants. Plants that are grazed either decrease, increase, or invade. Decreaser and increaser plants are climax plants. Generally, *decreasers* are the most heavily grazed and, consequently, the first to be injured by overgrazing. *Increasers* withstand grazing better or are less palatable to livestock. They increase under grazing and replace the decreasers. *Invaders* are weeds that become established after the climax vegetation has been reduced by grazing.

Range condition is expressed in four condition classes that compare the present vegetation on a range site to the vegetation that grew on it originally. The condition is *excellent* if 76 to 100 percent of the vegetation is climax; *good* if 51 to 75 percent is climax; *fair* if 26 to 50 percent is climax; and *poor* if 0 to 25 percent is climax.

Descriptions of range sites

The range sites represented in Dawes County are Wet Land, Subirrigated, Silty Overflow, Clayey Overflow, Sandy Lowland, Silty Lowland, Saline Lowland, Sands, Savannah, Sandy, Silty, Clayey, Limy Upland,

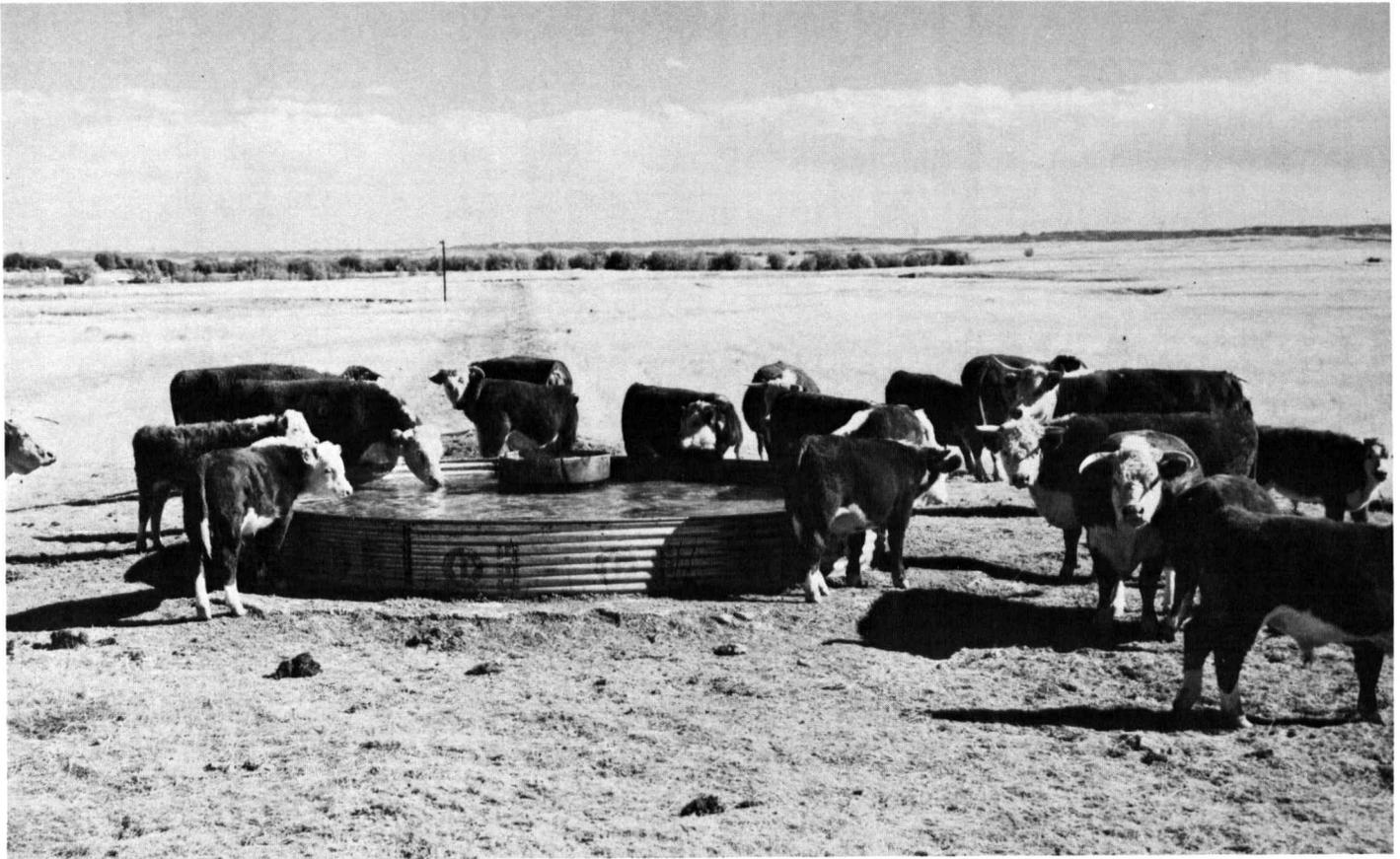


Figure 23.—Livestock watering in the Pierre Shale area. The water is provided by an underground plastic pipeline.

Shallow Clay, Shallow to Gravel, Shallow Limy, Thin Loess, Saline Upland, and Panspots.

The description of each site includes the topography of the site, a brief description of the mapping units in the site, the dominant vegetation on the site when it is in excellent range condition, the dominant vegetation when it is in poor range condition, and the site's total annual production of air-dry herbage per acre for years when growing conditions are favorable and unfavorable.

The range site for each soil mapping unit is shown in the "Guide to Mapping Units." Badlands, Rock outcrop, and Shale outcrop are not assigned to a range site because these land types are not used for range.

WET LAND RANGE SITE

Only Wet alluvial land, 0 to 3 percent slopes, is in this site. This land type consists of deep, poorly drained alluvial sediment on bottom lands. It is a fine sandy loam, loamy fine sand, or fine sand. During most years the water table is at the surface in early spring and ranges to a depth of 2 feet in early fall. The kind of vegetation that grows on this site is influenced mainly by the moisture from the high water table.

About 70 percent of the climax plant cover is a mixture of such decreaser grasses as prairie cordgrass, Canada wildrye, and various reedgrasses. About 30 percent consists of other perennial grasslike plants and

forbs. Members of the sedge family are the principal increasers.

If the site is in poor condition, the typical plant community consists of Kentucky bluegrass, red clover, redtop, asters, dandelion, and sparse amounts of prairie cordgrass and members of the sedge family.

If the site is in excellent condition, the total annual yield of air-dry herbage ranges from 4,000 pounds per acre in unfavorable years to 5,000 pounds in favorable years.

SUBIRRIGATED RANGE SITE

In this site are deep, somewhat poorly drained, nearly level to very gently sloping soils on bottom lands. The soils have a surface layer of loamy fine sand to silt loam, and their underlying material is fine sand to stratified very fine sandy loam and loamy fine sand. In most years the water table is at a depth of 2 feet in spring to 6 feet in early fall. The kind of vegetation that grows on this site is influenced mainly by the moisture from the moderately high water table that remains within the rooting zone during the growing season.

About 70 percent of the climax plant cover is a mixture of such decreaser grasses as big bluestem, little bluestem, indiagrass, switchgrass, prairie cordgrass, and Canada wildrye. About 30 percent consists of other perennial grasses and forbs. Kentucky blue-

grass, green muhly, western wheatgrass, and members of the sedge family are the principal increasers.

If the site is in poor condition, the typical plant community consists of Kentucky bluegrass, redtop, foxtail barley, dandelion, western ragweed, blue verben, and sparse amounts of western wheatgrass and members of the sedge family.

If the site is in excellent condition, the total annual yield of air-dry herbage ranges from 4,000 pounds per acre in unfavorable years to 5,000 pounds in favorable years.

SILTY OVERFLOW RANGE SITE

In this site are deep, well-drained, nearly level to very gently sloping soils and land types on bottom lands. The soils have a surface layer of silt loam or silty clay loam, and their underlying material is very fine sandy loam or silt loam. They are subject to occasional flooding. The kind of vegetation that grows on this site is influenced mainly by the additional moisture received from periodic overflow, by sediment deposited by floods, and by the high available water capacity of the soils.

About 65 percent of the climax plant cover is a mixture of such decreaser grasses as big bluestem, little bluestem, switchgrass, side-oats grama, green needlegrass, and Canada wildrye. About 35 percent consists of other grasses and forbs. Western wheatgrass, green muhly, Kentucky bluegrass and members of the sedge family are the principal increasers.

If the site is in poor condition, the typical plant community consists of Kentucky bluegrass, western wheatgrass, and members of the sedge family.

If the site is in excellent condition, the total annual yield of air-dry herbage ranges from 3,000 pounds per acre in unfavorable years to 4,250 pounds in favorable years.

CLAYEY OVERFLOW RANGE SITE

Only Clayey alluvial land, 0 to 3 percent slopes, is in this site. This land type consists mainly of deep, stratified silty clay loam, silty clay, and clay sediment. It is on bottom lands that are subject to flooding. The kind of vegetation that grows on this site is influenced mainly by the moisture received from flooding and runoff.

About 75 percent of the climax plant cover is a mixture of such decreaser grasses as western wheatgrass, green needlegrass, and side-oats grama. About 25 percent consists of other grasses and forbs. Blue grama, Kentucky bluegrass, inland saltgrass, and members of the sedge family are the principal increasers.

If the site is in poor condition, the typical plant community consists of Kentucky bluegrass, inland saltgrass, western ragweed, and members of the sedge family.

If the site is in excellent condition, the total annual yield of air-dry herbage ranges from 2,250 pounds per acre in unfavorable years to 3,500 pounds in favorable years.

SANDY LOWLAND RANGE SITE

In this site are deep, well-drained to somewhat excessively drained, nearly level to very gently sloping soils

and land types on bottom lands. The soils have a surface layer of loamy fine sand to loamy very fine sand, and their underlying material is fine sand to loamy very fine sand. The water table is at a depth of 6 to 10 feet. Some areas are subject to occasional flooding. The kind of vegetation that grows on this site is influenced mainly by the additional moisture from the water table or from periodic overflow.

About 40 percent of the climax plant cover is a mixture of sand bluestem, little bluestem, switchgrass, and Canada wildrye. About 60 percent consists of other grasses and forbs. Prairie sandreed, needleandthread, blue grama, Scribner panicum, sand dropseed, western wheatgrass, and members of the sedge family are the principal increasers.

If the site is in poor condition, the typical plant community consists of blue grama, sand dropseed, Scribner panicum, and western ragweed.

If the site is in excellent condition, the total annual yield of air-dry herbage ranges from 2,500 pounds per acre in unfavorable years to 3,750 pounds in favorable years.

SILTY LOWLAND RANGE SITE

Only Haverson silt loam, 0 to 3 percent slopes, is in this site. It is a deep, well-drained soil on high bottom lands and low stream terraces. It has a surface layer of silt loam, and its underlying material is very fine sandy loam to silt loam. The water table is at a depth of 6 to 10 feet. The kind of vegetation that grows on this site is influenced by the additional moisture received from runoff and from the water table.

About 65 percent of the climax plant cover is a mixture of such decreaser grasses as big bluestem, little bluestem, switchgrass, side-oats grama, green needlegrass, and Canada wildrye. About 35 percent consists of other grasses and forbs. Western wheatgrass, needleandthread, blue grama, Kentucky bluegrass, and members of the sedge family are the principal increasers.

If the site is in poor condition, the typical plant community consists of blue grama, Kentucky bluegrass, western wheatgrass, western ragweed, and members of the sedge family.

If the site is in excellent condition, the total annual yield of air-dry herbage ranges from 3,000 pounds per acre in unfavorable years to 4,250 pounds in favorable years.

SALINE LOWLAND RANGE SITE

In this site are deep, well-drained, nearly level to strongly sloping soils and land types on upland, foot slopes, and stream terraces. The soils and land types are moderately affected to strongly affected by salts or alkali. They have a surface layer of silt loam or silty clay loam, and their subsoil is silt loam or heavy silty clay. Some areas of saline-alkali land receive runoff water from surrounding areas. This water ponds on the surface for short periods. Some areas are occasionally flooded. The kind of vegetation that grows on this site is influenced mainly by the additional moisture received from runoff and periodic overflow, and by the saline or alkaline condition of the soils.

About 70 percent of the climax plant cover is a mixture of such decreaser grasses as alkali sacaton,

western wheatgrass, switchgrass, plains bluegrass, and slender wheatgrass. About 30 percent consists of other perennial grasses and forbs. Inland saltgrass, Sandberg bluegrass, blue grama, and members of the sedge family are the principal increasers.

If the site is in poor condition, the typical plant community consists of inland saltgrass, blue grama, Sandberg bluegrass, broom snakeweed, and common pricklypear.

If the site is in excellent condition, the total annual yield of air-dry herbage ranges from 2,000 pounds per acre in unfavorable years to 3,250 pounds in favorable years.

SANDS RANGE SITE

Only Valent and Dwyer loamy fine sands, 3 to 17 percent slopes, are in this site. These soils consist of deep, excessively drained, gently sloping to steep soils on uplands. They have a surface layer of loamy fine sand, and their underlying material is fine sand. The kind of vegetation that grows on this site is influenced mainly by the moisture stored deep in the soil, which is readily released to plants.

About 65 percent of the climax plant cover is a mixture of such decreaser plants as sand bluestem, little bluestem, switchgrass, prairie junegrass, and leadplant. About 35 percent consists of other perennial grasses, forbs, and shrubs. Prairie sandreed, needleandthread, blue grama, Scribner panicum, sand dropseed, cudweed sagewort, fringed sagewort, brittle pricklypear, and small soapweed are the principal increasers.

If the site is in poor condition, the typical plant community consists of blue grama, hairy grama, sand paspalum, sand dropseed, western ragweed, and small soapweed.

If the site is in excellent condition, the total annual yield of air-dry herbage ranges from 1,250 pounds per acre in unfavorable years to 2,500 pounds in favorable years.

SAVANNAH RANGE SITE

In this site are shallow to deep, well-drained, steep to very steep soils on uplands. The soils have a surface layer of loam or silt loam, and their subsoil is very fine sandy loam to silt loam. The shallow soils have sandstone at a depth of 10 to 20 inches. The kind of vegetation that grows on this site is influenced mainly by the wide variations in soil depth, available water capacity, and relief. This site is in the Pine Ridge area and in a few other areas where the vegetation consists mainly of mixed grass and ponderosa pine trees (fig. 24).

About 65 percent of the climax plant cover is a mixture of such decreaser grasses as little bluestem, big bluestem, side-oats grama, plains muhly, green needlegrass, prairie junegrass, slender wheatgrass, bearded wheatgrass, and western wheatgrass. About 35 percent consists of other perennial grasses, forbs, shrubs, and trees. Blue grama, prairie sandreed, hairy grama, fringed sagewort, cudweed sagewort, small soapweed, western snowberry, skunkbush sumac, and isolated ponderosa pine are the principal increasers.

If the site is in poor condition the typical plant community consists of ponderosa pine and numerous species of shrubs and vines. On some northern and

eastern exposures, a woodland site is associated with this site.

If the site is in excellent condition, the total annual yield of air-dry herbage ranges from 1,500 pounds per acre in unfavorable years to 2,500 pounds in favorable years.

SANDY RANGE SITE

In this site are deep, well-drained to somewhat excessively drained, nearly level to steep soils on uplands and stream terraces. The soils have a surface layer of fine sandy loam to loamy fine sand, and their underlying material is fine sandy loam to fine sand. Some areas of these soils are eroded. The kind of vegetation that grows on this site is influenced mainly by the moderately rapid to rapid permeability of the soils.

About 50 percent of the climax plant cover is a mixture of such decreaser plants as sand bluestem, little bluestem, and prairie junegrass. About 50 percent consists of other perennial grasses, forbs, and shrubs. Blue grama, threadleaf sedge, prairie sandreed, needleandthread, sand dropseed, western wheatgrass, fringed sagewort, and small soapweed are the principal increasers.

If the site is in poor condition, the typical plant community consists of blue grama, threadleaf sedge, sand dropseed, and western ragweed.

If the site is in excellent condition, the total annual yield of air-dry herbage ranges from 1,250 pounds per acre in unfavorable years to 2,500 pounds in favorable years.

SILTY RANGE SITE

In this site are deep, well-drained, nearly level to steep soils on uplands, foot slopes, and stream terraces. The soils have a surface layer of very fine sandy loam, loam, or silt loam, and their subsoil and underlying material are very fine sandy loam to heavy silty clay loam. The kind of vegetation that grows on this site is influenced mainly by the moderately slow or moderately slow or moderate permeability of the soils and by their moderate to high available water capacity.

About 50 percent of the climax plant cover is a mixture of such decreaser grasses as big bluestem, little bluestem, side-oats grama, western wheatgrass, and prairie junegrass. About 50 percent consists of other perennial grasses, forbs, and shrubs. Blue grama, buffalograss, threadleaf sedge, needleandthread, Arkansas rose, and numerous forbs such as dotted gayfeather, false boneset, heath aster, skeletonplant, and scarlet globemallow are the principal increasers.

If the site is in poor condition, the typical plant community consists of blue grama, buffalograss, threadleaf sedge, and sand dropseed.

If the site is in excellent condition, the total annual yield of air-dry herbage ranges from 1,500 pounds per acre in unfavorable years to 3,000 pounds in favorable years.

CLAYEY RANGE SITE

In this site are deep and moderately deep, well-drained, nearly level to steep soils on uplands, foot slopes, and stream terraces. The soils have a surface layer of silty clay loam or silty clay, and their subsoil is light silty clay loam to clay. The kind of vegetation



Figure 24.—An area of Savannah range site. The plant community consists of native grasses and ponderosa pines. This site is used mainly for grazing by livestock.

that grows on this site is influenced mainly by the very slow or slow permeability of the soils.

About 75 percent of the climax plant cover is a mixture of such decreaser grasses as western wheatgrass, green needlegrass, prairie junegrass, and side-oats grama. About 25 percent consists of other perennial grasses and forbs. Blue grama, buffalograss, Sandberg bluegrass, heath aster, and slimflower scurfpea are the principal increasers.

If the site is in poor condition, the typical plant community consists of broom snakeweed, and curlycup gumweed.

If the site is in excellent condition, the total annual yield of air-dry herbage ranges from 750 pounds per acre in unfavorable years to 2,000 pounds in favorable years.

LIMY UPLAND RANGE SITE

In this site are deep and moderately deep, well-drained, nearly level to steep soils on uplands, foot slopes, and stream terraces. The soils have a surface layer of silt loam or silty clay loam, and their subsoil

is silt loam to heavy silty clay loam that is high in lime. The kind of vegetation that grows on this site is influenced mainly by the limy soil conditions and by the fact that the soils absorb moisture easily and release it readily to plants.

About 70 percent of the climax plant cover is a mixture of such decreaser grasses as little bluestem, side-oats grama, green needlegrass, and western wheatgrass. About 30 percent consists of other perennial grasses and forbs. Blue grama, buffalograss, prairie sandreed, needleandthread, threadleaf sedge, and broom snakeweed are the principal increasers.

If the site is in poor condition, the typical plant community consists of blue grama, buffalograss, sand dropseed, and threadleaf sedge.

If the site is in excellent condition, the total annual yield of air-dry herbage ranges from 1,250 pounds per acre in unfavorable years to 2,750 pounds in favorable years.

SHALLOW CLAY RANGE SITE

In this site are shallow, well-drained, gently sloping

to very steep soils on uplands. The soils have a surface layer and underlying material of silty clay. Shale is at a depth of 10 to 20 inches. The kind of vegetation that grows on this site is influenced mainly by the slow permeability of the soils and by their shallow rooting zone.

About 60 percent of the climax plant cover is a mixture of such decreaser grasses as side-oats grama, Fendler theewawn, western wheatgrass, and green needlegrass. About 40 percent consists of other perennial grasses and forbs. Buffalograss, threadleaf sedge, Sandberg bluegrass, common pricklypear, heath aster, slimflower scurfpea, scarlet globemallow, and broom snakeweed are the principal increasers.

The site is rarely in poor condition because it is inaccessible to livestock.

If the site is in excellent condition, the total annual yield of air-dry herbage ranges from 500 pounds per acre in unfavorable years to 1,500 pounds in favorable years.

SHALLOW TO GRAVEL RANGE SITE

In this site are somewhat excessively drained to excessively drained, gently sloping to steep soils and land types on uplands and bottom lands. The soils have a surface layer of gravelly very fine sandy loam to gravelly sand, and their underlying material is gravelly sediment at a depth of 5 to 20 inches. Some areas are subject to flooding. The kind of vegetation that grows on this site is influenced mainly by the very low available water capacity of the soils and by their shallow rooting zone.

About 30 percent of the climax plant cover is a mixture of such decreaser grasses as sand bluestem and needleandthread. About 70 percent consists of other perennial grasses and forbs. Blue grama, hairy grama, sand dropseed, threadleaf sedge, fringed sageswort, common pricklypear, scarlet globemallow, and broom snakeweed are the principal increasers.

If the site is in poor condition the typical plant community consists of sand dropseed, fringed sageswort, western ragweed, and common pricklypear.

If the site is in excellent condition, the total annual yield of air-dry herbage ranges from 500 pounds per acre in unfavorable years to 1,500 pounds in favorable years.

SHALLOW LIMY RANGE SITE

In this site are shallow, well-drained or somewhat excessively drained, nearly level to very steep soils on uplands. The soils have a surface layer and underlying material of loamy fine sand to silty clay loam. Sandstone, siltstone, or shale bedrock is at a depth of 10 to 20 inches. The soils are rich in lime. The kind of vegetation grows on this site is influenced mainly by the very low to low available water capacity of the soils, by their limy condition, and by their shallow rooting zone.

About 75 percent of the climax plant cover is a mixture of such decreaser grasses as little bluestem, sand bluestem, side-oats grama, needleandthread, prairie sandreed, plains muhly, and western wheatgrass. About 25 percent consists of other perennial grasses, forbs, and shrubs. Blue grama, hairy grama, threadleaf sedge, fringed sageswort, common pricklypear, broom

snakeweed, skunkbush sumac, and western snowberry are the principal increasers.

The site is rarely in poor condition because it is inaccessible to livestock.

If the site is in excellent condition, the total annual yield of air-dry herbage ranges from 750 pounds per acre in unfavorable years to 1,750 pounds in favorable years.

THIN LOESS RANGE SITE

Only the Breaks part of Breaks-Alluvial land complex is in this site. This land type consists of deep, well-drained, steep to very steep soil material along areas that border drainageways. The soil material is very fine sandy loam to silty clay loam and is high in lime. The kind of vegetation that grows on this site is influenced mainly by steepness of slope, lack of soil development, and the limy condition of the soil material.

About 80 percent of the climax plant cover is a mixture of such decreaser grasses as little bluestem, side-oats grama, plains muhly, prairie sandreed, and western wheatgrass. About 20 percent consists of other perennial grasses, forbs, and shrubs. Blue grama, threadleaf sedge, sand dropseed, fringed sageswort, Arkansas rose, and broom snakeweed are the principal increasers.

The site is rarely in poor condition because it is inaccessible to livestock.

If the site is in excellent condition, the total annual yield of air-dry herbage ranges from 750 pounds per acre in unfavorable years to 1,500 pounds in favorable years.

SALINE UPLAND RANGE SITE

In this site are shallow, well-drained, gently sloping to steep soils on uplands. The soils have a surface layer and underlying material of silty clay loam. Clayey shale is at a depth of 10 to 20 inches. The soils are moderately affected by soluble salts and alkali. The kind of vegetation that grows on this site is influenced mainly by the moderately alkaline or saline condition of the soils.

About 40 percent of the climax plant cover is a mixture of such decreaser grasses as western wheatgrass. About 60 percent consists of other perennial grasses and forbs. Blue grama, inland saltgrass, Sandberg bluestem, and common pricklypear are the principal increasers.

If the site is in poor condition, the typical plant community consists of inland saltgrass, Sandberg bluegrass, and annual bromes.

If the site is in excellent condition, the total annual yield of air-dry herbage ranges from 300 pounds per acre in unfavorable years to 1,200 pounds in favorable years.

PANSPOTS RANGE SITE

In this site are deep, poorly drained soil materials on uplands, foot slopes, and stream terraces. The soils have a surface layer and subsoil of silty clay loam or silty clay. They are strongly alkaline or very strongly alkaline and are affected by soluble salts to varying degrees. Small depressions are common. Runoff water ponds in the depressions for short periods after rains. The kind of vegetation that grows on this site is

influenced mainly by the slow to moderately slow permeability of the soils and by their saline or alkaline condition.

About 70 percent of the climax plant cover is a mixture of such decreaser grasses as western wheatgrass and alkali sacaton. About 30 percent consists of other perennial grasses and forbs. Inland saltgrass, Sandberg bluegrass, common pricklypear, and broom snakeweed are the principal increasers.

If the site is in poor condition, the typical plant community consists of inland saltgrass, Sandberg bluegrass, and annual bromes.

If the site is in excellent condition, the total annual yield of air-dry herbage ranges from 300 pounds per acre in unfavorable years to 800 pounds in favorable years.

Grazable woodland

Grazable woodland is forest land whose understory includes plants that can be grazed without significantly impairing forest values. In Dawes County, the Pine Ridge area supports a woodland community of ponderosa pine that has an understory of herbaceous plants, grasses, and forbs. In some places, the trees are so close together that an understory does not grow. These areas are generally small and are included in the Savannah range site.

The herbaceous plant community consists of:

1. Open areas (sparse canopy)—little bluestem, big bluestem, side-oats grama, plains muhly, green needlegrass, western wheatgrass, blue grama, hairy grama, prairie sandreed, prairie junegrass, threadleaf sedge, needleandthread, littleseed ricegrass, and fringed sagewort.
2. Shaded areas (medium and dense canopy)—Kentucky bluegrass, Canada wildrye, spike-fescue, slender wheatgrass, and bearded wheatgrass.

The total annual production for herbaceous plants is:

Canopy class	Pounds per acre, <i>air-dry</i>
Sparse.....	650 to 1,000
Medium.....	350 to 650
Dense.....	100 to 350

Woodland⁵

Natural woodland makes up about 7 percent of Dawes County, or about 69,000 acres. It consists of about 45,000 acres of privately owned commercial forest and about 24,000 acres in Federal and State land.

Ponderosa pine is the principal tree species in the natural wooded areas of the county. It is extensive in the Canyon-Bridget-Rock outcrop association, steep, indicated on the soil map by the symbol CaG. The soils in the unit CaG occur in such a complex pattern that they were not separated on the detailed soil map. This unit is in the Pine Ridge area.

Plants that make up the understory in the ponderosa pine community are western snowberry, skunkbush sumac, wild rose, western chokecherry, common juniper, flowering currant, small soapweed, and poison-ivy. The pine stands in Dawes County are relatively uni-

form in age. Much of this pine forest was cut over between 1880 and 1900, so that the average age of the trees is now approximately 80 years (6). A few stands are about 50 to 60 years old, and a few areas that escaped cutting are 125 to 150 years old. These stands are on ridgetops, mainly in areas of Canyon soils.

A small acreage of this commercial forest is made up of deciduous trees. They are mainly along streams and drainageways where the roots have access to a permanent water table that is generally near the surface. Unlike the pine community, deciduous trees are widely distributed throughout the county. Species in the deciduous community are green ash, American elm, box elder, hackberry, and small amounts of eastern cottonwood and peachleaf willow. In areas not excessively grazed by livestock, common chokecherry, flowering currant, western snowberry, wild rose, and poison-ivy make up the understory.

The woodland resources of the Pine Ridge are used locally for fenceposts, poles, and lumber. More recently use has expanded to include pulpwood and lath. Besides producing wood products, the soils of these woodlands absorb water and thus aid in regulating streamflow and replenishing the underground water supply. Trees and litter protect the soils from water erosion and are valuable as habitat for wildlife and for recreation. The value of this woodland resource for livestock grazing varies with its accessibility, the density of the trees, and the abundance of palatable forage plants.

Woodland suitability groups

To assist in planning the management of a native woodland, soils in Dawes County that are important for producing wood products have been grouped into four woodland suitability groups, shown in table 3 and described in the text. Each group is made up of soils that produce similar kinds and amounts of wood crops and that require similar management.

For management purposes, thickness of the solum (depth to top of the C horizon), slope position (distance up the slope as a percentage of total slope length), slope class, and aspect are used to determine potential productivity. The Forest Service has found these variables important in determining the site index of ponderosa pine in growth studies conducted in the Black Hills of South Dakota (3). These variables are given in the description of each group.

Table 3 lists the potential productivity of the soils in each woodland suitability group and rates the hazards and limitations that affect management. Some of the terms used in table 3 are explained in the paragraphs that follow.

The *site index* indicates productivity. It expresses the average height of the taller trees in a stand at a specified age. In table 3, the site index is the height in feet of ponderosa pine at 100 years of age.

The increments of *periodic annual growth* are expressed in cubic feet for stands 80 years of age. These yields are based on studies by the Forest Service on managed, even-aged stands of ponderosa pine in the Black Hills (4). In a managed stand of ponderosa pine 80 years old, on a soil having a site index of 65, the merchantable volume of wood products added each year would be about 55 cubic feet. By using the conversion factors at the bottom of table 3 it can be deter-

⁵ By JAMES W. CARR, JR., woodland conservationist, Soil Conservation Service.

TABLE 3.—*Potential productivity and degree of limitations of soils in woodland suitability groups for ponderosa pine*

[The symbol > means "more than"]

Woodland suitability group number and soil series	Aspect	Potential soil productivity		Erosion hazard	Seedling mortality	Plant competition	Equipment limitation	Windthrow hazard
		Site index	Approximate periodic annual growth per acre at 80 years of age ¹					
		<i>Feet</i>	<i>Cubic feet</i>					
Group 1: Duroc -----	North and east..	>70	>65	Slight to moderate.	Slight ----	Slight to moderate.	Slight ----	Slight.
Group 2: Bridget, Busher, Oglala, Ulysses.	North and east..	60-69	55	Moderate --	Slight ----	Slight ----	Moderate --	Slight.
Group 3: Canyon -----	North and east..	50-59	40	Moderate to severe.	Slight to severe.	Slight ----	Moderate to severe.	Moderate to severe.
Group 4: Canyon, Tassel --	South and west..	40-49	30	Severe ----	Severe ----	Slight ----	Severe ----	Severe.

¹ Divide by 90 to convert cubic feet to approximate cords; multiply by 6 to convert cubic feet to approximate board feet.

mined that this amounts to approximately six-tenths of a cord, or 338 board feet per acre per year. This is approximately double the increase in volume for the same period for a stand of the same age on a soil that has a site index of 45.

Erosion hazard is rated according to the risk of damage to woodland areas where normal practices are used in managing and harvesting the trees. The hazard is *slight* where erosion is not an important concern. It is *moderate* where practices must be applied to check soil losses. It is *severe* where steep slopes, rapid runoff, slow infiltration, slow permeability, and past erosion make the soil susceptible to severe erosion.

Seedling mortality refers to the expected percentage of mortality of naturally occurring or planted seedlings as influenced by soil texture, soil depth, drainage, flooding, and soil erosion. Plant competition is assumed not to be a limiting factor. Mortality is *slight* if the expected loss is less than 25 percent; *moderate* if losses are between 25 and 50 percent; and *severe* if losses are more than 50 percent.

Plant competition refers to the invasion of unwanted trees, shrubs, vines, and other plants where there are openings in the canopy. Competition is *slight* if it does not hinder the establishment of a desirable stand, and *moderate* if competing plants delay the establishment of a desirable stand.

The ratings for *equipment limitations* are based on the degree to which soil features and topography restrict or prohibit the use of equipment normally employed in tending a crop of trees. The limitation is *slight* if there is little or no restriction on the type of equipment or the time of year that the equipment can be used. It is *moderate* if the use of equipment is seasonally limited or if modified equipment or methods

of harvesting are needed. It is *severe* if special equipment is needed or if the use of such equipment is severely restricted by one or more unfavorable soil characteristics. These unfavorable characteristics include drainage, soil slope, number and size of stones, outcrops of rock, and soil texture.

Windthrow hazard indicates the relative danger of trees being blown over by high winds that normally occur, excluding tornadoes. The hazard is *slight* if windthrow is no special concern. It is *moderate* if roots hold the trees firmly except when the soil is especially wet or when the wind is strongest. It is *severe* if rooting is not deep enough to give adequate stability. Individual trees are likely to be blown over if they are released on all sides.

WOODLAND SUITABILITY GROUP 1

Only Duroc soils are in this group. These soils are very gently sloping. They are mainly on foot slopes that have north- and east-facing exposures. A few areas are at the head of drainageways and in swales. The solum ranges from 30 to 42 inches in thickness. These soils are mainly in the low part of the total slope length. The site index for ponderosa pine ranges from 70 to 82. Ponderosa pine grows better on soils in this group than on soils in other groups.

WOODLAND SUITABILITY GROUP 2

In this group are Bridget, Busher, Oglala, and Ulysses soils. These soils are deep and moderately steep to steep. They are on uplands and foot slopes that mainly have north- and east-facing exposures. The solum ranges from 16 to 30 inches in thickness. These soils are mainly in the middle part of the total slope length. The site index ranges from 60 to 69. The



Figure 25.—A stand of ponderosa pine on Canyon soils, in woodland suitability group 3. This stand is overpopulated and needs thinning to release harvest trees.

steep soils have moderate limitations for managing and harvesting trees. Ponderosa pine grows well on soils in this group.

WOODLAND SUITABILITY GROUP 3

Only Canyon soils are in this group (fig. 25). These soils are shallow to bedrock and are calcareous at the surface. They are steep and very steep and generally have north- and east-facing exposures. The solum ranges from 3 to 16 inches in thickness. These soils are mainly in the upper part of the total slope length. Because the soils are shallow, aspect is very influential in determining the site index, growth potential, and management practices. The site index for ponderosa pine ranges from 50 to 59. Hazards and limitations indicated in table 3 should be carefully considered in managing trees on soils in this group.

WOODLAND SUITABILITY GROUP 4

In this group are Tassel and Canyon soils. Tassel soils are shallow and calcareous. They are mainly in the western part of the county. Canyon soils are not so coarse as Tassel soils but are similar in most other characteristics. Both soils are on ridgetops and have south- and west-facing exposures where the temperatures are quite warm. The solum ranges from 3 to 16 inches in thickness. These soils are mainly in the upper part of the total slope length but in places are also in the middle part. Because the soils are shallow, aspect is very influential in determining the site index, growth potential, and management practices. The productivity of trees on these soils is low or moderate. The site index for ponderosa pine ranges from 40 to 49.

Open stands of ponderosa pine associated with the Savannah range site grow on these soils, and they have warm-season grasses in the understory. The soils in this group have severe limitations and hazards, even though they have potential for producing commercial timber. They are better suited to grazing, habitat for wildlife, or recreation.

Windbreaks

A well-placed windbreak that has properly spaced trees protects farmsteads, fields, livestock, and wildlife from wind and snow. It controls snowdrifts by reducing the velocity of the wind. In addition to the protection it gives, a well-tended windbreak is attractive and improves the esthetic setting of farm and ranch buildings.

Although trees are not easily established in Dawes County, observing basic rules of tree culture can result in a high degree of tree survival on most soils. Exceptions are soils that are shallow, very strongly saline or alkaline, very poorly drained, steep, or too clayey. Few farmsteads, however, are built on soils having these adverse characteristics. Healthy seedlings of adapted species, maintained in good condition and properly planted in a well-prepared soil site, can survive and grow well. They require care after planting if they are to survive.

Table 4 gives the expected height, at 20 years of age, of trees suitable for windbreaks in the county. Forestry technicians took the measurements of trees in windbreaks about 20 years old. Measurements were

TABLE 4.—*Suitability of adapted trees and shrubs (dryland)*
 [Height estimates are not given for species rated poor. Ratings are not given for

Tree and shrub species	Windbreak suitability group—					
	1		2		3	
	Suitability	Height	Suitability	Height	Suitability	Height
		<i>Feet</i>		<i>Feet</i>		<i>Feet</i>
Conifers:						
Austrian pine -----	Good -----	24-28	Fair -----	18-22	Good -----	22-26
Blue spruce -----	Good -----	20-22	Poor -----		Poor -----	
Eastern redcedar -----	Good -----	20-22	Good -----	15-18	Good -----	14-18
Ponderosa pine -----	Good -----	24-28	Poor -----		Good -----	22-28
Rocky Mountain juniper -----	Good -----	18-20	Poor -----		Good -----	12-16
Scotch pine -----	Fair -----	24-26	Fair -----	18-20	Fair -----	20-24
Low broadleaf trees:						
Russian-olive -----	Good -----	16-18	Poor -----		Fair -----	12-14
Medium to tall broadleaf trees:						
Eastern cottonwood -----	Fair -----	45-50	Fair -----	45-55	Fair -----	45-50
Ash -----	Good -----	24-26	Fair -----	22-26	Fair -----	20-22
Hackberry -----	Good -----	24-26	Poor -----		Poor -----	
Honey locust -----	Good -----	26-28	Fair -----	22-26	Fair -----	20-22
Siberian elm -----	Good -----	36-38	Good -----	34-36	Good -----	24-34
Shrubs:						
American plum -----	Fair -----	5-6	Poor -----		Fair -----	6-8
Amur honeysuckle -----	Good -----	6-8	Poor -----		Fair -----	5-6
Common chokecherry -----	Good -----	8-10	Fair -----	6-8	Good -----	6-8
Lilac -----	Good -----	5-6	Poor -----		Fair -----	5-6
Peking cotoneaster -----	Good -----	5-6	Poor -----		Poor -----	
Red-osier dogwood -----	Good -----	5-6	Good -----	6-8	Poor -----	
Siberian peashrub -----	Good -----	8-10	Poor -----		Poor -----	
Silver buffaloberry -----	Fair -----	6-8	Fair -----	5-6	Poor -----	
Skunkbush sumac -----	Good -----	6-8	Poor -----		Fair -----	5-6

taken for most tree and shrub species listed in the table; however, some tree heights and suitability ratings were estimated. The soils were then grouped into nine windbreak suitability groups. The soils in each group are similar in characteristics that affect the growth of trees. The soils in a group produce similar growth, and the chance for survival under normal conditions of weather and care is similar.

The suitability ratings in table 4 are based on observations of the general vigor and condition of the trees in the windbreak. A rating of *good* indicates that one or more of the following conditions generally apply: the leaves (or needles) are normal in color and growth, and small amounts of dead wood (tops, branches, and twigs) are within the live crown. Evidence of disease, insect, or climatic damage is limited. A rating of *fair* indicates one or more of the following conditions: leaves (or needles) are obviously abnormal in color and growth, and substantial amounts of dead wood are within the live crown. Evidence of moderate disease, insect, or climatic damage is obvious. Current year's growth is obviously less than normal. A rating of *poor* indicates one or more of the following conditions: leaves (or needles) are very abnormal in color or growth, and large amounts of dead wood are within the live crown. Evidence of extensive disease, insect, or climatic damage is obvious.

Eastern redcedar, ponderosa pine, and Rocky Mountain juniper are well suited to windbreaks. Local measurements and observations indicate that these species are the most reliable for windbreaks, and they rate high in survival and vigor. These species hold their leaves throughout the winter, thus giving maximum protection when it is most needed. Table 4 also lists several broadleaf species that are well suited to use in windbreaks in Dawes County.

Eastern redcedar can reach a height of 25 feet at maturity on the most suitable sites. Rocky Mountain juniper attains a slightly lower height at maturity. Ponderosa pine grows slightly faster and is somewhat taller at maturity. The same is true of broadleaf trees.

Rate of growth in a windbreak varies widely with soil moisture conditions and soil fertility. Exposure and arrangement of trees within the planting also has a marked effect on growth. Some species grow faster than others; some make an early fast growth but tend to die young. This is occasionally true of cottonwood. Siberian elm and Russian-olive are vigorous early growers. They can, however, spread where they are not wanted and can be short lived.

Windbreak suitability groups

In this section the windbreak suitability groups in the survey area are described. Soils in Nebraska are

for windbreaks and their estimated height at 20 years of age
group 10, because soils in this group are not generally suited to windbreaks]

Windbreak suitability group—Continued									
4		5		7		8		9	
Suitability	Height	Suitability	Height	Suitability	Height	Suitability	Height	Suitability	Height
	<i>Feet</i>		<i>Feet</i>		<i>Feet</i>		<i>Feet</i>		<i>Feet</i>
Good -----	20-24	Fair -----	18-20	Fair -----	16-20	Poor -----	-----	Poor -----	-----
Poor -----	-----	Poor -----	-----	Poor -----	-----	Poor -----	-----	Poor -----	-----
Good -----	16-22	Good -----	12-15	Good -----	12-14	Fair -----	10-12	Fair -----	10-12
Good -----	20-24	Good -----	18-22	Good -----	16-20	Fair -----	14-18	Poor -----	-----
Good -----	14-18	Good -----	12-14	Good -----	10-12	Good -----	10-12	Good -----	10-12
Fair -----	18-22	Poor -----	-----	Fair -----	14-18	Poor -----	-----	Poor -----	-----
Fair -----	14-16	Fair -----	10-12	Poor -----	-----	Fair -----	10-12	Fair -----	12-14
Poor -----	-----	Poor -----	-----	Poor -----	-----	Fair -----	35-40	Poor -----	-----
Fair -----	18-22	Poor -----	-----	Poor -----	-----	Fair -----	15-17	Poor -----	-----
Fair -----	16-20	Poor -----	-----						
Fair -----	20-24	Poor -----	-----						
Good -----	30-36	Fair -----	24-28	Poor -----	-----	Fair -----	30-35	Fair -----	16-20
Fair -----	6-8	Poor -----	-----						
Fair -----	6-8	Poor -----	-----						
Good -----	8-10	Poor -----	-----						
Good -----	5-6	Poor -----	-----						
Poor -----	-----	Poor -----	-----	Poor -----	-----	Poor -----	-----	Poor -----	-----
Poor -----	-----	Poor -----	-----	Poor -----	-----	Poor -----	-----	Poor -----	-----
Good -----	8-10	Fair -----	6-8	Poor -----	-----	Poor -----	-----	Good -----	5-6
Poor -----	-----	Poor -----	-----	Poor -----	-----	Fair -----	4-5	Poor -----	-----
Good -----	6-8	Good -----	5-6	Poor -----	-----	Poor -----	-----	Good -----	5-6

grouped into windbreak suitability groups according to a statewide system. Not all groups in this system are represented in Dawes County. To find the name of all the soils in any group refer to the Guide to Mapping Units.

Specific information on design, establishment, and care of windbreaks is available from the Soil Conservation Service and the Cooperative Extension Service forester serving the county.

WINDBREAK SUITABILITY GROUP 1

In this group are deep, well-drained, nearly level and very gently sloping soils on bottom lands and low stream terraces. The surface layer is silt loam or silty clay loam. The underlying material is very fine sandy loam or silt loam that commonly contains strata of sandy to clayey material. Some of the soils on bottom lands are subject to occasional flooding.

The soils in this group provide good tree planting sites. The survival and growth of adapted species are good. Moisture competition from weeds and grasses is the main limitation.

WINDBREAK SUITABILITY GROUP 2

In this group are deep, somewhat poorly drained, nearly level soils on bottom lands. The surface layer

is silt loam to loamy fine sand. The underlying material is stratified loamy fine sand and very fine sandy loam to fine sand. In most years the water table is at a depth of 2 feet in spring to 6 feet early in fall.

The soils in this group provide good tree planting sites. The survival and growth of adapted species are good. These soils are suited to trees that can tolerate occasional wetness. The abundant herbaceous vegetation that grows on these soils is a concern of management in establishing trees. The establishment of seedlings can be a concern during wet years.

WINDBREAK SUITABILITY GROUP 3

In this group are deep, well-drained to excessively drained, nearly level to steep soils on uplands, stream terraces, and bottom lands. The surface layer is loamy fine sand, loamy very fine sand, or fine sandy loam. The underlying material is fine sand to loamy very fine sand. A few areas on uplands are eroded. A few areas on bottom lands are subject to occasional flooding.

These soils provide fair tree planting sites. Survival and growth of adapted species are fair. A lack of moisture and soil blowing are the main limitations. Maintaining strips of sod or other vegetation between tree rows helps to control soil blowing. Cultivation generally should be restricted to the tree rows.

WINDBREAK SUITABILITY GROUP 4

In this group are deep and moderately deep, well-drained, nearly level to steep soils on uplands, foot slopes, and stream terraces. The surface layer is mainly very fine sandy loam to silt loam, but in a few areas it is silty clay. The subsoil and underlying material are very fine sandy loam to heavy silty clay loam. A few areas on uplands are eroded.

The soils in this group generally provide good tree planting sites. Survival of adapted species is good, and growth of adapted species is fair. Droughtiness and moisture competition from weeds and grasses are the main limitations. Water erosion is a hazard on the gently sloping to steep soils. A lack of sufficient moisture restricts the growth of trees on the steeper slopes because of rapid runoff.

WINDBREAK SUITABILITY GROUP 5

In this group are deep and moderately deep, well-drained, nearly level to steep soils on uplands, foot slopes, and stream terraces. The surface layer is silt loam, loam, or silty clay loam. The subsoil and the underlying material are silt loam to light silty clay.

The soils in this group provide fair to poor tree planting sites. Survival and growth of adapted species are fair to poor. In some areas, restrictive rooting depth is a limitation, and in other areas, lime at or near the surface limits the growth of certain broad-leaved species.

WINDBREAK SUITABILITY GROUP 7

Only Valent and Dwyer loamy fine sands, 3 to 17 percent slopes, are in this group. They are deep, excessively drained, undulating to steep soils on uplands. The surface layer is loamy fine sand. The underlying material is fine sand.

These soils are loose, and they should not be cultivated. Trees should be planted in shallow furrows. Young trees are affected by high winds and can be covered by drifting sand. These soils are suited only to conifers.

WINDBREAK SUITABILITY GROUP 8

Only Tripp silt loam, saline-alkali, 0 to 2 percent slopes, is in this group. This deep, well-drained soil is on stream terraces. The surface layer and subsoil are silt loam. The underlying material is very fine sandy loam. This soil is mildly saline and moderately alkaline to strongly alkaline. The saline-alkali condition is in spots and is not uniformly distributed throughout the area.

Establishment of trees can be a concern on this soil. This soil is suited only to trees and shrubs that can tolerate a saline-alkali condition.

WINDBREAK SUITABILITY GROUP 9

In this group are deep and moderately deep, nearly level to steep, well-drained soils on uplands and stream terraces. The surface layer is silty clay. The subsoil and the underlying material are clay. In many areas shale bedrock is at a depth of 20 to 40 inches.

The soils in this group provide poor tree planting sites. The survival and growth of adapted species are fair to poor. These soils are suited only to trees and shrubs that can tolerate extremely droughty conditions.

Growth of trees and shrubs is poor because the soils have a high content of clay.

WINDBREAK SUITABILITY GROUP 10

In this group are shallow to deep, well-drained to somewhat excessively drained, nearly level to steep soils and land types on uplands, stream terraces, and bottom lands. The surface layer and underlying material are loamy very fine sand to silty clay. Many areas are underlain by sandstone, siltstone, shale, or gravel at a depth of 10 to 20 inches. Some areas have bedrock at the surface. Some areas are too wet, too frequently flooded, or too steep for successful planting of trees.

The soils in this group are generally not suited to windbreak plantings because of their unfavorable qualities and characteristics. Some areas can be used for recreation, forestation, and wildlife plantings of adapted species of trees and shrubs if the species are hand planted or if special management practices are used.

Wildlife⁶

Wildlife populations are determined largely by the quality and quantity of vegetation that the soils are capable of producing. Cover, food, and water, in proper combination, are the three elements essential to wildlife abundance. Mainly game species of wildlife are discussed in this section, although nongame species are becoming increasingly important in Dawes County. When living conditions for game species are improved, nongame species also benefit.

The presence of wildlife is indicative of the quality of the environment.

In many instances, the soils that have a high potential for wildlife do not have a large wildlife population, because of such factors as hunting pressure, clean tillage, and improved harvesting methods. The potential still remains, and wildlife habitat can be enhanced at little cost and effort. Wildlife has a place in both rural and urban settings and needs to be considered when planning for optimum use of these areas.

Topography plays a major role in determining wildlife numbers, as do such soil characteristics as soil fertility. Fertile soils produce more and better quality wildlife than nonfertile soils. Steep slopes and rough, irregular topography present hazards to livestock and are poorly suited to crop production. In these areas, the natural undisturbed landscape can become escape cover for wildlife and provide a source of food. In many instances, where vegetation is lacking, flowering and fruiting trees and shrubs can be planted. Refer to the section on woodland and windbreaks for suited species.

Wetness, permeability, and available water capacity are important soil characteristics to consider in selecting pond sites for wildlife and recreation.

Fish ponds that fill by runoff from fertile areas usually produce more pounds of fish than the average because of the increased food production. Zooplankton are microscopic animals and phytoplankton are microscopic plants produced in fertile ponds. They provide

⁶ ROBERT O. KOERNER, biologist, Soil Conservation Service, prepared the sections "Wildlife" and "Recreation."

food for larger aquatic animals such as frogs which, in turn, are used as food by fish.

The major soils in the soil associations, as shown in color on the general soil map, are evaluated in this section for wildlife habitat potential. Table 5 rates the potential of the major soils for each habitat element. The ratings are good, fair, poor, or very poor. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderate intensity of management and fairly frequent attention are required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and requires intensive effort. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of wildlife are very severe, and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

Grain and seed crops are domestic grain or other seed-producing annuals, planted to produce wildlife food. They include corn, sorghum, wheat, oats, barley, millet, soybeans, and sunflowers.

Domestic grasses and legumes are domestic perennial grasses and herbaceous legumes, planted to provide wildlife cover and food. Included are fescue, bluegrass, brome grass, timothy, orchardgrass, clover, alfalfa, trefoil, and crownvetch.

Wild herbaceous plants are native or naturally established dryland herbaceous grasses and forbs (including weeds) that provided food and cover for wildlife. Examples are bluestem, indian grass, goldenrod, beggarweed, partridgepea, pokeweed, wheatgrasses, fescues, and grammas.

Hardwood trees and shrubs include nonconiferous trees and associated wood understory plants that provide wildlife cover or that produce nuts, buds, catkins, twigs, bark, or foliage used as food by wildlife. Shrubby plants, such as snowberry, honeysuckle, and Russian-olive, produce buds, twigs, bark, or foliage used as food by wildlife, or provide cover and shade for some wildlife species.

Coniferous plants include cone-bearing trees, shrubs, or ground cover that furnish wildlife cover or supply food in the form of browse, seeds, or fruitlike cones. Commonly established through natural processes, they can be planted or transplanted. Examples are pine, spruce, fir, cedar, and juniper trees.

Wetland food and cover consists of annual and perennial wild herbaceous plants of moist to wet sites, exclusive of submerged or floating aquatics, that produce food or cover used extensively by wetland forms of wildlife. Examples are smartweed, wild millet, rushes, sedges, reeds, cordgrass, and cattail.

Shallow water areas are areas of surface water that have an average depth of less than 5 feet, useful to wildlife. They include natural wet areas and those created by dams, levees or water-control devices in

marshes or streams. They serve as muskrat marshes, water-fowl feeding areas, wildlife watering developments, wildlife ponds, and beaver ponds.

Soils are rated according to their suitability for producing various kinds of wildlife habitat: Openland, woodland, wetland, and rangeland. They are directly related to the four broad classes of wildlife.

Open-land wildlife: Birds and mammals, such as pheasant, meadowlark, killdeer, cottontail rabbit, badger, and red fox, of croplands, pastures, meadows, lawns, and areas overgrown with grasses, herbs, shrubs, and vines.

Woodland wildlife: Birds and mammals, such as wild turkey, prairie grouse, thrushes, vireos, woodpecker, squirrel, raccoon, white-tailed deer, and mule deer, of wooded areas containing either hardwood or coniferous trees and shrubs, or a mixture of both.

Wetland wildlife: Birds and mammals such as ducks, geese, herons, shore birds, rails, kingfishers, muskrat, and beaver, of swampy, marshy, or open water areas.

Rangeland wildlife: Birds and mammals, such as antelope, white-tailed deer, mule deer, prairie grouse, lark bunting, and prairie dog, of natural rangelands.

Soil associations are rated according to their potential for producing habitat for both rangeland and woodland wildlife. Many kinds of wildlife frequent both types of habitat in the county. In general, Dawes County is suited to many kinds of wildlife. Some kind of wildlife is usually in view at all times, either on land, in water, or in the air.

In the Pierre-Samsil-Kyle association the soils are mainly clayey. Most areas are in native rangeland. A small acreage is cultivated, and grain and alfalfa are the main crops. Underground pipelines, which have water tanks along the lines, provide water for better distribution of grazing and also offer a reliable source of water for many kinds of wildlife. Antelope and deer, both white-tailed and mule, are the main big game species in this association, which has fewer than one deer per square mile and 2 to 4 antelope per square mile.⁷ Prairie grouse are generally scarce, fewer than five birds per square mile. In the ponded areas of this association, ducks, such as mallard, blue winged teal, pintail, and shovelers, are common. Blackbirds, magpie, and the rare longbilled curlews are also present.

The Kyle-Buffington association is nearly level to gently sloping. Most of the surface irrigation in Dawes County is in this association. This association offers good habitat for pheasant. The irrigated cropland provides food, and the irrigation ditches, which have native willow thickets volunteering along the banks, provide cover. Water is available along the full length of the ditches. Many songbirds, such as bobolink and blackbirds, frequent the association. Ducks, such as mallards, pintails, and blue winged teal, use the ditches and the ponded areas.

The Bufton-Orella-Norrest association is mainly native rangeland, but a small acreage is in alfalfa. This association is mostly in grass, but it contains some areas of alkali soils and small badland areas, where little or no vegetation grows. The western part

⁷ All population density estimates obtained from the Nebraska Fish and Wildlife Plan, vol 1: Nebraska Wildlife Resource Inventory, Nebraska Game and Parks Commission, 1972.

TABLE 5.—Potential of major soils in soil associations for producing

Soil association	Potential for—			
	Grain and seed crops	Domestic grasses and legumes	Wild herbaceous plants	Hardwood trees and shrubs
Pierre-Samsil-Kyle:				
Pierre -----	Poor -----	Poor -----	Fair -----	Poor -----
Samsil -----	Poor -----	Poor -----	Poor -----	Very poor -----
Kyle -----	Poor -----	Poor -----	Fair -----	Poor -----
Kyle-Buffington:				
Kyle -----	Poor -----	Poor -----	Fair -----	Poor -----
Buffington -----	Fair -----	Good -----	Good -----	Fair -----
Buften-Orella-Norrest:				
Buften -----	Fair -----	Good -----	Fair -----	Good -----
Orella -----	Poor -----	Poor -----	Poor -----	Very poor -----
Norrest -----	Fair -----	Fair -----	Fair -----	Fair -----
Kadoka-Keith-Mitchell:				
Kadoka -----	Good -----	Good -----	Good -----	Good -----
Keith -----	Good -----	Good -----	Good -----	Good -----
Mitchell -----	Good -----	Good -----	Good -----	Good -----
Minnequa-Penrose:				
Minnequa -----	Poor -----	Fair -----	Fair -----	Fair -----
Penrose -----	Poor -----	Poor -----	Fair -----	Poor -----
Canyon-Bridget-Oglala:				
Canyon -----	Very poor -----	Poor -----	Fair -----	Fair -----
Bridget -----	Good -----	Good -----	Good -----	Good -----
Oglala -----	Good -----	Good -----	Good -----	Good -----
Richfield-Alliance-Rosebud:				
Richfield -----	Good -----	Good -----	Good -----	Good -----
Alliance -----	Good -----	Good -----	Good -----	Good -----
Rosebud -----	Fair -----	Good -----	Good -----	Fair -----
Canyon-Alliance-Rosebud:				
Canyon -----	Poor -----	Poor -----	Fair -----	Poor -----
Alliance -----	Good -----	Good -----	Good -----	Good -----
Rosebud -----	Fair -----	Good -----	Good -----	Fair -----
Busher-Tassel-Vetal:				
Busher -----	Fair -----	Fair -----	Good -----	Fair -----
Tassel -----	Poor -----	Poor -----	Fair -----	Poor -----
Vetal -----	Fair -----	Fair -----	Good -----	Fair -----
Valent-Dwyer-Jayem:				
Valent -----	Poor -----	Fair -----	Fair -----	Poor -----
Dwyer -----	Poor -----	Fair -----	Fair -----	Poor -----
Jayem -----	Fair -----	Fair -----	Good -----	Fair -----
Tripp-Haverson-Glenberg:				
Tripp -----	Good -----	Good -----	Good -----	Good -----
Haverson -----	Good -----	Good -----	Good -----	Good -----
Glenberg -----	Good -----	Good -----	Good -----	Good -----
Bankard:				
Bankard -----	Fair -----	Fair -----	Fair -----	Fair -----
Bankard variant -----	Good -----	Good -----	Good -----	Fair -----

¹ Good for redcedar.

of this association is well suited to big game such as antelope and deer, having about four to eight deer and two to four antelope per square mile. These species are scarcer in the eastern part. A few active prairie dog towns remain in this association. Prairie dog towns are very important in wildlife communities and should be preserved where possible.

The Minnequa-Penrose association is a unique area

in the extreme northeastern corner of the county. The soils are formed in Niobrara chalk and in material weathered from Carlile shales. Native redcedar is common in this association. A few woodland species, such as bobcat and squirrel, frequent this area, in addition to deer and turkey.

The Kadoka-Keith-Mitchell association contains some of the better farmland in Dawes County. Small grain

elements of wildlife habitat and habitat for different kinds of wildlife

Potential for—continued			Potential for—			
Coniferous plants	Wetland food and cover	Shallow water areas	Open-land wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Poor ----- Very poor ----- Poor -----	Very poor ----- Very poor ----- Very poor -----	Very poor ----- Very poor ----- Very poor -----	Poor ----- Very poor ----- Poor -----	Poor ----- Very poor ----- Poor -----	Very poor ----- Very poor ----- Very poor -----	Fair. Fair. Fair.
Poor ----- Fair -----	Very poor ----- Very poor -----	Very poor ----- Very poor -----	Poor ----- Fair -----	Poor ----- Fair -----	Very poor ----- Very poor -----	Fair. Good.
Good ----- Very poor ----- Good -----	Very poor ----- Very poor ----- Very poor -----	Very poor ----- Very poor ----- Very poor -----	Fair ----- Poor ----- Fair -----	Fair ----- Very poor ----- Fair -----	Very poor ----- Very poor ----- Very poor -----	Fair. Poor. Fair.
Good ----- Good ----- Good -----	Very poor ----- Very poor ----- Very poor -----	Very poor ----- Very poor ----- Very poor -----	Good ----- Good ----- Good -----	Good ----- Good ----- Good -----	Very poor ----- Very poor ----- Very poor -----	Good. Good. Good.
Fair ¹ ----- Poor ¹ -----	Very poor ----- Very poor -----	Very poor ----- Very poor -----	Poor ----- Poor -----	Fair ----- Fair -----	Very poor ----- Very poor -----	Fair. Fair.
Fair ² ----- Good ----- Good -----	Very poor ----- Very poor ----- Very poor -----	Very poor ----- Very poor ----- Very poor -----	Poor ----- Fair ----- Fair -----	Good ----- Good ----- Good -----	Very poor ----- Very poor ----- Very poor -----	Fair. Good. Good.
Good ----- Good ----- Good -----	Very poor ----- Very poor ----- Very poor -----	Very poor ----- Very poor ----- Very poor -----	Good ----- Good ----- Fair -----	Good ----- Good ----- Fair -----	Very poor ----- Very poor ----- Very poor -----	Good. Good. Good.
Fair ----- Good ----- Good -----	Very poor ----- Very poor ----- Very poor -----	Very poor ----- Very poor ----- Very poor -----	Poor ----- Good ----- Fair -----	Fair ----- Good ----- Fair -----	Very poor ----- Very poor ----- Very poor -----	Fair. Good. Good.
Fair ----- Fair ----- Fair -----	Very poor ----- Very poor ----- Very poor -----	Very poor ----- Very poor ----- Very poor -----	Fair ----- Poor ----- Fair -----	Fair ----- Fair ----- Fair -----	Very poor ----- Very poor ----- Very poor -----	Good. Fair. Good.
Fair ----- Fair ----- Fair -----	Very poor ----- Very poor ----- Very poor -----	Very poor ----- Very poor ----- Very poor -----	Poor ----- Poor ----- Fair -----	Poor ----- Poor ----- Fair -----	Very poor ----- Very poor ----- Very poor -----	Fair. Fair. Good.
Good ----- Good ----- Good -----	Very poor ----- Very poor ----- Very poor -----	Very poor ----- Very poor ----- Very poor -----	Good ----- Good ----- Good -----	Fair ----- Good ----- Good -----	Very poor ----- Very poor ----- Very poor -----	Good. Good. Good.
Good ----- Poor -----	Very poor ----- Fair -----	Very poor ----- Good -----	Fair ----- Fair -----	Fair ----- Fair -----	Very poor ----- Good -----	Fair. Good.

¹ Good for ponderosa pine.

and alfalfa grown in rotation provide an abundance of good food for pheasant. Many species of open-land wildlife are in this association.

The Richfield-Alliance-Rosebud association consists chiefly of soils on the tablelands. They are mainly cropped to small grain and alfalfa. Pheasant and rabbit are predominant species in this association, but

songbirds and other kinds of open-land wildlife are also common.

The Canyon-Bridget-Oglala association is locally known as the Pine Ridge. Vegetation includes plum, currant, and buckbrush thickets in drainageways. Cottonwood, box elder, and ash trees along the small spring-fed streams provide wildlife food and cover.

Wildlife includes open-land, woodland, and rangeland species. Flocks of wild turkey live in this association. These birds prefer large areas of undisturbed woodland adjacent to cropland. Some small grain and alfalfa are planted along with sunflowers and provide supplemental food for the turkey. Other kinds of wildlife in the Pine Ridge include deer, bobcat, fox, coyote, porcupine, raccoon, jackrabbit, and cottontails.

The Canyon-Alliance-Rosebud association in the upper drainage area of the Niobrara River, and the Busher-Tassel-Vetal association below it, have similar habitat for wildlife. The Canyon-Alliance-Rosebud association has more wooded draws and more cropland, however, and thus is better suited to wild turkey and deer. It has many jackrabbits and cottontails. This association also supports antelope, but not so many as the Pierre-Samsil-Kyle association. Pheasant and grouse are present in both associations. The common songbirds are western kingbird and lark bunting. There are many small rodents, such as ground squirrels and pocket gophers.

The Valent-Dwyer-Jayem association is a narrow band on uplands on either side of the Niobrara River. The chief kinds of wildlife in this association are antelope and deer, and some prairie grouse and songbirds.

The Tripp-Haverson-Glenberg association is mainly along the White River and a few larger tributary creeks. It has much woody and herbaceous escape cover for wildlife. Mourning doves and many prairie songbirds, such as lark bunting and meadowlarks, are common in the association. Deer use the area for food, cover, and water, and there is a fair population of pheasant. Muskrat, beaver, weasel, raccoon, opossum, fox, and bobcat are also common.

The Bankard association is in the Niobrara River valley. The Box Butte Reservoir is in this association. Muskrat, beaver, weasel, raccoon, fox, coyote, bobcat, and opossum are common. Waterfowl include ducks such as mallard, pintail, and blue winged teal, as well as shore birds. A fair population of pheasant is in this association. Deer and antelope use the area for cover, food, and water. The wildlife associated with the Niobrara River migrate between the Bankard association and the sandy areas of the Valent-Dwyer-Jayem association.

Streams in Dawes County, totaling 319 miles, flow into the Niobrara River and the White River. Cold-water streams total 49 miles; mixed cold- and warm-water streams total 25 miles; and warm-water streams total 171 miles. The Niobrara River is considered a cold-water stream above the Box Butte Reservoir and a warm-water stream below the reservoir. The White River is classed as a cold-water stream above Fort Robinson and a warm-water or mixed water stream below. Other small cold-water streams, such as Bordeaux Creek, are spring fed.

The streams in Dawes County are fair for trout production. Natural reproduction is supplemented by artificial stocking. Trout are caught mainly in cold-water streams. Fish in Whitney Lake are walleye, northern pike, carp, suckers, channel catfish, black bullheads, white bass, largemouth bass, black crappies, bluegills, and perch. Fish in Box Butte Reservoir are mainly northern pike, channel catfish, white bass,

smallmouth bass, largemouth bass, bluegill, trout, walleye, and suckers. Farm ponds support limited fishing for bass, bluegill, and other panfish.

Recreation

Dawes County has a noteworthy recreational role. Results of a study of recreation potential are published in "An Appraisal of Potentials for Outdoor Recreational Development, Sioux-Dawes County," Soil Conservation Service, 1971. Twelve kinds of recreation were evaluated and appraised by representatives of county, State, and Federal agencies, as well as local private organizations. Rated especially high were vacation cabins, vacation ranches, camping grounds, and natural, scenic, and historic areas. The private recreation sector is expected to expand as demand for these services increases.

Public recreation facilities maintained by the State Game and Parks Commission are: Ponderosa Special Use Area—3,600 acres; James Ranch-Smiley Canyon Special Use Area—10,295 acres (in Dawes and Sioux Counties); Chadron State Park—802 acres; Fort Robinson State Park—12,377 acres; Cochran State Wayside Area—14 acres; and Box Butte Recreation Area—2,212 acres.

Fort Robinson is an important State-owned recreational facility that provides overnight camping and inn facilities. During the summer vacation season, guided tours, hikes, and plays are provided. Two excellent museums, one of Indian relics and one of natural history, are at the Fort. Pioneer Museum, maintained by the Crawford Historical Society, is in the town of Crawford. The Museum of the Fur Trade is located 3 miles east of Chadron.

Federal recreation areas are: Crawford National Fish Hatchery, Crawford—501 acres; Pine Ridge Division, National Forest—49,998 acres (includes Spotted Tail Campground and Red Cloud picnic areas south of Chadron); and Oglala National Grasslands—94,344 acres.

Developing good habitat for wildlife and sites for recreation requires proper location and distribution of vegetation. Technical assistance in planning wildlife or recreational developments and in determining suitable species of vegetation for planting can be obtained at the local office of the Soil Conservation Service in Crawford. Additional information and assistance can be obtained from Nebraska Game and Parks Commission, the Bureau of Sport Fisheries and Wildlife, and the Cooperative Extension Service.

Engineering Uses of the Soils⁸

This section is useful to those who need information about soils used as structural material or as the foundation upon which structures are built. Among those who can benefit from this section are members of planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Properties of soils highly important in engineering include permeability, strength, compaction characteristics, soil drainage condition, shrink-swell potential,

⁸ ROBERT J. FREDERICKSON, civil engineer, Soil Conservation Service, assisted in preparing this section.

grain size, plasticity, and soil reaction. Also important are depth to the water table, depth to bedrock, and soil slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreation areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built, for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 6, 7, and 8, which show, respectively, several estimated soil properties significant to engineering; interpretations of soil properties for various engineering uses; and results of engineering laboratory tests on soil samples.

This information, along with the soil map and other parts of this publication, can be used to make interpretations in addition to those given in tables 6 and 7, and it also can be used to make other useful maps. It does not, however, eliminate the need for further investigation at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths greater than 6 feet. Inspection of sites, especially small ones, is needed also because many delineated areas of a given soil mapping unit contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this section have different meanings in soil science than in engineering. The Glossary defines many of these terms as they are commonly used in soil science.

Engineering soil classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system (2) used by Soil Conservation Service engineers, the Department of Defense, and others, and the AASHTO system (1) adopted by the American Association of State Highway and Transportation Officials.

The Unified system is used to classify soils according to engineering uses as building material or for the support of structures other than highways. Soils are classified according to particle-size distribution plasticity index, liquid limit, and organic-matter content.

Soils are grouped into 15 classes. Eight classes of coarse-grained soils are divided on the basis of gravel and sand content. These are identified as GW, GP, GM, GC, SW, SP, SM, and SC. Six classes of fine-grained soils are divided on the basis of the plasticity index. Nonplastic classes are ML, MH, OL, and OH; plastic classes are CL and CH. There is one class of highly organic soils, Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, CL-ML.

The AASHTO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A-1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A-7, are clay soils that have low strength when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A-1, A-2, and A-7 groups are divided as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6.

As an additional refinement, the engineering value of a soil material can be indicated by a group index number, ranging from 0 for the best material to 20 or more for the poorest. The AASHTO classification for tested soils, with group index numbers in parentheses, is shown in table 8; the estimated classification, without group index numbers, is given in table 6 for all soils mapped in the survey area.

Estimated soil properties significant to engineering

Several estimated soil properties significant to engineering are given in table 6. These estimates are of layers of representative soil profiles having significantly different soil properties. They are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties. Following are explanations of some of the columns in table 6.

Depth to bedrock is the distance from the surface of the soil to a rock layer within the depth of observation.

Depth to seasonal high water table is the distance from the surface of the soil to the highest level that ground water reaches in the soil in most years.

Soil texture is described in table 6 in the standard terms used by the Department of Agriculture. These terms are based on the percentages of sand, silt, and clay in the fraction of the soil less than 2 millimeters in diameter. "Loam," for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, as for example, "gravelly loamy sand." "Sand," "silt," "clay," and some of the other terms used in USDA textural classification are defined in the Glossary.

Liquid limit and *plasticity index* are water contents obtained by specified operations. As the moisture content of a clayey soil from which the particles coarser than 0.42 millimeter have been removed is increased from a dry state, the soil changes from a semisolid to

TABLE 6.—*Estimated soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The instructions for referring to other series that appear in the first column of

Soil series and map symbols	Depth to—		Depth from surface	Dominant USDA texture	Classification	
	Bedrock	Seasonal high water table			Unified	AASHTO
	<i>Feet</i>	<i>Feet</i>	<i>Inches</i>			
Alliance: AcB, AcD, AcD2 -----	3.3-6.0	>10	0-11 11-20 20-26 26-60	Silt loam ----- Silty clay loam ----- Silt loam ----- Very fine sandy loam -----	CL or ML CL or CH CL ML	A-4 or A-6 A-6 or A-7 A-4 or A-6 A-4
Badland: Ba. Too variable to be rated.						
Bankard: Bc -----	>10	6-10	0-16 16-48 48-60	Loamy fine sand ----- Fine sand ----- Sand -----	SM SM, SP, or SP-SM SM, SP, or SP-SM	A-2 A-2 or A-3 A-2 or A-3
Bankard variant: Bd -----	>10	2-4	0-20 20-48 48-60	Loamy fine sand ----- Fine sand ----- Coarse sand -----	SM SM, SP, or SP-SM SM, SP, or SP-SM	A-2 A-2 or A-3 A-1 or A-2
Breaks-Alluvial land complex: Bf. Too variable to be rated.						
*Bayard: ----- Mapped only in a complex with Vetal soils.	>10	>10	0-15 15-60	Loamy very fine sand ----- Loamy very fine sand -----	SM or ML SM or ML	A-2 or A-4 A-2 or A-4
Bridget: Bg, BgB, BgD, BgF -----	>10	>10	0-18 18-60	Silt loam ----- Very fine sandy loam -----	ML ML	A-4 or A-6 A-4
Buffington: Bh -----	>10	>10	0-11 11-18 18-60	Silty clay ----- Silty clay loam ----- Light silty clay loam -----	CH CL or CH CL	A-7 A-6 or A-7 A-4 or A-6
Bufton: Bn, BnB, BnD, BnF, BoD ----- Properties of Slickspots part of BoD are too variable to be rated.	>10	>10	0-6 6-36 36-60	Silty clay loam ----- Heavy silty clay loam ----- Silty clay loam -----	ML, CL, or CH CH CL or CH	A-7 A-7 A-6 or A-7
*Busher: BuC, BuC2, BuD, BuD2, BuF, BxF ----- For properties of Tassel part of BxF, see Tassel series.	3.3-6.0	>10	0-24 24-44 44-60	Loamy very fine sand ----- Loamy very fine sand ----- Fine grained sandstone.	SM or ML SM or ML	A-2 or A-4 A-2 or A-4
*Canyon: CaG, CcF, CcG ----- For properties of Bridget part of CaG, see Bridget series; proper- ties of Rock outcrop part of CaG are too variable to be rated.	0.9-1.6	>10	0-5 5-15 15-24	Loam ----- Loam ----- Fine grained sandstone.	CL-ML or CL CL-ML or CL	A-4 or A-6 A-4 or A-6
Clayey alluvial land: Cf. Too variable to be rated.						
Duroc: DuB -----	>10	>10	0-33 33-60	Very fine sandy loam ----- Very fine sandy loam -----	ML or CL ML or CL	A-4 A-4
*Dwyer: ----- Mapped only in complexes with Valent soils.	>10	>10	0-5 5-60	Loamy fine sand ----- Fine sand -----	SM SM, SP, or SP-SM	A-2 A-2 or A-3
Epping: EpF, EsG ----- Properties of Badland part of EsG are too variable to be rated.	0.9-1.6	>10	0-15 15-20	Silt loam ----- Siltstone.	ML or CL	A-4 or A-6

significant to engineering

soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the this table. The symbol > means more than; the symbol < means less than]

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
	100	95-100	55-90	25-40	5-15	0.6-2.0	0.22-0.24	6.6-7.8	Low.
	100	90-100	80-95	30-55	20-35	0.6-2.0	0.18-0.20	6.6-7.8	Moderate.
	100	90-100	60-90	25-40	8-15	0.6-2.0	0.20-0.22	6.6-7.8	Low.
95-100	90-100	85-100	50-70	<40	<10	0.6-2.0	0.17-0.19	7.4-8.4	Low.
	100	70-85	15-35	¹ NP	NP	6.0-20.0	0.10-0.12	7.9-8.4	Low.
100	95-100	65-80	3-25	NP	NP	6.0-20.0	0.06-0.08	7.9-8.4	Low.
100	95-100	50-70	2-20	NP	NP	6.0-20.0	0.05-0.07	7.9-8.4	Low.
	100	70-85	15-35	NP	NP	6.0-20.0	0.10-0.12	7.9-9.0	Low.
100	95-100	65-80	3-25	NP	NP	6.0-20.0	0.06-0.08	8.5-9.0	Low.
100	75-90	15-50	2-20	NP	NP	6.0-20.0	0.05-0.07	7.4-7.8	Low.
	100	90-100	30-60	NP	NP	2.0-6.0	0.15-0.17	7.4-7.8	Low.
	100	90-100	30-60	NP	NP	2.0-6.0	0.12-0.14	7.4-8.4	Low.
	100	90-100	60-90	25-40	<15	0.6-2.0	0.22-0.24	6.6-7.8	Low.
95-100	95-100	85-100	50-90	20-35	<10	0.6-2.0	0.17-0.19	7.4-8.4	Low.
	100	95-100	90-95	50-80	25-50	0.06-0.2	0.12-0.14	7.4-7.8	High.
	100	90-100	85-95	30-55	20-35	0.2-0.6	0.18-0.20	7.9-8.4	High.
	100	90-100	60-90	25-40	8-15	0.2-2.0	0.19-0.21	8.5-9.0	Moderate.
	100	95-100	80-95	40-60	15-30	0.06-0.6	0.17-0.19	² 7.4-8.4	High.
	100	95-100	85-95	50-80	25-45	0.06-0.6	0.14-0.16	7.9-9.0	High.
	100	90-100	80-95	30-55	15-30	0.2-0.6	0.18-0.20	7.9-9.0	Moderate.
	100	90-95	30-60	NP	NP	2.0-6.0	0.15-0.17	6.6-7.8	Low.
	100	90-95	30-60	NP	NP	2.0-6.0	0.13-0.15	6.6-8.4	Low.
95-100	95-100	85-95	50-75	20-40	4-15	0.6-2.0	0.20-0.22	7.4-8.4	Low.
95-100	95-100	85-95	50-75	20-40	4-15	0.6-2.0	0.17-0.19	7.9-8.4	Low.
	95-100	85-100	50-90	<25	<10	0.6-2.0	0.20-0.22	7.4-7.8	Moderate.
95-100	95-100	85-100	50-90	<25	<10	0.6-2.0	0.17-0.19	7.9-8.4	Moderate.
	100	70-95	15-30	NP	NP	6.0-20.0	0.10-0.12	7.4-7.8	Low.
100	95-100	60-90	2-20	NP	NP	6.0-20.0	0.06-0.08	7.4-7.8	Low.
	100	90-100	70-90	20-40	2-15	0.6-2.0	0.20-0.22	7.4-8.4	Low.

TABLE 6.—Estimated soil properties

Soil series and map symbols	Depth to—		Depth from surface	Dominant USDA texture	Classification	
	Bedrock	Seasonal high water table			Unified	AASHTO
	<i>Feet</i>	<i>Feet</i>	<i>Inches</i>			
Glenberg: GbB, GoB -----	>10	6-10	0-48 48-60	Loamy very fine sand ----- Coarse sand and gravel -----	SM or ML SP or SW	A-2 or A-4 A-1 or A-2
Gravelly alluvial land: Gr. Too variable to be rated.						
Haverson:						
HaB, HbB -----	>10	6-10	0-6 6-16 16-60	Silt loam ----- Very fine sandy loam ----- Silt loam -----	ML or CL ML or CL ML or CL	A-4 or A-6 A-4 A-4 or A-6
HcB -----	>10	6-10	0-17 17-27 27-60	Silty clay loam ----- Very fine sandy loam ----- Silt loam -----	CL or CH ML or CL ML or CL	A-6 or A-7 A-4 A-4 or A-6
*Jayem: JmC, JmD, JvD ----- For properties of Vetal part of JvD, see Vetal series.	5-20	>10	0-60	Loamy very fine sand -----	SM or ML	A-2 or A-4
Kadoka, variant: KaB, KaD, KaD2 -----	3.3-10	>10	0-9 9-21 21-60	Silt loam ----- Silty clay loam ----- Silt loam -----	ML or CL ML or CL ML or CL	A-4 or A-6 A-6 or A-7 A-4 or A-6
*Keith: KeB, KeD, KfD ----- For properties of Ulysses part of KfD, see Ulysses series.	>5	>10	0-9 9-17 17-60	Silt loam ----- Light silty clay loam ----- Silt loam -----	CL or ML-CL CL ML or CL	A-4 or A-6 A-6 or A-7 A-4 or A-6
*Keota: KoB, KpD ----- For properties of Epping part of KpD, see Epping series.	1.6-3.3	>10	0-4 4-30 30-40	Silt loam ----- Silt loam ----- Siltstone.	ML ML	A-4 A-4
Kyle: Ky, KyC, Kz ----- Properties of Slickspots part of Kz are too variable to be rated.	>5	>10	0-3 3-30 30-60	Silty clay ----- Clay ----- Clay -----	CH CH CH	A-7 A-7 A-7
Las Animas: La -----	>10	2-6	0-6 6-60	Silt loam or fine sandy loam. Stratified very fine sandy loam to coarse sand.	SM or ML SM or ML	A-4 or A-6 A-4
Loamy alluvial land: Lo. Too variable to be rated.						
Minnequa: MnC, MnD -----	1.6-3.3	>10	0-16 16-38 38-60	Silty clay loam ----- Light silty clay loam ----- Chalky shale.	CL or CH CL	A-6 or A-7 A-6 or A-7
*Mitchell: Mt, MtC, MtD, MtF, MxF ----- For properties of Epping part of MxF, see Epping series.	>5	>10	0-16 16-60	Silt loam ----- Silt loam -----	ML ML	A-4 A-4
Norrest: NrB, NrD, NrF -----	1.6-3.3	>10	0-4 4-17 17-25 25-34 34-60	Silty clay loam ----- Light silty clay ----- Heavy silty clay loam ----- Silty clay loam ----- Clay shale.	CL CL or CH CL or CH CL	A-6 or A-7 A-7 A-7 A-6 or A-7
*Oglala: OgF, OhF ----- For properties of Canyon part of OhF, see Canyon series.	3.3-6.0	>10	0-14 14-60	Loam ----- Silt loam -----	ML ML	A-4 or A-6 A-4 or A-6
Orella: OrF, OsG ----- Properties of Badland part of OsG are too variable to be rated.	0.9-1.6	>10	0-17 17-25	Silty clay loam ----- Silty shale.	CL or CH	A-6 or A-7

significant to engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
50-75	100 20-50	90-100 10-30	30-60 0-5	NP NP	NP NP	<i>Inches per hour</i> 2.0-6.0 6.0->20.0	<i>Inches per inch of soil</i> 0.15-0.17 0.02-0.04	<i>pH</i> 7.4-7.8 7.9-8.4	Low. Low.
95-100	100 95-100	90-100 85-100	70-90 50-90	20-40 <25	2-15 <10	0.6-2.0 0.6-2.0	0.22-0.24 0.17-0.19	7.9-8.4 7.9-8.4	Low to moderate. Low.
95-100	100 95-100	90-100 85-100	70-90 50-90	20-40 20-25	2-15 <10	0.6-2.0 0.6-2.0	0.20-0.22 0.17-0.19	7.9-9.0 7.9-8.4	Low to moderate. High.
95-100	100 95-100	90-100 85-100	80-95 50-90	30-55 20-25	15-30 <10	0.2-0.6 0.6-2.0	0.21-0.23 0.17-0.19	7.9-8.4 7.9-8.4	High. Low.
95-100	100 95-100	90-100 85-100	70-90 70-90	20-40 20-40	2-15 2-15	0.6-2.0 0.6-2.0	0.20-0.22 0.20-0.22	7.9-9.0 7.9-9.0	Low to moderate. Low to moderate.
100	90-100	90-95	30-60	<30	<10	2.0-6.0	0.15-0.17	7.4-7.8	Low.
-----	100	90-100	75-95	25-40	5-15	0.6-2.0	0.22-0.24	7.4-7.8	Low.
-----	100	90-100	85-95	35-50	10-25	0.2-0.6	0.18-0.20	7.4-7.8	Moderate.
-----	100	90-100	80-98	30-40	5-15	0.6-2.0	0.20-0.22	7.9-8.4	Low.
-----	100	95-100	70-90	20-40	3-15	0.6-2.0	0.22-0.24	7.4-7.8	Low.
-----	100	95-100	85-95	35-50	15-30	0.6-2.0	0.19-0.21	7.4-7.8	Moderate.
-----	100	95-100	80-95	25-40	5-15	0.6-2.0	0.20-0.22	7.4-8.4	Low.
-----	100	90-100	70-90	20-40	2-10	0.6-2.0	0.22-0.24	7.9-8.4	Low.
-----	100	90-100	70-90	20-40	2-10	0.6-2.0	0.20-0.22	7.9-8.4	Low.
-----	100	95-100	85-95	50-70	25-50	0.06-0.2	0.12-0.14	7.4-7.8	High.
-----	100	95-100	90-100	55-80	30-55	<0.06	0.09-0.11	7.4-8.4	High.
-----	100	95-100	90-100	55-80	30-55	<0.06	0.08-0.10	7.4-7.8	High.
-----	100	70-100	40-90	<30	<10	0.6-6.0	0.16-0.24	7.4-7.8	Low.
-----	100	60-85	30-55	NP	NP	2.0-6.0	0.11-0.17	7.4-8.4	Low.
-----	100	90-100	85-95	35-55	10-35	0.2-0.6	0.21-0.23	7.9-8.4	Moderate.
-----	100	95-100	85-95	30-50	10-30	0.2-0.6	0.19-0.21	7.9-8.4	Moderate.
-----	100	95-100	70-95	25-40	<10	0.6-2.0	0.22-0.24	7.9-8.4	Low.
-----	100	90-100	70-90	<40	<10	0.6-2.0	0.17-0.22	7.9-8.4	Low.
-----	100	90-100	80-95	25-50	15-35	0.2-0.6	0.21-0.23	7.4-7.8	Moderate to high.
-----	100	95-100	85-95	45-70	20-40	0.2-0.6	0.11-0.13	7.9-8.4	High.
-----	100	95-100	85-95	40-60	20-35	0.2-0.6	0.14-0.16	7.9-8.4	High.
-----	100	90-100	80-95	25-50	10-30	0.2-0.6	0.18-0.20	7.9-8.4	Moderate to high.
95-100	95-100	90-100	70-95	25-40	2-10	0.6-2.0	0.20-0.22	7.4-7.8	Moderate to low.
95-100	95-100	85-100	60-95	<40	<15	0.6-2.0	0.20-0.22	7.4-8.4	Moderate to low.
-----	100	90-100	80-95	35-60	20-35	0.2-0.6	0.18-0.23	7.4-9.0	High.

TABLE 6.—Estimated soil properties

Soil series and map symbols	Depth to—		Depth from surface	Dominant USDA texture	Classification	
	Bedrock	Seasonal high water table			Unified	AASHTO
	<i>Feet</i>	<i>Feet</i>	<i>Inches</i>			
*Penrose: PeG, PmF ----- Properties of Shale outcrop part of PeG are too variable to be rated; for properties of Minnequa part of PmF, see Minnequa series.	0.9-1.6	>10	0-16 16-42	Silty clay loam ----- Chalky shale.	CL or CH	A-6 or A-7
Pierre: PrC, PrF, PsD ----- Properties of Slickspots part of PsD are too variable to be rated.	1.6-3.3	>10	0-5 5-34 34-60	Silty clay ----- Clay ----- Clay shale.	CH CH	A-7 A-7
Richfield: RhB -----	>5	>10	0-7 7-10 10-24 24-30 30-60	Silt loam ----- Light silty clay loam ----- Heavy silty clay loam ----- Light silty clay loam ----- Silt loam -----	CL or ML CL CL or CH CL ML or CL	A-4 or A-6 A-6 or A-7 A-7 A-6 or A-7 A-4 or A-6
*Rock outcrop: RoG. Too variable to be rated. For properties of Canyon part of RoG, see Canyon series.						
*Rosebud: RsB, RxD ----- For properties of Canyon part of RxD, see Canyon series.	1.6-3.3	>10	0-8 8-25 25-30 30-60	Silt loam ----- Silty clay loam ----- Silt loam ----- Sandstone.	ML or CL CL or CH ML or CL	A-4 or A-6 A-6 or A-7 A-4 or A-6
Saline-Alkali land: Sa. Too variable to be rated.						
Samsil: Sbf, ShG ----- Properties of Shale outcrop part of ShG are too variable to be rated.	0.9-1.6	>10	0-16 16-24	Silty clay ----- Clay shale.	CH	A-7
Sandy alluvial land: Sn. Too variable to be rated.						
*Sarben: SrC, SrD, SrF, SvF ----- For properties of Vetal part of SvF, see Vetal series.	>5	>10	0-60	Fine sandy loam -----	SM or ML	A-2 or A-4
Schamber: SyF -----	>5	>10	0-12 12-60	Gravelly very fine sandy loam. Gravel -----	SM or ML SP-SM, SW-SM, SM, GP-GM, GW-GM, or GM	A-4 A-1 or A-2
*Shale outcrop. Too variable to be rated. Mapped only in complexes with Penrose and Samsil soils.						
*Slickspots. Too variable to be rated. Mapped only in complexes with Bufton, Kyle, and Pierre soils.						
Tassel: TaF -----	0.9-1.6	>10	0-18 18-24	Loamy very fine sand ----- Sandstone.	SM or ML	A-2 or A-4
Tripp: Tr, TrB, Ts -----	>5	>10	0-13 13-28 28-60	Silt loam ----- Silt loam ----- Very fine sandy loam -----	ML or CL ML or CL ML	A-4 or A-6 A-4 or A-6 A-4

significant to engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
100	95-100	90-100	80-95	35-55	20-35	0.2-0.6	0.18-0.23	7.9-8.4	Moderate to high.
-----	100	95-100	85-95	55-80	30-55	0.6-0.2	0.12-0.14	7.4-7.8	High.
-----	100	95-100	80-100	55-80	30-55	<0.06	0.09-0.11	7.9-8.4	High.
-----	100	95-100	55-90	25-35	5-15	0.6-2.0	0.22-0.24	7.4-7.8	Moderate.
-----	100	95-100	60-95	35-50	20-30	0.2-0.6	0.21-0.23	7.4-7.8	Moderate.
-----	100	95-100	70-95	40-60	20-35	0.2-0.6	0.17-0.19	7.4-7.8	High.
-----	100	95-100	60-95	35-50	20-30	0.2-0.6	0.21-0.23	7.9-8.4	Moderate.
-----	100	95-100	55-80	25-35	5-15	0.6-2.0	0.20-0.22	7.9-8.4	Moderate.
100	95-100	80-100	55-90	25-40	5-15	0.6-2.0	0.22-0.24	6.6-7.3	Low.
100	95-100	80-100	55-95	30-55	15-30	0.6-2.0	0.18-0.20	6.6-7.8	Moderate.
100	95-100	60-100	50-90	25-40	5-15	0.6-2.0	0.20-0.22	7.9-8.4	Low.
-----	100	95-100	85-95	50-80	30-55	0.06-0.2	0.10-0.14	7.4-8.4	High.
100	90-100	90-95	30-60	<25	<7	2.0-6.0	0.15-0.17	7.4-8.4	Low.
80-100	70-100	60-75	35-75	NP	NP	6.0-20.0	0.12-0.15	7.4-8.4	Low.
35-70	25-60	15-50	5-30	NP	NP	>20.0	0.02-0.04	7.9-8.4	Low.
-----	100	50-95	25-60	NP	NP	2.0-6.0	0.15-0.17	7.4-8.4	Low.
95-100	95-100	85-100	60-90	25-35	2-15	0.6-2.0	0.22-0.24	^a 7.4-7.8	Low.
95-100	95-100	85-100	60-90	25-35	2-15	0.6-2.0	0.20-0.22	7.4-8.4	Low.
95-100	95-100	85-95	60-75	<30	<7	0.6-2.0	0.17-0.19	7.9-8.4	Low.

TABLE 6.—Estimated soil properties

Soil series and map symbols	Depth to—		Depth from surface	Dominant USDA texture	Classification	
	Bedrock	Seasonal high water table			Unified	AASHTO
	<i>Feet</i>	<i>Feet</i>	<i>Inches</i>			
Ulysses: U _s F -----	>5	>10	0-8	Silt loam -----	ML-CL or ML	A-4
			8-16	Silt loam -----	ML-CL or ML	A-4
			16-60	Silt loam -----	ML or ML-CL	A-4
*Valent: V _a B, V _a F ----- For properties of Dwyer part of V _a B and V _a F, see Dwyer series.	>5	>10	0-4	Loamy fine sand -----	SM or SP-SM	A-2
			4-60	Fine sand -----	SM or SP-SM	A-2 or A-3
*Vetal: V _e C ----- For properties of Bayard part of V _e C, see Bayard series.	>5	>10	0-60	Loamy very fine sand -----	SM or ML	A-2 or A-4
Wet alluvial land: W _x . Too variable to be rated.						

¹ NP means nonplastic.

² Reaction of soil in unit BoD is 8.5 to 9.0.

a plastic state. If the moisture content is further increased, the soil changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material changes from a semisolid to a plastic state; and the liquid limit, from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of water content within which a soil material is plastic. Liquid limit and plasticity index are estimated in table 6, but in table 8 the data on liquid limit and plasticity index are based on tests of soil samples.

Permeability is the quality of a soil that enables it to transmit water or air. It is estimated on the basis of soil characteristics observed in the field, particularly structure, porosity, and texture. Lateral seepage or such transient soil features as plowpans and surface crusts are not considered.

Available water capacity is an estimate of the capacity of soils to hold water for use by most plants. It is defined here as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most plants.

Reaction refers to the acidity or alkalinity of a soil, expressed in pH values for a stated soil-solution mixture. The pH value and terms used to describe soil reaction are explained in the glossary.

Shrink-swell potential is the relative change in volume to be expected of soil material as the moisture content changes, that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. The extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and

swelling of soils damages building foundations, roads, and other structures. Soils having a *high* shrink-swell potential are the most hazardous. Shrink-swell is not indicated for organic soils or for certain soils that shrink markedly on drying but do not swell quickly when rewetted.

Engineering interpretations of the soils

The estimated interpretations in table 7 are based on the engineering properties of soils shown in table 6, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of Dawes County. In table 7, ratings are used to summarize limitation or suitability of the soils for all listed purposes other than for ponds and reservoirs, embankments, drainage of cropland and pasture, irrigation, and terraces and diversions. For these uses, table 7 lists those soil features not to be overlooked in planning, installation, and maintenance.

Soil limitations are indicated by the ratings *slight*, *moderate*, and *severe*. *Slight* means that soil properties are generally favorable for the rated use, or in other words, limitations are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means that soil properties are so unfavorable and so difficult to correct or overcome as to require major soil reclamation, special designs, or intensive maintenance. For some uses, the rating of *severe* is divided to give ratings of *severe* and *very severe*. *Very severe* means that one or more soil properties are so unfavorable for a particular use

significant to engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
-----	100	95-100	60-85	20-35	5-10	0.6-2.0	0.22-0.24	7.4-7.8	Low.
-----	100	95-100	60-90	20-35	5-10	0.6-2.0	0.20-0.22	7.4-7.8	Low.
-----	100	95-100	70-90	20-35	5-10	0.6-2.0	0.20-0.22	7.9-8.4	Low.
-----	100	80-95	10-30	NP	NP	6.0-20.0	0.10-0.12	7.4-7.8	Low.
-----	100	80-95	5-20	NP	NP	6.0-20.0	0.06-0.08	7.4-7.8	Low.
100	95-100	90-100	30-60	NP	NP	2.0-6.0	0.15-0.17	6.6-8.4	Low.

^a Reaction of soil in unit Ts is 7.9 to 9.0.

that overcoming the limitations is most difficult and costly and is commonly impractical.

Soil suitability is rated by the terms *good*, *fair*, and *poor*, which have, respectively, meanings approximately parallel to the terms slight, moderate, and severe.

Following are explanations of some of the columns in table 7:

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material from a depth of 18 inches to 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope is a soil property that affects difficulty of layout and construction and also the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor and has sides, or embankments, of compacted soil material. It is assumed that the embankment is compacted to medium density and the pond is protected from flooding. Properties are considered that affect the pond floor and the embankment. Those that affect the pond floor permeability, organic-matter content, and slope; if the floor needs to be leveled, depth to bedrock becomes important. Properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified soil classification, and

the amount of stones, if any, which influences the ease of excavation and compaction of the embankment material.

Shallow excavations are those that require digging or trenching to a depth of less than 6 feet, as for example, excavations for pipelines, sewer lines, phone and power transmission lines, basement, open ditches, and cemeteries. Desirable soil properties are good workability, moderate resistance to sloughing, gentle slopes, absence of rock outcrops or large stones, and freedom from flooding or a high water table.

Dwellings, as rated in table 7, are not more than three stories high and are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to capacity to support load and resist settlement under load, and those that relate to ease of excavation. Soil properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

Local roads and streets, as rated in table 7, have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base consisting of gravel, crushed rock, or soil material stabilized by lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep. Soil properties that most affect design and construction of roads and streets are the load-supporting capacity and stability of the subgrade, and

TABLE 7.—*Interpretations of engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The instructions for referring to other series that appear

Soil series and map symbols	Degree and kind of limitation for—						
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with or without basements	Local roads and streets	Sanitary landfills ¹	
						Area type	Trench type
Alliance: AcB, AcD, AcD2 ---	Moderate where sandstone is at a depth of 48 to 60 inches. Severe where sandstone is at a depth of less than 48 inches: moderate permeability.	Moderate: moderate permeability; bedrock at a depth of 40 to 60 inches.	Moderate where sandstone is at a depth of 40 to 60 inches.	Moderate: moderate shrink-swell potential; bedrock at a depth of 40 to 60 inches.	Slight -----	Severe: bedrock generally at a depth of 40 to 60 inches.	Severe: bedrock generally at a depth of 40 to 60 inches.
Badland: Ba. Too variable to be rated. Severe limitations for most uses because bedrock is at surface.							
Bankard: Bc -----	Severe: subject to occasional flooding. ²	Severe: rapid permeability; subject to occasional flooding.	Severe: poor side-wall stability; subject to occasional flooding in places.	Severe: subject to occasional flooding in places.	Moderate: subject to occasional flooding.	Severe: rapid permeability; sandy; subject to occasional flooding.	Severe: rapid permeability; sandy; subject to occasional flooding.
Bankard, variant: Bd -----	Severe: seasonal high water table at a depth of 2 to 4 feet; subject to flooding. ²	Severe: rapid permeability; seasonal high water table at a depth of 2 to 4 feet; subject to flooding.	Severe: seasonal high water table at a depth of 2 to 4 feet; poor sidewall stability.	Severe: seasonal high water table; subject to flooding; subject to frost action.	Moderate: somewhat poorly drained; seasonal high water table; subject to frost action.	Severe: seasonal high water table at a depth of 2 to 4 feet; rapid permeability; sandy.	Severe: seasonal high water table at a depth of 2 to 4 feet; rapid permeability; sandy.
Breaks-Alluvial land complex: Bf. Too variable to be rated. Severe limitations for most uses because of very steep slopes and susceptibility to flooding.							

properties of the soils

soils in such mapping units may have different properties and limitations and for this reason, it is necessary to follow carefully the in the first column of this table]

Suitability as source of—				Soil features affecting—				
Daily cover for landfill	Roadfill	Sand	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Good -----	Fair: thickness limited by sandstone bedrock below a depth of 40 inches.	Unsuited ---	Good -----	Moderate permeability below a depth of 2 feet; moderate seepage potential; sandstone below a depth of 40 inches.	Sandstone below a depth of 40 inches in places; fair to good compaction characteristics.	Well drained; features generally favorable.	High available water capacity; moderately low intake; moderate permeability.	Erodibility of slopes; sandstone below a depth of 40 inches.
Fair: sandy soil.	Good: wet at a depth of 6 to 10 feet in places.	Fair: too many fines; poor gradation.	Poor: sandy.	Rapid permeability; high seepage potential.	High susceptibility to seepage; easily compacted.	Most features favorable; well drained; subject to occasional flooding in places.	Rapid permeability; low available water capacity; very high intake; needs protection from flooding in places.	Diversion slopes unstable. ^a
Fair: sandy soil.	Fair: wet at a depth of 2 to 4 feet in places; somewhat poorly drained.	Fair: too many fines.	Poor: sandy.	High seepage potential; suitable sites for dugouts in places.	High susceptibility to seepage; wet borrow areas at a depth of 2 feet in places.	Somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; suitable outlets difficult to obtain in places.	Rapid permeability; seasonal high water table at a depth of 2 to 4 feet; very high intake in upper 2 feet; low available water capacity.	Diversion slopes unstable. ^a

TABLE 7.—Interpretations of engineering

Soil series and map symbols	Degree and kind of limitation for—						
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with or without basements	Local roads and streets	Sanitary landfills ¹	
						Area type	Trench type
*Bayard ----- Mapped only in a complex with Vetal soils.	Slight ² -----	Severe: moderately rapid permeability.	Slight -----	Moderate: subject to frost action.	Moderate: subject to frost action.	Severe: moderately rapid permeability.	Severe: moderately rapid permeability.
Bridget: Bg, BgB, BgD, BgF --	Slight where slopes are 0 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent.	Moderate where slopes are 2 to 7 percent: moderate permeability. Severe where slopes are greater than 7 percent.	Slight where slopes are 0 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent.	Moderate where slopes are 8 to 15 percent: subject to frost action. Severe where slopes are greater than 15 percent.	Moderate where slopes are 8 to 15 percent: subject to frost action. Severe where slopes are greater than 15 percent.	Slight where slopes are 0 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent.	Slight where slopes are 0 to 15 percent. Moderate where slopes are 15 to 25 percent.
Buffington: Bh -----	Moderate: moderately slow permeability; moderate percolation rate.	Slight -----	Slight -----	Severe: high shrink-swell potential; subject to frost action.	Severe: high shrink-swell potential; subject to frost action.	Slight -----	Moderate: soil texture.
Bufton: Bn, BnB, BnD, BnF, BnD. Properties of Slickspots part of BnD are too variable to be rated.	Severe: moderately slow permeability.	Slight where slopes are 0 to 2 percent. Moderate where slopes are 2 to 7 percent. Severe where slopes are greater than 7 percent.	Slight where slopes are 0 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent.	Severe: high shrink-swell potential; subject to frost action.	Severe: high shrink-swell potential; subject to frost action.	Moderate where slopes are greater than 8 percent.	Moderate where slopes are 15 to 20 percent: soil texture.

properties of the soils—Continued

Suitability as source of—				Soil features affecting—				
Daily cover for landfill	Roadfill	Sand	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Good -----	Fair: moderate susceptibility to frost action.	Poor: too many fines; poor gradation.	Fair: subject to soil blowing; limited thickness.	Moderate to high seepage potential; moderately rapid permeability.	Medium to low permeability when compacted; medium to high susceptibility to seepage.	Features generally favorable; well drained.	Moderate available water capacity; moderately high intake; erodibility of slopes; moderately rapid permeability.	Erodibility of slopes.
Good -----	Fair: subject to frost action.	Unsuited ---	Good where slopes are 0 to 8 percent. Fair where slopes are 8 to 15 percent. Poor where slopes are greater than 15 percent.	Moderate permeability; moderate seepage potential.	Medium to low permeability when compacted; low to medium susceptibility to seepage.	Features generally favorable; well drained.	Moderate permeability; moderate intake; high available water capacity; erodibility of slopes; not suited where slopes are more than 9 percent.	Susceptible to erosion and siltation.
Good to fair.	Poor: high shrink-swell potential in upper 1.5 feet.	Unsuited ---	Poor: too clayey.	Low seepage potential; moderately slow permeability.	Needs compaction control; low permeability when compacted.	Features generally favorable; well drained.	High available water capacity; very low intake; moderately slow permeability.	(°).
Fair to poor: slopes greater than 8 percent; too clayey.	Poor: high shrink-swell potential; needs compaction control.	Unsuited ---	Poor: too clayey; lacks thickness.	Low seepage potential; moderately slow permeability.	Low permeability when compacted; needs compaction control.	Features generally favorable; well drained.	Moderately slow permeability; high available water capacity; low intake.	Moderately slow permeability.

TABLE 7.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—						
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with or without basements	Local roads and streets	Sanitary landfills ¹	
						Area type	Trench type
*Busher: BuC, BuC2, BuD, BuD2, BuF, BxF. For properties of Tassel part of BxF, see Tassel series.	Slight where slopes are 0 to 8 percent. Moderate where slopes are 8 to 15 percent or where bedrock is at a depth of 48 to 60 inches. Severe where slopes are greater than 15 percent or where bedrock is at a depth of less than 48 inches.	Severe: moderately rapid permeability.	Slight where slopes are 0 to 8 percent. Moderate where slopes are 8 to 15 percent or where bedrock is at a depth of 40 to 60 inches. Severe where slopes are greater than 15 percent or where the soil above bedrock is subject to caving.	Slight where slopes are 0 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent or where sandstone bedrock is at a depth of 40 to 60 inches.	Slight where slopes are 0 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent: subject to soil blowing and water erosion.	Severe: rippable sandstone at a depth of 40 to 60 inches; moderately rapid permeability.	Severe: rippable sandstone at a depth of 40 to 60 inches; moderately rapid permeability.
*Canyon: CaG, CcF, CcG -- For properties of Bridget part of CaG, see Bridget series; properties of Rock outcrop part of CaG are too variable to be rated.	Severe: sandstone at a depth of 10 to 20 inches.	Severe: sandstone at a depth of 10 to 20 inches.	Severe: sandstone at a depth of 10 to 20 inches; slopes greater than 15 percent in places.	Severe: sandstone bedrock at a depth of 10 to 20 inches.	Severe: sandstone at a depth of 10 to 20 inches.	Severe: sandstone at a depth of 10 to 20 inches; slopes greater than 15 percent in many places.	Severe: sandstone at a depth of 10 to 20 inches; slopes greater than 15 percent in many places.
Clayey alluvial land: Cf. Too variable to be rated. Severe limitations for most uses because of susceptibility to flooding.							
Duroc: DuB -----	Slight -----	Moderate: moderate permeability.	Slight: subject to caving when wet.	Moderate: subject to frost action.	Moderate: subject to frost action.	Slight -----	Slight -----
*Dwyer ----- Mapped only in complexes with Valent soils.	Slight where slopes are less than 8 percent. Moderate where slopes are greater than 8 percent. ²	Severe: rapid permeability.	Severe: fine sand; poor sidewall stability.	Slight where slopes are less than 8 percent. Moderate where slopes are greater than 8 percent.	Slight where slopes are less than 8 percent. Moderate where slopes are greater than 8 percent.	Severe: rapid permeability.	Severe: rapid permeability.

properties of the soils—Continued

Suitability as source of—				Soil features affecting—				
Daily cover for landfill	Roadfill	Sand	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Good where slopes are 0 to 8 percent. Fair where slopes are 8 to 15 percent. Poor where slopes are greater than 15 percent.	Good where slopes are 0 to 15 percent. Fair where slopes are 15 to 25 percent or where bedrock is at a depth of 40 to 60 inches.	Poor: too many fines; poor gradation.	Good where slopes are 0 to 8 percent. Fair where slopes are 8 to 15 percent. Poor where slopes are greater than 15 percent: subject to soil blowing.	Moderate to high seepage potential; sandstone at a depth of 40 to 60 inches.	Medium to low permeability when compacted; susceptible to seepage; bedrock at a depth of 40 to 60 inches.	Features generally favorable; well drained to somewhat excessively drained.	Moderate available water capacity; moderately high intake; erodibility of slopes; moderately rapid permeability; not suited where slopes are more than 9 percent.	Subject to soil blowing and water erosion.
Poor: shallow.	Poor: sandstone at a depth of 10 to 20 inches.	Unsuited ---	Poor: lacks thickness; rock outcrops in many places.	Sandstone at a depth of 10 to 20 inches; high seepage potential.	Sandstone at a depth of 10 to 20 inches.	Features generally favorable; well drained.	Not suited --	Sandstone at a depth of 10 to 20 inches.
Good -----	Fair: subject to frost action.	Unsuited ---	Good -----	Moderate permeability; moderate seepage potential.	Medium to low permeability when compacted; susceptible to seepage.	Features generally favorable; well drained.	Moderate intake and permeability; high available water capacity.	(⁸).
Poor: slopes greater than 8 percent: subject to soil blowing and water erosion.	Good: slopes need protection from soil blowing and water erosion.	Fair: limited uses because of gradation.	Poor: too sandy.	Rapid permeability; high seepage potential.	High permeability when compacted; high susceptibility to seepage.	Features generally favorable; excessively drained.	Very high intake; rapid permeability; low available water capacity; subject to soil blowing.	Erodibility; coarse textures; not stable.

TABLE 7.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—						
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with or without basements	Local roads and streets	Sanitary landfills ¹	
						Area type	Trench type
Epping: EpF, EsG ----- Properties of Badland part of EsG are too variable to be rated.	Severe: siltstone at a depth of 10 to 20 inches.	Severe: siltstone at a depth of 10 to 20 inches.	Severe: siltstone at a depth of 10 to 20 inches.	Severe: siltstone at a depth of 10 to 20 inches.	Moderate: siltstone at a depth of 10 to 20 inches.	Severe: siltstone at a depth of 10 to 20 inches; slopes greater than 15 percent.	Severe: siltstone at a depth of 10 to 20 inches; slopes greater than 15 percent.
Glenberg: GbB, GoB -----	Slight for unit GbB. Severe for unit GoB: subject to occasional flooding. ²	Severe: moderately rapid permeability; unit GoB subject to occasional flooding in places.	Severe: coarse texture results in poor sidewall stability; unit GoB subject to occasional flooding.	Moderate for GbB. Severe for GoB: subject to occasional flooding; excavations subject to caving; water table at a depth of 6 to 10 feet; subject to frost action.	Moderate: subject to frost action and occasional flooding.	Severe: moderately rapid permeability; subject to occasional flooding.	Severe: moderately rapid permeability; subject to occasional flooding.
Gravelly alluvial land: Gr. Too variable to be rated. Severe limitations for most uses because of susceptibility to flooding.							
Haverson: HaB -----	Slight -----	Moderate: moderate permeability.	Slight -----	Slight -----	Slight to moderate: low to moderate shrink-swell potential.	Moderate: subject to rare flooding.	Moderate: subject to rare flooding.
HbB, HcB -----	Severe: subject to occasional flooding.	Severe: subject to occasional flooding.	Severe: subject to occasional flooding.	Severe: subject to occasional flooding and frost action.	Severe: subject to occasional flooding and frost action.	Severe: subject to occasional flooding.	Severe: subject to occasional flooding.

properties of the soils—Continued

Suitability as source of—				Soil features affecting—				
Daily cover for landfill	Roadfill	Sand	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Poor: lacks thickness.	Poor: siltstone at a depth of 10 to 20 inches.	Unsuited ---	Poor: lacks thickness; rock outcrops in many places.	Siltstone at a depth of 10 to 20 inches.	Siltstone at a depth of 10 to 20 inches.	Features generally favorable; well drained.	Not suited --	Siltstone at a depth of 10 to 20 inches; generally unsuited.
Fair above a depth of 4 feet; poor below.	Good below a depth of 4 feet. Fair: subject to frost action; water table at a depth of 6 to 10 feet.	Fair above a depth of 4 feet; good below.	Poor: lacks thickness; subject to soil blowing.	High seepage potential; moderately rapid permeability.	Medium to low permeability when compacted; susceptible to seepage.	Features generally favorable; well drained to somewhat excessively drained; unit G _o B subject to occasional flooding.	Moderately rapid permeability; moderately high intake; moderate available water capacity; needs protection from occasional flooding in unit G _o B in places.	Erodibility of diversion slopes. ³
Good -----	Fair: low to moderate shrink-swell potential.	Unsuited ---	Fair: lacks thickness.	Moderate permeability; moderate seepage potential.	Low permeability when compacted; susceptible to seepage.	Features generally favorable; well drained except unit H _b B; subject to occasional flooding.	High available water capacity; moderate intake; moderate permeability.	Erodibility of diversion slopes. ³
Good to fair.	Fair: low to high shrink-swell potential.	Unsuited ---	Fair: lacks thickness; too clayey for easy workability in unit H _c B.	Moderate permeability below a depth of 2 feet; moderate seepage potential.	Low permeability when compacted; medium to low susceptibility to seepage.	Features generally favorable; well drained.	Moderately slow permeability; high available water capacity; low intake; needs protection from occasional flooding.	Erodibility of diversion slopes. ³

TABLE 7.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—						
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with or without basements	Local roads and streets	Sanitary landfills ¹	
						Area type	Trench type
*Jayem: JmC, JmD, JvD For properties of Vetal part of JvD, see Vetal series.	Slight	Severe: moderately rapid permeability.	Slight	Moderate: check depth to bedrock before excavating; subject to frost action.	Moderate: subject to frost action.	Severe: moderately rapid permeability.	Severe: moderately rapid permeability.
Kadoka, variant: KaB, KaD, KaD2.	Severe: moderately slow permeability where siltstone is above a depth of 48 inches.	Moderate: moderate permeability at a depth below 2 feet.	Slight where siltstone is below a depth of 60 inches. Moderate where siltstone is at a depth of 40 to 60 inches.	Moderate: bedrock at a depth of 40 to 60 inches in places; subject to frost action.	Moderate: subject to frost action.	Slight	Slight
*Keith: KeB, KeD, KfD For properties of Ulysses part of KfD, see Ulysses series.	Slight: moderate permeability in subsoil horizon.	Moderate: moderate permeability. Severe where slopes are greater than 7 percent.	Slight	Moderate: subject to frost action.	Moderate: moderate shrink-swell potential; subject to frost action.	Slight	Slight
*Keota: KoB, KpD For properties of Epping part of KpD, see Epping series.	Severe: siltstone at a depth of 20 to 40 inches.	Severe: siltstone at a depth of 20 to 40 inches.	Moderate: siltstone at a depth of 20 to 40 inches.	Moderate to severe: siltstone at a depth of 20 to 40 inches; subject to frost action above bedrock.	Moderate: subject to frost action; siltstone at a depth of 20 to 40 inches.	Slight	Moderate: rippable siltstone at a depth of 20 to 40 inches.
Kyle: Ky, KyC, Kz Properties of Slick-spots part of Kz are too variable to be rated.	Severe: very slow permeability.	Slight where slopes are less than 2 percent. Moderate where slopes are greater than 2 percent.	Severe: clayey.	Severe: high shrink-swell potential.	Severe: high shrink-swell potential.	Slight	Severe: clayey.

properties of the soils—Continued

Suitability as source of—				Soil features affecting—				
Daily cover for landfill	Roadfill	Sand	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Good: slopes less than 8 percent.	Fair: subject to frost action; check depth to bedrock.	Poor: too many fines; poor gradation.	Fair: lacks thickness; subject to soil blowing.	Moderately rapid permeability; moderate to high seepage potential.	Medium to low permeability when compacted; susceptible to seepage; erodibility of slopes.	Features generally favorable; well drained to somewhat excessively drained.	Moderate available water capacity; moderately rapid permeability; high intake; erodibility of slopes.	Erodibility of slopes.
Good: check depth to bedrock.	Fair: subject to frost action.	Unsuited ---	Fair: lacks thickness.	Moderate permeability below a depth of 2 feet; moderate to low seepage potential; siltstone at a depth below 40 inches.	Medium to low permeability when compacted; susceptible to seepage; siltstone at a depth below 40 inches.	Features generally favorable; well drained.	High available water capacity; moderately low intake; moderately slow permeability; erodibility of slopes.	Erodibility of slopes.
Good -----	Fair: subject to frost action.	Unsuited ---	Good -----	Moderate permeability below a depth of 2 feet; moderate seepage potential.	Medium to low permeability when compacted; susceptible to seepage.	Features generally favorable; well drained.	High available water capacity; moderately low intake; moderately slow permeability.	Erodibility of slopes.
Fair: 20 to 40 inches thick.	Poor: subject to frost action; bedrock at a depth of 20 to 40 inches.	Unsuited ---	Fair to poor: lacks thickness; high in lime content.	Moderate permeability; moderate seepage potential; siltstone at a depth of 20 to 40 inches.	Medium to low permeability when compacted; susceptible to seepage; siltstone at a depth of 20 to 40 inches.	Features generally favorable; well drained.	Moderate available water capacity; moderate intake; moderate permeability; erodibility of slopes.	Siltstone at a depth of 20 to 40 inches; erodibility of slopes; moderate siltation potential.
Poor: clayey.	Poor: high shrink-swell potential.	Unsuited ---	Poor: clayey.	Very slow permeability; low seepage potential.	Low permeability when compacted; low susceptibility to seepage; high shrink-swell potential.	Features generally favorable; well drained.	Moderate available water capacity; very low intake; very slow permeability; not suited where slopes are more than 1 percent.	Very slow permeability; clayey soil difficult to work.

TABLE 7.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—						
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Local roads and streets	Sanitary landfills ¹	
						Area type	Trench type
Las Animas: La -----	Severe: water table at a depth of 2 to 6 feet; subject to occasional flooding. ²	Severe: water table at a depth of 2 to 6 feet; moderately rapid permeability; subject to rare flooding.	Severe: water table at a depth of 2 to 6 feet; subject to occasional flooding.	Severe: water table at a depth of 2 to 6 feet; subject to rare flooding and frost action.	Moderate: subject to frost action; water table at a depth of 2 to 6 feet.	Severe: water table at a depth of 2 to 6 feet.	Severe: water table at a depth of 2 to 6 feet.
Loamy alluvial land: Lo. Too variable to be rated. Severe limitations for most uses because of susceptibility to flooding.							
Minnequa: MnC, MnD -----	Severe: chalky shale at a depth of 20 to 40 inches.	Severe: chalky shale at a depth of 20 to 40 inches; slopes greater than 7 percent.	Moderate: chalky shale at a depth of 20 to 40 inches.	Moderate: chalky shale at a depth of 20 to 40 inches; moderate shrink-swell potential.	Moderate: moderate shrink-swell potential; bedrock at a depth of 20 to 40 inches.	Moderate: bedrock at a depth of 20 to 40 inches.	Moderate: bedrock at a depth of 20 to 40 inches.
*Mitchell: Mt, MtC, MtD, MtF, MxF. For properties of Epping part of MxF, see Epping series.	Slight where slopes are 0 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent.	Moderate where slopes are 2 to 7 percent; moderate permeability. Severe where slopes are greater than 7 percent.	Slight where slopes are 0 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent.	Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent; subject to frost action.	Slight where slopes are 0 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent; subject to frost action.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent.	Slight where slopes are less than 15 percent. Moderate where slopes are greater than 15 percent.

properties of the soils—Continued

Suitability as source of—				Soil features affecting—				
Daily cover for landfill	Roadfill	Sand	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Good -----	Fair: water table at a depth of 2 to 6 feet; subject to frost action.	Poor: too many fines; check below a depth of 4 feet.	Poor: lacks thickness.	Moderately rapid permeability; water table at a depth of 2 to 6 feet; dugouts possible.	Medium to low permeability when compacted; medium to high susceptibility to seepage; wet borrow areas.	Somewhat poorly drained; water table at a depth of 2 to 6 feet; subject to occasional flooding in places.	Moderate available water capacity; moderately high intake; moderately rapid permeability; water table at a depth of 2 to 6 feet.	Erodibility of diversion slopes; unstable. ^a
Poor: texture; lacks thickness; cracks when dry.	Poor: moderate shrink-swell potential; subject to frost action; shale at a depth of 20 to 40 inches.	Unsuited ---	Poor: lacks thickness; poor workability; rock outcrops in places.	Moderately slow permeability; chalky shale at a depth between 20 and 40 inches.	Low permeability when compacted; low susceptibility to seepage; chalky shale at a depth of 20 to 40 inches.	Features generally favorable; well drained.	Moderate available water capacity; low intake; moderately slow permeability; chalky shale at a depth of 20 to 40 inches; not suited where slopes are greater than 5 percent.	Chalky shale at a depth of 20 to 40 inches; erodibility of slopes; high siltation potential.
Good -----	Fair: subject to frost action; slopes are too steep for borrow areas in places.	Unsuited ---	Fair: low organic-matter content; high lime content. Poor: slopes greater than 15 percent.	Moderate permeability; moderate seepage potential.	Low permeability when compacted; high susceptibility to seepage.	Features generally favorable; well drained.	High available water capacity; moderate intake; moderate permeability; erodibility of slopes; not suited where slopes are greater than 9 percent.	High erodibility; susceptible to siltation; suitable where slopes are less than 15 percent.

TABLE 7.—Interpretations of engineering

Soil series and map symbols	Degree and kind of limitation for—						
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with or without basements	Local roads and streets	Sanitary landfills ¹	
						Area type	Trench type
Norrest: NrB, NrD, NrF ----	Severe: silty shale at a depth of 20 to 40 inches.	Severe: silty shale at a depth of 20 to 40 inches.	Moderate: silty shale at a depth of 20 to 40 inches.	Moderate to severe: moderate to high shrink-swell potential; shale at a depth of 20 to 40 inches; slopes greater than 8 percent in places; high potential frost action.	Severe: moderate to high shrink-swell potential; subject to frost action; shale at a depth of 20 to 40 inches.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent.	Slight where slopes are less than 15 percent. Moderate where slopes are greater than 15 percent.
*Oglala: OgF, OhF ----- For properties of Canyon part of OhF, see Canyon series.	Moderate where slopes are 8 to 15 percent: moderate permeability. Severe where slopes are greater than 15 percent and where bedrock is above a depth of 48 inches.	Severe: slopes greater than 7 percent.	Moderate where slopes are 8 to 15 percent or where bedrock is at a depth of 40 to 60 inches in places. Severe where slopes are greater than 15 percent.	Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent or where bedrock is at a depth of 40 to 60 inches in places.	Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent.	Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent.	Moderate where slopes are 15 to 25 percent. Severe where slopes are greater than 25 percent.
Orella: OrF, OsG ----- Properties of Badland part of OsG are too variable to be rated.	Severe: shale at a depth of 10 to 20 inches.	Severe: shale at a depth of 10 to 20 inches.	Severe: shale at a depth of 10 to 20 inches; slopes greater than 15 percent in places.	Severe: silty shale at a depth of 10 to 20 inches; high shrink-swell potential; slopes of 15 to 50 percent in many places.	Severe: high shrink-swell potential; subject to frost action; shale bedrock at a depth of 10 to 20 inches.	Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent.	Severe: shale at a depth of 10 to 20 inches.

properties of the soils—Continued

Suitability as source of—				Soil features affecting—				
Daily cover for landfill	Roadfill	Sand	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Fair to poor: loamy and clayey; rippable shale at a depth of 20 to 40 inches.	Poor: moderate to high shrink-swell potential; shale at a depth of 20 to 40 inches; soil over bedrock is difficult to compact.	Unsuited ---	Poor: lacks thickness; poor workability.	Moderately slow permeability; shale at a depth of 20 to 40 inches.	Low permeability when compacted; low susceptibility to seepage; moderate to high shrink-swell potential; shale at a depth of 20 to 40 inches.	Features generally favorable; well drained.	Low available water capacity; low intake; moderately slow permeability; erodibility of slopes; shale at a depth of 20 to 40 inches; not suited where slopes are greater than 9 percent.	Shale at a depth of 20 to 40 inches; erodibility of slopes.
Fair -----	Fair: slopes of 9 to 25 percent.	Unsuited ---	Fair where slopes are 8 to 15 percent. Poor where slopes are greater than 15 percent.	Moderate permeability; moderate seepage potential; sandstone at a depth below 40 inches.	Low permeability when compacted; susceptible to seepage; medium compressibility; sandstone at a depth below 40 inches.	Features generally favorable; well drained.	Steep slopes--	Erodibility of slopes; suitable where slopes are less than 15 percent.
Poor: lacks thickness.	Poor: high shrink-swell potential; bedrock at a depth of 10 to 20 inches.	Unsuited ---	Poor: lacks thickness; poor workability; clayey; shale outcrops in places.	Shale at a depth of 10 to 20 inches; possible seepage in fractures; moderately slow permeability.	Low permeability when compacted; low susceptibility to seepage except in fractured bedrock; shale at a depth of 10 to 20 inches; limited amount of borrow soil available.	Features generally favorable; well drained.	Not suited --	Shale at a depth of 10 to 20 inches; clayey; difficult to work; generally unsuited.

TABLE 7.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—						
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with or without basements	Local roads and streets	Sanitary landfills ¹	
						Area type	Trench type
*Penrose: PeG, PmF ----- Properties of Shale outcrop part of PeG are too variable to be rated; for properties of Minnequa part of PmF, see Minnequa series.	Severe: chalky shale at a depth of 10 to 20 inches; slopes greater than 15 percent.	Severe: chalky shale at a depth of 10 to 20 inches; slopes greater than 7 percent.	Severe: chalky shale at a depth of 10 to 20 inches; slopes greater than 15 percent in places.	Severe: chalky shale at a depth of 10 to 20 inches; high shrink-swell potential; steep slopes in places.	Severe: moderate to high shrink-swell potential; slopes greater than 15 percent in many places; chalky shale at a depth of 10 to 20 inches.	Moderate where slopes are less than 8 to 15 percent. Severe where slopes are greater than 15 percent.	Severe: chalky shale at a depth of 10 to 20 inches.
Pierre: PrC, PrF, PsD ----- Properties of Slickspots part of PsD are too variable to be rated.	Severe: very slow permeability; clayey shale at a depth of 20 to 40 inches.	Severe: shale at a depth of 20 to 40 inches.	Severe: silty clay; slopes greater than 15 percent in many places; shale at a depth of 20 to 40 inches.	Severe: high shrink-swell potential; slopes greater than 15 percent in some places; clayey; shale bedrock at a depth of 20 to 40 inches.	Severe: high shrink-swell potential; slopes greater than 15 percent; bedrock at a depth of 20 to 40 inches.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent.	Severe: shale at a depth of 20 to 40 inches; clayey.
Richfield: RhB -----	Severe: moderately slow permeability in subsoil.	Slight, but moderate permeability at a depth below 3 feet.	Slight -----	Moderate to severe: moderate to high shrink-swell potential; subject to frost action.	Moderate: moderate to high shrink-swell potential; subject to frost action.	Slight -----	Slight -----
*Rock outcrop: RoG. Too variable to be rated. Severe limitations for most uses because bedrock is at surface. For properties of Canyon part of RoG, see Canyon series.							
*Rosebud: RsB, RxD ----- For properties of Canyon part of RxD, see Canyon series.	Severe: sandstone at a depth of 20 to 40 inches.	Severe: sandstone at a depth of 20 to 40 inches.	Severe: sandstone at a depth of 20 to 40 inches.	Severe: sandstone at a depth of 20 to 40 inches; moderate shrink-swell potential in subsoil; subject to frost action.	Moderate: sandstone at a depth of 20 to 40 inches; moderate shrink-swell potential; subject to frost action.	Slight -----	Severe: sandstone at a depth of 20 to 40 inches.

properties of the soils—Continued

Suitability as source of—				Soil features affecting—				
Daily cover for landfill	Roadfill	Sand	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Poor: cracks when dry.	Poor: shrink-swell potential; slopes greater than 15 percent; bedrock at a depth of 10 to 20 inches.	Unsuited ---	Poor: lacks thickness; shale outcrops in many places.	Chalky shale at a depth of 10 to 20 inches; possible seepage in fractures.	Low permeability when compacted; low susceptibility to seepage; possible seepage in fractures; chalky shale at a depth of 10 to 20 inches.	Features generally favorable; well drained.	Not suited --	Chalky shale at a depth of 10 to 20 inches; difficult to work; generally unsuited.
Poor: clayey.	Poor: bedrock at a depth of 20 to 40 inches; high shrink-swell potential.	Unsuited ---	Poor: clayey; poor workability; limited amount.	Shale at a depth of 20 to 40 inches; possible seepage in fractures.	Low permeability when compacted; low susceptibility to seepage; possible seepage in fractures; shale at a depth of 20 to 40 inches.	Features generally favorable; well drained.	Not suited --	Shale at a depth of 20 to 40 inches; high shrink-swell potential; clayey; difficult to work.
Good to fair: silty clay loam.	Fair: moderate to high shrink-swell potential; subject to frost action; depth to bedrock.	Unsuited ---	Fair: moderately thick surface layer.	Moderate permeability at a depth below 3 feet; moderate seepage potential.	Low permeability when compacted; low susceptibility to seepage.	Features generally favorable; well drained.	High available water capacity; moderately low intake; moderately slow permeability.	Erodibility of slopes.
Fair: lacks thickness.	Poor: bedrock at a depth of 20 to 40 inches.	Unsuited ---	Fair: moderately thick surface layer; rock outcrops in places.	Sandstone at a depth of 20 to 40 inches; possible seepage in fractures.	Low permeability when compacted; susceptible to seepage in fractured rock; sandstone at a depth of 20 to 40 inches.	Features generally favorable; well drained.	Moderate available water capacity; moderate intake; moderate permeability; sandstone at a depth of 20 to 40 inches.	Sandstone at a depth of 20 to 40 inches; erodibility.

TABLE 7.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—						
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with or without basements	Local roads and streets	Sanitary landfills ¹	
						Area type	Trench type
Saline-Alkali land: Sa. Too variable to be rated. Severe limitations for most uses because of strong alkalinity.							
Samsil: SbF, ShG ----- Properties of Shale outcrop part of ShG are too variable to be rated.	Severe: clayey shale at a depth of 10 to 20 inches; slow permeability.	Severe: clayey shale at a depth of 10 to 20 inches.	Severe: shale at a depth of 10 to 20 inches; slopes greater than 15 percent in places; silty clay.	Severe: clayey; shale at a depth of 10 to 20 inches; high shrink-swell potential.	Severe: high shrink-swell potential; slopes of 50 percent; shale at a depth of 10 to 20 inches.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent.	Severe: shale at a depth of 10 to 20 inches.
Sandy alluvial land: Sn. Too variable to be rated. Severe limitations for most uses because of susceptibility to flooding.							
*Sarben: SrC, SrD, SrF, SvF --- For properties of Vetal part of SvF, see Vetal series.	Slight where slopes are 0 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent.	Severe: moderately rapid permeability.	Slight where slopes are 0 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent: subject to caving.	Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent: subject to frost action.	Slight where slopes are 0 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent: subject to frost action and water erosion.	Severe: moderately rapid permeability; slope.	Severe: moderately rapid permeability; slope.
Schamber: SyF -----	Slight where slopes are 0 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent.	Severe: rapid permeability; slopes greater than 7 percent in most places.	Severe: loose, very gravelly material; subject to caving.	Slight where slopes are 0 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent: subject to caving.	Slight where slopes are 0 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent.	Severe: very rapid permeability.	Severe: very rapid permeability.

properties of the soils—Continued

Suitability as source of—				Soil features affecting—				
Daily cover for landfill	Roadfill	Sand	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Poor: clayey.	Poor: shale at a depth of 10 to 20 inches; high shrink-swell potential.	Unsuited ---	Poor: limited amount; poor workability; clay shale outcrops in many places.	Shale at a depth of 10 to 20 inches; possible seepage in fractures.	Shale at a depth of 10 to 20 inches; low susceptibility to seepage; low permeability when compacted.	Features generally favorable; well drained.	Not suited --	Shale at a depth of 10 to 20 inches; clayey; difficult to work; generally unsuited.
Good -----	Fair: subject to frost action; slopes greater than 15 percent in places.	Poor: too many fines; poor gradation.	Fair: subject to soil blowing; low organic-matter content.	Moderately rapid permeability; moderate to high seepage potential.	Medium to low permeability when compacted; susceptible to seepage.	Features generally favorable; well drained.	Moderate available water capacity; moderately high intake; moderately rapid permeability; erodibility of slopes; not suited where slopes are greater than 9 percent.	Erodibility of slopes.
Poor: too gravelly.	Good where slopes are less than 15 percent. Fair where slopes are greater than 15 percent.	Good: needs screening to remove fines in places; check availability of larger particle sizes.	Poor: too gravelly; thin surface layer.	Very rapid permeability; high seepage potential; gravelly.	High permeability when compacted; high susceptibility to seepage.	Features generally favorable; somewhat excessively drained.	Not suited --	Very rapid permeability; sand and gravel at a depth of 1 foot to 1.5 feet; generally unsuited.

TABLE 7.—Interpretations of engineering

Soil series and map symbols	Degree and kind of limitation for—						
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with or without basements	Local roads and streets	Sanitary landfills ¹	
						Area type	Trench type
<p>*Shale outcrop. Too variable to be rated. Severe limitation for most uses because bedrock is at a very shallow depth. Mapped only in complexes with Penrose and Samsil soils.</p> <p>*Slickspots. Too variable to be rated. Severe limitation for most uses because of very strongly alkaline reaction. Mapped only in complexes with Bufton, Kyle, and Pierre soils.</p>							
Tassel: TaF -----	Severe: sandstone at a depth of 10 to 20 inches.	Severe: sandstone at a depth of 10 to 20 inches.	Severe: sandstone at a depth of 10 to 20 inches; slopes greater than 15 percent in places.	Severe: sandstone at a depth of 10 to 20 inches; slopes as much as 30 percent.	Severe: sandstone at a depth of 10 to 20 inches; subject to wind blowing and water erosion.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent.	Severe: sandstone at a depth of 10 to 20 inches; slopes greater than 15 percent in most places.
Tripp: Tr, TrB, Ts -----	Slight -----	Moderate: moderate permeability.	Slight -----	Moderate for units Tr, TrB: subject to frost action. Severe for unit Ts: high alkalinity.	Moderate: moderate frost action potential.	Slight -----	Slight -----
Ulysses: UsF -----	Slight where slopes are 0 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent.	Moderate where slopes are 0 to 7 percent: moderate permeability. Severe where slopes are greater than 7 percent.	Slight where slopes are 0 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are greater than 15 percent.	Moderate where slopes are 0 to 15 percent: subject to frost action. Severe where slopes are greater than 15 percent.	Moderate where slopes are 0 to 8 percent: subject to frost action. Severe where slopes are greater than 15 percent.	Moderate: slope.	Slight -----

properties of the soils—Continued

Suitability as source of—				Soil features affecting—				
Daily cover for landfill	Roadfill	Sand	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Poor: lacks thickness.	Fair to poor: sandstone at a depth of 10 to 20 inches.	Unsuited ---	Poor: thin surface layer; rock outcrops in many places.	Sandstone at a depth of 10 to 20 inches; possible seepage in fractures; moderately rapid permeability.	Medium to low permeability when compacted; medium susceptibility to seepage; sandstone at a depth of 10 to 20 inches; limited amount of borrow soil available.	Features generally favorable; well drained.	Not suited --	Sandstone at a depth of 10 to 20 inches. Generally not needed.
Good -----	Fair: subject to frost action; needs compaction control.	Unsuited ---	Good: poor for unit Ts; high alkalinity.	Moderate permeability; moderate seepage potential.	Medium to low permeability when compacted; susceptible to seepage in foundation soil.	Features generally favorable; well drained.	High available water capacity; moderate permeability; moderate intake.	(⁹).
Good to fair: slope.	Fair: subject to frost action; soil blowing, and water erosion.	Unsuited ---	Fair: moderately thick surface layer.	Moderate permeability; moderate seepage potential.	Low permeability when compacted; susceptible to seepage in foundation soil.	Features generally favorable; well drained.	High available water capacity; moderate permeability; moderate intake; erodibility of slopes; not suited where slopes are greater than 9 percent.	Erodibility of slopes.

TABLE 7.—Interpretations of engineering

Soil series and map symbols	Degree and kind of limitation for—						
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with or without basements	Local roads and streets	Sanitary landfills ¹	
						Area type	Trench type
*Valent: VaB, VaF ----- For properties of Dwyer part of VaB and VaF, see Dwyer series.	Slight where slopes are 0 to 8 percent. Moderate where slopes are greater than 8 percent. ^a	Severe: rapid permeability.	Severe: fine sand; poor sidewall stability.	Slight where slopes are 0 to 8 percent. Moderate where slopes are greater than 8 percent: subject to caving.	Slight where slopes are 0 to 8 percent. Moderate where slopes are greater than 8 percent: subject to soil blowing and water erosion.	Severe: rapid permeability.	Severe: rapid permeability.
*Vetal: VeC ----- For properties of Bayard part of VeC, see Bayard series.	Slight where slopes are 0 to 8 percent. Moderate where slopes are greater than 8 percent.	Severe: moderately rapid permeability; slopes greater than 7 percent.	Severe: subject to caving.	Slight where slopes are 0 to 8 percent. Moderate where slopes are greater than 8 percent: subject to caving for footing and basement excavation.	Slight where slopes are 0 to 8 percent. Moderate where slopes are greater than 8 percent.	Severe: moderately rapid permeability.	Severe: moderately rapid permeability.
Wet alluvial land: Wx. Too variable to be rated. Severe limitations for most uses because of susceptibility to frequent flooding.							

¹ Onsite deep studies of the underlying strata, water table, and hazard of aquifer pollution and drainage into groundwater need to be made for landfills deeper than 5 or 6 feet.

the workability and quantity of cut and fill material available. AASHTO and Unified classifications of the soil material, and also the shrink-swell potential, indicate traffic-supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect ease of excavation and amount of cut and fill needed to reach an even grade.

Sanitary landfill is a method of disposing of refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The most suitable soils have moderately slow permeability, can withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated the ratings in table

7 apply only to a depth of about 6 feet, and therefore ratings of *slight* or *moderate* may not be valid if trenches are to be much deeper than that. For some soils, reliable predictions can be made to a depth of 10 to 15 feet, but regardless of that, every site should be investigated before a selection is made.

Roadfill is soil material used in embankments for roads. The suitability ratings reflect (1) the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage, and (2) the relative ease of excavating the material at borrow areas.

Sand is used in great quantities in many kinds of construction. The ratings in table 7 provide guidance on probable sources of sand. A soil rated a *good* or *fair* source of sand generally has a layer at least 3 feet thick, the top of which is within a depth of 6 feet. The ratings do not take into account thickness of over-

properties of the soils—Continued

Suitability as source of—				Soil features affecting—				
Daily cover for landfill	Roadfill	Sand	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Poor: subject to soil blowing and water erosion.	Good: easily compacted; subject to soil blowing and water erosion.	Poor: limited uses because of poor gradation.	Poor: thin surface layer; subject to soil blowing; coarse; low fertility.	Rapid permeability; high seepage potential.	Medium to high permeability when compacted; subject to soil blowing and water erosion; easily compacted.	Features generally favorable; excessively drained.	Low available water capacity; very high intake; rapid permeability; subject to soil blowing.	High erodibility; unstable on steeper slopes. Generally not needed.
Good -----	Fair: subject to frost action, soil blowing and water erosion.	Poor: too many fines; poor gradation.	Fair: coarse; subject to soil blowing.	Moderately rapid permeability; moderate to high seepage potential.	Medium to low permeability when compacted; susceptible to seepage; fair compaction characteristics.	Features generally favorable; well drained.	Moderate available water capacity; moderately rapid permeability; moderately high intake; not suited where slopes are greater than 9 percent.	Subject to soil blowing and water erosion.

² In places pollution to ground water is a hazard because permeability is moderately rapid or rapid.

³ Terraces generally not needed. The soils are nearly level or very gently sloping.

burden, depth to the water table, or other factors that affect mining of the material, and they do not indicate quality of the deposit.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as for preparing a seedbed; natural fertility of the soil, or the response of plants when fertilizer is applied; and absence of substances toxic to plants. Texture of the soil material and its content of stone fragments affect suitability. Also considered in the ratings is damage that will result at the area from which topsoil is taken.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to permeability and depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material resistant to seepage and piping and of favorable stability, shrink-swell potential, shear strength, and compactibility. Presence of stones or organic material in a soil are among the unfavorable factors.

Drainage of cropland and pasture is affected by such soil properties as permeability, texture, and structure; depth of claypan, rock, or other layers that influence rate of water movement; depth to the water table; slope; stability in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage.

Irrigation of a soil is affected by such features as slope; susceptibility to stream overflow, water erosion, or soil blowing; soil texture; content of stones; accumulations of salts and alkali; depth of root zone; rate of water intake at the surface; permeability of soil layers below the surface layer or layers that re-

TABLE 8.—Engineering

[Tests performed by the Nebraska Department of Roads in accordance with standard procedures

Soil name and location	Parent material	Report No S72-	Depth	Specific gravity	Mechanical analysis ¹		
					Percentage passing sieve—		
					¾-inch	⅜-inch	No. 4 (4.7 mm)
Alliance silt loam: 1,584 feet north and 100 feet west of the SE corner of sec. 26, T. 30 N., R. 51 W. (Modal profile)	Loess over weathered sandstone.	92	0-8	2.62			
		93	15-20	2.67			
		94	26-60	2.69	100	99	98
Bridget silt loam: 1,584 feet north and 50 feet east of the SW corner of sec. 5, T. 31 N., R. 50 W. (Modal profile)	Silty colluvium.	90	0-6	2.59			
		91	18-60	2.65	100	98	98
Bufton silty clay loam: 792 feet north of the SE corner of sec. 30, T. 32 N., R. 51 W. (Modal profile)	Colluvium from shale.	84	0-7	2.60			
		85	7-18	2.69			
		86	25-60	2.68			
Jayem loamy very fine sand: 1,320 feet north and 150 feet east of the SW corner of sec. 21, T. 32 N., R. 52 W. (Modal profile)	Eolian sandy and loamy material.	81	8-13	2.61			
		82	13-25	2.63			
		83	36-60	2.61			
Kadoka silt loam, variant: 2,904 feet north and 50 feet east of the SW corner of sec. 20, T. 33 N., R. 47 W. (Modal profile)	Weathered siltstone.	73	6-9	2.60			
		74	9-17	2.66			
		75	21-60	2.63			
Keith silt loam: 1,584 feet west and 100 feet north of the SE corner of sec. 32, T. 32 N., R. 50 W. (Modal profile)	Peoria loess.	70	0-6	2.60			
		71	9-17	2.70			
		72	24-60	2.68			
Kyle silty clay: 1,320 feet north and 500 feet east of the SW corner of sec. 34, T. 33 N., R. 51 W. (Modal profile)	Weathered clayey shale.	64	0-3	2.65			
		65	3-15	2.72			
		66	30-45	2.73			
Mitchell silt loam: 528 feet north and 150 feet west of the SE corner of sec. 17, T. 33 N., R. 47 W. (Modal profile)	Weathered siltstone.	76	0-6	2.60			
		77	16-60	2.62			
Oglala loam: 264 feet north and 200 feet east of the SW corner of sec. 35, T. 31 N., R. 50 W. (Modal profile)	Weathered fine-grained sandstone.	87	0-14	2.60			
		88	14-24	2.58			
		89	24-60	2.58	100	99	99
Richfield silt loam: 792 feet west and 1,056 feet south of the NE corner of sec. 7, T. 32 N., R. 50 W. (Modal profile)	Peoria loess.	67	0-8	2.66			
		68	8-13	2.69			
		69	19-60	2.74			
Ulysses silt loam: 1,320 feet east and 500 feet south of the NW corner of sec. 11, T. 31 N., R. 50 W. (Modal profile)	Peoria loess.	78	0-5	2.67			
		79	8-16	2.69			
		80	16-60	2.68			
Valent loamy fine sand: 2,112 feet north and 50 feet east of the SW corner of sec. 18, T. 29 N., R. 40 W. (Modal profile)	Eolian sands.	95	0-4	2.61			
		96	14-60	2.66			

test data

of the American Association of State Highway and Transportation Officials (AASHTO)]

Mechanical analysis—Continued ¹								Liquid limit	Plasticity index	Classification	
Percentage passing sieve—Continued				Percentage smaller than—						AASHTO ²	Unified ³
No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 60 (0.25 mm)	No. 200 (0.074 mm)	0.05 mm	0.02 mm	0.005 mm	0.002 mm				
	100	99	78	64	34	24	18	29	7	A-4(8)	CL-ML
	100	99	85	65	48	37	32	47	23	A-7-6(15)	CL
96	91	87	62	43	25	14	12	NP ⁴	NP	A-4(5)	ML
	100	99	80	56	35	20	16	34	7	A-4(8)	ML
98	97	95	78	63	32	14	12	30	3	A-4(8)	ML
	100	99	87	78	56	40	30	48	19	A-7-6(13)	ML
	100	99	93	90	78	64	52	75	41	A-7-5(27)	CH
	100	99	84	76	64	48	39	52	25	A-7-6(16)	CH
	100	99	52	37	17	12	11	NP	NP	A-4(3)	ML
	100	99	54	31	15	11	9	NP	NP	A-4(4)	ML
	100	99	49	31	13	8	7	NP	NP	A-4(3)	SM
	100	100	89	70	40	24	18	33	7	A-4(8)	ML
100	99	98	93	86	60	36	26	46	18	A-7-6(12)	ML
	100	99	94	87	52	28	24	36	9	A-4(8)	ML
	100	99	76	56	32	20	15	27	3	A-4(8)	ML
		100	90	80	51	36	28	44	22	A-7-6(14)	CL
		100	88	76	41	24	17	33	9	A-4(8)	ML
	100	97	88	86	79	58	44	58	30	A-7-6(20)	CH
100	99	99	96	94	86	72	56	64	40	A-7-6(25)	CH
	100	99	97	96	93	76	64	69	45	A-7-6(28)	CH
	100	99	88	75	34	18	13	35	4	A-4(8)	ML
100	99	97	80	60	29	12	11	NP	NP	A-4(8)	ML
		100	85	60	34	20	17	34	7	A-4(8)	ML
		100	88	70	29	13	10	33	1	A-4(8)	ML
99	99	99	89	62	32	11	9	NP	NP	A-4(8)	ML
	100	98	70	53	38	26	22	30	11	A-6(7)	CL
	100	98	64	46	48	39	34	45	26	A-7-6(13)	CL
100	99	97	60	50	40	32	24	33	15	A-6(7)	CL
		100	66	48	28	22	18	28	5	A-4(6)	ML
		100	71	56	33	22	17	31	7	A-4(7)	ML
		100	78	58	34	20	16	30	7	A-4(8)	ML
	100	94	24	19	8	6	5	NP	NP	A-2-4(0)	SM
100	90	64	13	7	4	3	2	NP	NP	A-2-4(2)	SM

TABLE 8.—Engineering

Soil name and location	Parent material	Report No S72-	Depth	Specific gravity	Mechanical analysis ¹		
					Percentage passing sieve—		
					¾ -inch	⅜ -inch	No. 4 (4.7 mm)
Vetal loamy very fine sand: 1,320 feet south and 100 feet east of the NW corner of sec. 31, T. 31 N., R. 52 W. (Modal profile)	Sandy and loamy colluvium.	97 98	0-15 26-54	2.62 2.60	-----	-----	-----
					-----	-----	-----

¹ Mechanical analyses according to AASHTO Designation T 88-47 (1). Results by this procedure may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soil.

strict movement of water; available water capacity; and need for drainage or depth to water table or bedrock.⁹

Terraces and diversions are embankments or ridges constructed across slopes to intercept runoff so that it soaks into the soil or flows slowly to a prepared outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock or other unfavorable material; presence of stones; permeability; and resistance to water erosion, soil slipping, and soil blowing. A soil suited to these structures provides outlets for runoff and is not difficult to vegetate.

Soil test data

Table 8 contains engineering test data for some of the major soil series in Dawes County. These tests were made to help evaluate the soils for engineering purposes. The engineering classifications given are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods.

Specific gravity is the ratio of the unit weight of the soil solids to the unit weight of water. It is a means of expressing the heaviness of soil. The specific gravity of the solid particles of a soil, exclusive of the air spaces, is also called the "true" or "real" specific gravity. This property has an important influence on the density of the soil.

Tests to determine *liquid limit* and *plasticity index* measure the effect of water on the consistence of soil material. These terms are explained in the section "Estimated Soil Properties Significant to Engineering."

Formation and Classification of Soils

In this section the factors that have affected the

⁹ Further information on soil use for irrigation is contained in "Irrigation Guide for Nebraska," Soil Conservation Service, 1971.

formation of soils in Dawes County are discussed. In addition, the system of soil classification currently used is explained, and each soil series represented in the county is categorized within that system.

Factors of Soil Formation

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

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

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

Parent material

The soils of Dawes County formed in material weathered from the underlying geologic formations or in materials transported by wind and water. The oldest geologic exposures in Dawes County are the Greenhorn Limestone and Graneros Shale Formations. They

test data—Continued

Mechanical analysis—Continued ¹								Liquid limit	Plasticity index	Classification	
Percentage passing sieve—Continued				Percentage smaller than—						AASHTO ²	Unified ³
No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 60 (0.25 mm)	No. 200 (0.074 mm)	0.05 mm	0.02 mm	0.005 mm	0.002 mm				
-----	100	99	50	28	16	12	10	NP	NP	A-4(3)	SM
-----	100	99	38	20	10	7	2	NP	NP	A-4(1)	SM

¹ Based on AASHTO Designation M 145-49.

² Based on the Unified soil classification system (2).

³ Nonplastic.

outcrop only in a small area in the northeastern corner of the county.

The Carlile and Niobrara Formations are exposed in the northeastern part of the county and overlie the Greenhorn and Graneros Formations. The Carlile consists of fine-grained, grayish sandstone and grayish argillaceous shale. The Niobrara consists of gray to yellowish chalky shale and chalk. The materials weathered from these formations are calcareous and contain considerable amounts of soft gypsum and varying amounts of selenium. Minnequa and Penrose soils formed in materials weathered from the Carlile and Niobrara Formations.

The Pierre Formation, the most extensive shale formation in the county, overlies the Niobrara Formation. It is a black to olive-gray platy shale that contains layers of bentonite and indurated shaly chalk. This type of shale is exposed in the northern part of the county. It is of marine origin. It was covered by deposits and later exposed as a result of erosion. This marine-deposited sediment weathered to produce fine-textured soil materials. Kyle, Pierre, and Samsil soils formed in material weathered from shale. Kyle soil also formed in clayey alluvial sediment.

The Chadron Formation overlies the Pierre. It consists mostly of silty shales and claystone. The Chadron Formation is greenish to buff clay and silt and is channel sandstone locally at the base. Norrest and Orella soils formed in material weathered in place from the Chadron Formation. In some places this weathered material has been transported and deposited as colluvial and alluvial sediment on foot slopes and stream terraces. Bufton soils formed in this transported material and also in material weathered in place from the Chadron Formation. Salinity and alkalinity are moderate to strong in many areas where material weathered from the Chadron Formation.

The Brule Formation overlies the Chadron. The upper part is pinkish, massive silty clay that has thin layers of volcanic ash and sand. The lower part is pink sandy clay and channel sandstone. The Brule Formation is soft, massive material that weathers rapidly.

Epping, Kadoka variant, Keota, and Mitchell soils formed in material weathered in place from the Brule Formation. Mitchell soils also formed in material transported by water and gravity to foot slopes. Soils that formed in weathered from the Brule Formation are generally silty, but Kadoka variant soils formed in materials containing slightly more clay, and they have a subsoil of silty clay loam. The Chadron and Brule Formations are widely exposed on lower slopes north of the Pine Ridge area. Table 9 shows the particle-size distribution from representative samples of geologic materials in Dawes County.

Ridgetops and knolls in some parts of the Brule Formation are capped by cemented limy sandstone or gravelly material. Schamber soils formed in this material.

The uppermost exposure of consolidated bedrock in Dawes County is sandstone of Tertiary age. This sandstone ranges from gray or light brownish gray to pinkish gray. It is massive and has layers of compacted silt and clay. Hard sandstone ledges and pipy or potato-like concretions are common. Alliance, Busher, Canyon, Oglala, Tassel, and Rosebud soils formed in material weathered from sandstone. In places the sandstone is mixed with loess. Bayard, Bridget, and Vetal

TABLE 9.—Particle-size distribution of geologic materials from representative samples

[Tests performed by the Soil Survey Investigations Unit, Midwest Regional Technical Service Center, SCS, Lincoln, Nebraska]

Geological material	Sand	Silt	Clay
	Percent	Percent	Percent
Brule Siltstone -----	20.5	68.8	10.7
Chadron Shale -----	7.8	60.6	31.6
Pierre Shale -----	8.3	45.5	46.2
Niobrara Chalk -----	33.0	32.5	34.5

soils formed in colluvial and alluvial materials from sandstone. Soils that formed in material weathered from sandstone are extensive in the Pine Ridge area and extend southward through Dawes County.

Areas of wind-deposited silty material, or loess, are in many parts of the county. The loess forms a thin mantle, generally less than 6 feet thick. Most of the loess in Dawes County mantles sandstone or siltstone, but small deposits are in areas of shale. Keith, Richfield, and Ulysses soils formed in loess. In some areas, colluvial and alluvial materials of local origin have accumulated on stream terraces, foot slopes, and in upland swales. Duroc soils formed in such material.

Soils that formed in eolian sand are in widely separated areas of the county. The wind has worked the sandy materials into low hummocks and dunes. Dwyer and Valent soils formed in eolian sand. Eolian sand is mixed with silty material in some places. Jayem and Sarben soils formed in this material.

Recent alluvium is on stream terraces and bottom lands. It consists of sediment washed from uplands onto flood plains or deposited by water from flooding streams. Alluvium is clayey, loamy, or sandy, and the texture of soils derived from alluvium is closely related to the texture of the parent material. In Dawes County the oldest alluvium is on the higher stream terraces along the major streams and their tributaries. Buffington and Tripp soils formed in alluvium on stream terraces. Buffington soils formed in alluvium of silty clay loam and silty clay, and Tripp soils formed in alluvium of silt loam.

The most recent alluvium is along upland drainage-ways where fresh material is still being deposited after heavy rains. Soils that formed in young alluvium have weak profile development. Bankard, Bankard variant, Glenberg, Haverson, and Las Animas soils formed in this material. Haverson soils formed in alluvium of silt loam; Glenberg soils formed in alluvium of sandy loam; and Bankard soils formed in sandy alluvium. In some areas silty and sandy alluvium is underlain by a water table at a depth of 2 to 6 feet. Bankard variant and Las Animas soils formed in this material.

Climate

Climate influences vegetation, activity of soil micro-organisms, and the physical condition of soil. It directly affects weathering and soil formation through rainfall, changes in temperature, and the effects of wind. The climate of Dawes County is semiarid and continental. The average annual precipitation is 18.2 inches. Rainfall is fairly uniform throughout the county, but, because of variations in elevation, the Pine Ridge usually receives additional snow and rainfall. The county has wide seasonal variations in temperature. In summer the days are warm and the nights are cool. The mean annual temperature is 48° F., and the average growing season is about 135 days.

Because of the semiarid climate, soils are not deeply leached and most have a pH value of 7.0 or greater. Many young soils have free lime throughout the profile. Low humidity causes a considerable loss of water through evaporation and reduces the amount of water that percolates through the soil. Where dryfarmed, the soils are seldom wet below the depth of live roots. Surface flow caused by heavy rains detaches, mixes,

transports, and redeposits unconsolidated materials of all kinds. In Dawes County, the amount of clay that moved downward through the soils is not so great as it is in places where the rainfall is heavier.

Strong winds cause local changes in individual fields and farms. Winds have removed material from the surface in some places and have deposited material in other places.

Because of the relatively light rainfall, infrequent high temperatures, cool nights, and shallow frost penetration, the chemical and biological processes of soil formation proceed slowly. Organic matter decomposes slowly, and many of the soils are light colored.

Plant and animal life

When the weathering and deposition processes slow down, grasses and other plants take root. As soon as vegetation is established, many kinds of animals and organisms begin to make use of the food provided by the plants. The kinds of plants and animals that live on and in the soil are determined by such environmental factors as climate, parent material, relief, age of the soil, and the presence of associated organisms. Plants and animals are important in developing the chemical and physical characteristics of a soil.

The presence of grasses affects the color of the soils, their organic-matter content, and their physical and chemical properties. The fibrous root system of grasses tends to keep soils granular. In addition, grasses bring nutrients from the lower part of the soil and return them to the surface as organic matter. Grass roots and leaves decay to form humus, improving soil fertility, physical and chemical composition, and water-holding capacity.

Many kinds of micro-organisms are needed to transform organic material into humus from which plants can obtain nutrients. Earthworms and small, burrowing animals influence the formation of soils by mixing the organic and mineral parts of the soils. Their burrowing operations stir the soil and mix it with fresh nutrients, hastening the formation of organic matter.

The soils of Dawes County are typical of those that formed under grasses. Staining from the decay of organic matter over a long period has darkened the surface layer of many of the soils. Man also has altered the soils, mainly by farming practices.

Relief

Relief affects the formation of soils through its influence on runoff, drainage, and erosion. It influences the development of soils in relatively small areas, chiefly by controlling the movement of water on the surface. The degree of slope, the shape of the surface, and other features of relief affect the development of each soil.

Steeply sloping soils have a thinner surface layer and less development in the subsoil than more nearly level soils. Where slopes are steep, runoff is rapid, and only a small amount of water enters the soil. Plants grow slowly, and soil formation proceeds slowly. Unless a good plant cover is maintained, erosion can remove soil material as rapidly as it forms. The zone of carbonate accumulation is generally nearer the surface in steep soils. On the steeper slopes more materials move downward because of creep and erosion. Ridges

and hilltops are more exposed to air currents than lower areas and therefore are more susceptible to loss of moisture by evaporation.

Where the topography is low and flat, extra water is added to the soils. Runoff is slow, and low-lying areas receive runoff water from higher areas. The extra moisture is reflected in soils that have a thick, dark-colored surface layer and good horizon development. Such soils are leached of lime.

Soils on bottom lands and terraces have very little relief. The deposits have been in place a short period of time, and relief has had little effect. Some bottom-land soils have a high water table that affects decay of organic material, soil temperature, and alkalinity. Other bottom-land soils are subject to flooding and to continuous deposition of material.

Time

The formation of soil requires time; the length depends mainly on the kinds of parent material. For soils that form in residuum, rock weathering and the formation of soil horizons in the weathered parent material generally go on simultaneously. In transported, unconsolidated materials, such as loess, sand, and alluvium, soil formation can begin as soon as the materials are stabilized. A soil profile can form in some fresh materials within a few years; in other materials centuries must pass before distinct horizons form.

If the factors of soil formation have not been active long enough to form a soil that is in equilibrium with its environment, the soil is considered young or immature. Older soils have reached an equilibrium with their environment. If land use, irrigation, or other factors change the environment, the soils then establish a new equilibrium with the new environment.

The degree of development, or maturity, of a soil can be evaluated by soil characteristics. Characteristics commonly used to determine the maturity of soils are thickness and color of the surface layer, degree of structure in the subsoil, evidence of clay movement downward in the soil, and thickness of the solum.

The soils in Dawes County range from young soils that have little or no development to nearly mature soils that have well-developed horizons. Alliance, Keith, and Richfield soils have a well-developed subsoil and a thick surface layer. In these soils carbonates have been leached to the lower part of the subsoil. Genetically, they are among the oldest soils of the county and are near equilibrium with their environment. Haverson soils, alluvial soils on low bottom lands, are among the youngest soils in the county. They have little or no horizon development because of the short time their parent materials have been in place. In areas subject to flooding, deposition still occurs.

Classification of Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification, and then

through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories of classification, such as those used in detailed soil surveys, allow us to organize and apply knowledge about soils in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison over large areas such as countries and continents.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Because this system is under continual study, readers interested in current developments should search the latest literature available (5, 9).

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are also chosen, however, so that soils of similar genesis, or mode of origin, are grouped together. The same property or subdivisions of a property can be used in several different categories. In table 10, the soil series of Dawes County are placed in some categories of the current system. Categories are briefly defined in the following paragraphs.

ORDERS: Ten soil orders are recognized. The properties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. Three exceptions to this are the Entisols, Histosols, and Vertisols, which are found in many different climates. The name of each order is a word of three or four syllables ending in *sol* (Moll-i-sol).

SUBORDERS: Each order is divided into suborders using those soil characteristics that seem to produce classes that have the greatest genetic similarity. The suborders are more narrowly defined than the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of a water table at a shallow depth, soil climate, the accumulation of clay, iron, or organic carbon in the upper part of the solum, cracking of soils caused by a decrease in soil moisture and fine stratification. The names of suborders have two syllables. The last syllable indicates the order. An example is Aquoll (*Aqu*, meaning water or wetness, and *oll*, from Mollisol).

GREAT GROUPS: Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequence of soil horizons and features. The horizons used to make separations are those in which clay, carbonates, and other constituents have accumulated or have been removed; and those that have pans that interfere with growth of roots, movement of water, or both. Some features used are soil acidity, soil climate, soil composition, and soil color. The names of great groups have three or four syllables and are made by adding a prefix to the name of the suborder. An example is Haplaquoll (*Hapl*, meaning simple horizons, *qu* for wetness or water, and *oll*, for Mollisols).

SUBGROUPS: Great groups are divided into subgroups, one representing the central (typic) segment of the group, and others, called intergrades, that

TABLE 10.—*Classification of soil series*¹

Soil series	Family	Subgroup	Order
Alliance	Fine-silty, mixed, mesic	Aridic Argiustolls	Mollisols.
Bankard	Sandy, mixed, mesic	Ustic Torrifluvents	Entisols.
Bankard variant	Sandy, mixed, mesic	Aeric Fluvaquents	Entisols.
Bayard	Coarse-loamy, mixed, mesic	Torriorthentic Haplustolls	Mollisols.
Bridget	Coarse-silty, mixed, mesic	Torriorthentic Haplustolls	Mollisols.
Buffington	Fine, mixed, mesic	Torriorthentic Haplustolls	Mollisols.
Buften	Fine, mixed, mesic	Ustollic Camborthids	Aridisols.
Busher	Coarse-loamy, mixed, mesic	Torriorthentic Haplustolls	Mollisols.
Canyon	Loamy, mixed (calcareous), mesic, shallow	Ustic Torriorthents	Entisols.
Duroc	Fine-silty, mixed, mesic	Pachic Haplustolls	Mollisols.
Dwyer	Mixed, mesic	Ustic Torripsamments	Entisols.
Epping	Loamy, mixed (calcareous), mesic, shallow	Ustic Torriorthents	Entisols.
Glenberg	Coarse-loamy, mixed (calcareous), mesic	Ustic Torrifluvents	Entisols.
Haverson	Fine-loamy, mixed (calcareous), mesic	Ustic Torrifluvents	Entisols.
Jayem	Coarse-loamy, mixed, mesic	Aridic Haplustolls	Mollisols.
Kadoka variant	Fine-silty, mixed, mesic	Aridic Argiustolls	Mollisols.
Keith	Fine-silty, mixed, mesic	Aridic Argiustolls	Mollisols.
Keota	Coarse-silty, mixed (calcareous), mesic	Ustic Torriorthents	Entisols.
Kyle	Very-fine, montmorillonitic, mesic	Ustertic Camborthids	Aridisols.
Las Animas	Coarse-loamy, mixed (calcareous), mesic	Typic Fluvaquents	Entisols.
Minnequa	Fine-silty, mixed (calcareous), mesic	Ustic Torriorthents	Entisols.
Mitchell	Coarse-silty, mixed (calcareous), mesic	Ustic Torriorthents	Entisols.
Norrest	Fine, mixed, mesic	Ustollic Haplargids	Aridisols.
Oglala	Coarse-silty, mixed, mesic	Aridic Haplustolls	Mollisols.
Orella	Clayey, mixed (calcareous), mesic, shallow	Ustic Torriorthents	Entisols.
Penrose	Loamy, mixed (calcareous), mesic	Lithic Ustic Torriorthents	Entisols.
Pierre	Very-fine, montmorillonitic, mesic	Ustertic Camborthids	Aridisols.
Richfield	Fine, montmorillonitic, mesic	Aridic Argiustolls	Mollisols.
Rosebud ²	Fine-loamy, mixed, mesic	Aridic Argiustolls	Mollisols.
Samsil	Clayey, montmorillonitic (calcareous), mesic, shallow.	Ustic Torriorthents	Entisols.
Sarben	Coarse-loamy, mixed, nonacid, mesic	Ustic Torriorthents	Entisols.
Schamber	Sandy-skeletal, mixed, mesic	Ustic Torriorthents	Entisols.
Tassel	Loamy, mixed (calcareous), mesic, shallow	Ustic Torriorthents	Entisols.
Tripp	Coarse-silty, mixed, mesic	Aridic Haplustolls	Mollisols.
Ulysses	Fine-silty, mixed, mesic	Aridic Haplustolls	Mollisols.
Valent	Mixed, mesic	Ustic Torripsamments	Entisols.
Vetal	Coarse-loamy, mixed, mesic	Pachic Haplustolls	Mollisols.

¹ This table is current as of August, 1974.

² In Dawes County, the Rosebud soils are taxadjuncts to the Rosebud series because the subsoil is more silty than defined in the range for the series.

have properties of the group and also one or more properties of another great group, suborder, or order. Other subgroups can have soil properties unlike those of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is Typic Haplaquolls (a typical Haplaquoll).

FAMILIES: Soil families are separated within a subgroup primarily on the basis of properties important to the growth of plants or to the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, soil depth, and consistence. A family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names for texture, mineralogy, and so on, that are used as family differentiae (see table 10). An example is the coarse-loamy, mixed, mesic family of Pachic Haplustolls.

Physical and Chemical Analysis

Representative profiles of selected soils are sampled

from time to time. The soils are analyzed in a laboratory to determine their physical and chemical properties.

Soils of the Canyon, Keith, Keota, Mitchell, Rosebud, Tripp, Ulysses, and Valentine series were sampled in nearby counties, and the data are published in Soil Survey Investigations Report No. 5 (10). Data for soils of the Bayard, Buffington, Mitchell, Tripp, and Valentine series are published in the Soil Survey of Scottsbluff County, Nebraska (11). Data for soils of the Epping, Kadoka, Keith, Kyle, Pierre, and Rosebud series are published in the Soil Survey of Shannon County, South Dakota (12).

These data are useful to soil scientists in classifying soils and in developing concepts of soil genesis. They are also helpful in estimating available water capacity, hazard of soil blowing, fertility, tilth, and other practical aspects of soil management.

Environmental Factors Affecting Soil Use

This section gives information on climate, physio-

TABLE 11.—*Temperature and precipitation data*
 [All data from Fort Robinson, except snow depth, which is from Chadron]

Month	Temperature				Precipitation				
	Average daily maximum ¹	Average daily minimum ¹	Two years in 10 will have at least 4 days with—		Average monthly total	One year in 10 will have—		Days with 1 inch or more snow cover ¹	Average depth of snow on days with snow cover ¹
			Maximum temperature equal to or higher than— ²	Minimum temperature equal to or lower than— ²		Equal to or less than— ³	Equal to or more than— ³		
°F	°F	°F	°F	Inches	Inches	Inches	Number	Inches	
January -----	38	10	55	-15	0.4	0.1	1.3	14	5
February -----	42	14	59	-8	.5	.1	1.2	12	5
March -----	46	20	67	-2	.9	.2	1.9	10	3
April -----	59	31	76	16	1.9	.5	4.1	3	3
May -----	68	41	84	29	3.8	.7	5.0	(⁴)	4
June -----	78	50	94	38	3.7	.9	5.2	-----	-----
July -----	88	57	97	47	2.2	.5	4.0	-----	-----
August -----	88	55	97	45	1.4	.5	2.9	-----	-----
September -----	77	44	92	32	1.4	.2	2.9	(⁴)	4
October -----	66	34	82	19	1.0	.1	2.4	1	3
November -----	50	21	66	2	.6	.1	1.1	6	3
December -----	41	14	57	-9	.4	.1	1.1	13	4
Year -----	62	33	⁵ 101	⁶ -22	18.2	11.9	23.4	59	4

¹ Based on period 1942-71.

² Data, interpolated from surrounding stations, based on period 1914-63.

³ Based on period 1883-1971.

⁴ Less than 0.5 day.

⁵ Average annual highest temperature.

⁶ Average annual lowest temperature.

graphy, drainage, relief, water supply, transportation, markets, and farming in Dawes County.

Climate¹⁰

Dawes County is in the north-central part of the Panhandle of Nebraska. It is in the interior of the large landmass of North America and is far from large bodies of water. The climate is characterized by warm summers, cold winters, light precipitation, and frequent changes of weather.

The varied terrain of Dawes County has a complex influence on the weather. Summer temperatures are moderate by higher elevations, especially at night when the dry air cools rapidly. The Black Hills to the north in South Dakota, and the Rocky Mountains to the west in Colorado and Wyoming, act as climatic barriers in those directions. Moisture entering Nebraska from the south is often shunted to the east before reaching the Panhandle; therefore this area receives less rainfall than the rest of the State.

A small acreage is irrigated, but most of the limited farming—about one-fourth of the county's total acreage is cropland—relies on natural climatic conditions. The average annual precipitation is 18.2 inches. About 80 percent of the annual precipitation falls from April through September (table 11). Late spring and summer thunderstorms are severe at times, and they are

sometimes accompanied by local downpours, hail, and damaging winds. Severe storms are local and are usually brief. Hail produces damage in a variable and spotted pattern, but at times there is a total crop loss in the center of very intense storms. Tornadoes are rare.

Precipitation is generally light in winter and commonly falls as light snow. Falling temperatures often accompany the snow, and strong winds pile the snow into drifts. The cold spell following a snowfall usually lasts a few days before warm air moves in, bringing rapidly moderating temperatures. Occasionally, there is a heavy snow and persistently cold weather. January, 1949 was one of the coldest and snowiest months of record in the county. Nearly 5 feet of snow fell at Chadron, and the mean temperature for the entire month was 7.3° F.

The average date of the last freezing air temperature in spring at Chadron Airport is May 10; at Fort Robinson, May 19. The average date of the first freezing air temperature at Chadron Airport is September 29; at Fort Robinson, September 24. Average temperatures do not vary greatly with variations in terrain, but the dates when specified temperatures are reached can differ markedly over short distances. Whenever the freeze data are used, dates should be adjusted to fit the exposure in question. Less exposed areas have the last spring freeze earlier and the first fall freeze later. Table 12 gives probable dates of the last freezing temperatures in spring and the first in fall.

¹⁰ Supplied by Climatology Office, Conservation and Survey Division, University of Nebraska.

TABLE 12.—Probabilities of last freezing temperatures in spring and first in fall¹

[All data from Chadron]

Probability	Dates for given probability and temperatures				
	16° F or lower	20° F or lower	24° F or lower	28° F or lower	32° F or lower
Spring:					
1 year in 10 later than -----	April 19	April 28	May 4	May 15	May 26
2 years in 10 later than -----	April 13	April 22	April 28	May 9	May 21
5 years in 10 later than -----	April 3	April 12	April 18	April 28	May 10
Fall:					
1 year in 10 earlier than -----	October 19	October 10	October 3	September 21	September 14
2 years in 10 earlier than -----	October 25	October 16	October 8	September 26	September 19
5 years in 10 earlier than -----	November 5	October 25	October 18	October 6	September 29

¹ All freeze data are based on temperatures that are measured in a standard U.S. National Weather Service thermometer shelter; the thermometers are placed approximately 5 feet above the ground; the exposure is believed to be representative of that of the Chadron airport.

Since the keeping of records, in 1889 at Fort Robinson, temperature extremes of 110° on July 25, 1952, and -37° on February 19, 1899, have been recorded. Temperatures reach 90° or more on an average of 44 days per year at Chadron, but because these temperatures are generally accompanied by low humidity, undue heat stress to livestock is avoided.

Annual free-water evaporation from small lakes and farms ponds averages 44 inches, about 76 percent of which occurs from May through October.

Physiography, Drainage, and Relief

Dawes County is mainly in the mixed sandy and silty tableland area, but the northern part is in the Pierre Shale Plains and badlands areas of the Great Plains physiographic province. Geologically, it is a moderately eroded to deeply eroded area.

The White River flows northeastward through Dawes County. This river and its many tributaries drain the northern part of the county. Topographically, this is one of the roughest basins in the State. The most dependable source of water is from the spring-fed tributaries that originate in the Pine Ridge in the southern and eastern part of the drainage area. In their upper reaches in the Pine Ridge, most of these streams are well entrenched, forming an area of rough lands. Tributaries from the north and west cross a gently sloping area marked by clay hills and some badlands. The streams that drain the badlands area are generally dry except when carrying direct runoff from precipitation. These streams form narrow bottom lands that have well-defined terraces. Runoff is usually rapid because of the steep slopes and the slowly permeable soils. As a result, the entire drainage area has cut deeply into the surrounding land and formed narrow valleys.

The tributaries that flow to the south and east into the White River are the Little Cottonwood, Soldiers, Sand, Big Cottonwood, Lone Tree, Messenger, Willow, Rush, Bohemian, Maiden, and Alkali Creeks.

The tributaries that flow to the north into the White River and drain the Pine Ridge area are the Dead

Mans, White Clay, Squaw, Hooker, West Ash, East Ash, Indian, Trunk Butte, Dead Horse, Chadron, Bordeaux, Little Bordeaux, and Beaver Creeks.

The Niobrara River flows eastward along the southern border of Dawes County. It drains the flat tablelands, bordered on the north by the Pine Ridge and the Sandhills area, which extend into the county from the west. Streamflow in the Niobrara River is variable. The Box Butte Reservoir on the Niobrara River controls runoff from the drainage area. The three major tributaries along the Niobrara are the Cottonwood, Pebble, and Pepper Creeks. These three tributaries drain to the south into the Niobrara River. Sand Canyon Creek drains to the north into the Niobrara River.

In most of the county, elevations range from 3,400 to 4,500 feet above sea level. The highest point in the county is about 4,600 feet. The White River enters the county at an elevation of about 3,800 feet and leaves at an elevation of about 3,100 feet. The difference in elevation between the White River and the top of the Pine Ridge ranges from 1,000 to 1,200 feet. The elevation at Crawford is 3,678 feet; Chadron, 3,312 feet; and Whitney, 3,409 feet.

Water Supply

Ground water in the part of the county north of the Pine Ridge escarpment comes mainly from bedded siltstone and clay shales. The siltstone produces mostly low-yield wells of moderate-quality water. The clay shales yield only poor-quality water, generally in small amounts. The water from these shales is high in sodium, sulphates, and other salts. The area north of the White River is historically short of water. Much of the water is unfit for drinking. In recent years, rural water companies have been formed to bring water by pipelines, from deep wells in the Pine Ridge, for livestock and domestic use. These deep wells yield about 15 to 30 gallons per minute of good-quality water. In places a limited supply of water is available from alluvium in valleys in the area. Larger amounts of ground water can be obtained by drilling to the deep-

lying Dakota Sandstone, but the water is generally higher mineralized.

Southward from the Pine Ridge escarpment, geologic materials consist of several hundred feet of sandstone. The ground water supply in this area is quite variable and usually not predictable. In the Niobrara River valley, wells can be developed that yield more than 1,000 gallons per minute. Over the rest of the drainage area, medium- to low-yield wells of less than 1,000 gallons per minute can be drilled, but lifts generally exceed 200 feet and pumping costs increase. It is generally easier to locate low-yield wells for livestock and domestic use than suitable wells for irrigation, which requires higher yields.

Surface flow is variable in the Niobrara River and the White River. Small spring-fed creeks that originate in the Pine Ridge area flow during most years. These rivers and creeks provide a source or irrigation water for small individual tracts of land. Surface water for irrigation is stored in Whitney Reservoir, an offstream impoundment that stores water diverted from the White River. Irrigation water is also stored in the Box Butte Reservoir on the Niobrara River. These reservoirs also serve as recreation areas.

Crawford is entirely dependent on surface water for its needs. The water supply of Crawford is from the White River and Dead Mans Creek. The water supply of Chadron is from deep wells located south of the city. Whitney also obtains its water supply from deep wells.

Future irrigation development in most areas of Dawes County appears to be limited by the small supply of available water. Small livestock dams on drainageways throughout the county supply water for livestock and a small quantity of water for irrigation systems. Many of these small dams are suitable as recreation areas.

Transportation and Markets

U.S. Highways 20 and 385 provide transportation routes east-west and north-south, respectively, out of Chadron. State Highway 2 extends north-south across the western part of the county near Crawford. Graveled or improved roads, graded dirt roads, and trails serve the rest of the county. Rural mail routes reach all parts of the county.

The Burlington Northern and Chicago and North Western Railroads provide ample rail service. Chadron and the surrounding communities are served by major trucking companies. Bus service is available at Chadron. A commercial airline operates regular daily flights from the Chadron Municipal Airport.

Weekly livestock auctions are held at Chadron and at Crawford. Grain and feed products that are not used or stored on farms are marketed at local elevators at Chadron, Crawford, and Whitney and then transported by rail or truck to larger markets. Some grain is sold at Hemingford in adjacent Box Butte County. Alfalfa seed is also sold locally.

Wood-processing mills are located in Chadron and Crawford. Timber cut locally is marketed at these mills. Wood products that are not sold locally are shipped to other parts of the county.

Farming

The raising of livestock and dryland farming are the main kinds of farming in Dawes County. According to the 1969 Census of Agriculture, there were 535 farm or ranch-operating units in the county, and the average size was about 1,715 acres.

Most of the operating units are ranches for raising livestock, mainly cow and calf herds. Nearly all of the ranches have a small acreage used for growing alfalfa for winter livestock feed. Ranches range from 1,000 to 30,000 acres in size.

Farms in Dawes County are mostly combination cash grain and livestock types. Dryfarmed winter wheat, sold as a cash crop, is the main crop. Alfalfa and oats are the other major crops and are used mostly for feed. Cattle, sheep, and hogs are raised. Farms range from 160 to 2,000 acres in size.

Raising cattle and selling the calves in fall as feeders is the largest industry in the county. Large numbers of sheep and lambs are also raised, and most of the lambs are sold in fall as feeders. A few ranches produce purebred cattle and sheep that are sold as breeding stock. Many ranchers keep saddle horses for working cattle. Hogs are raised on some of the farms and are fattened in feedlots or sold as feeder pigs. Some farmers keep a small flock of chickens and a few milk cows. Livestock in the county, reported in the 1969 Census of Agriculture, consisted of 61,543 cattle and calves; 15,645 sheep and lambs; 6,964 hogs and pigs; 1,098 horses and ponies; and 12,673 chickens.

Crops are harvested from about half of the total cropland in the county. The rest of the cropland is in cultivated summer fallow, is used for pasture, or is idle. Nearly all of the cropland is dryfarmed. Only about 13,000 acres of Dawes County is irrigated. Half of this acreage is gravity irrigated from canals and ditches in the Whitney Irrigation Project. A small acreage is gravity irrigated by water diverted from the Niobrara River and the White River. Several center pivot irrigation systems are in the southern part of the county.

Winter wheat, grown to sell, is the main dryfarmed crop. Spring oats is an important feed grain crop. All the winter wheat and a large acreage of the oats are planted on soils left fallow the preceding year. Nearly 60,000 acres is summer fallowed in the county each year. Alfalfa is grown on ranches and farms throughout the county. Only about 5,000 acres of alfalfa is irrigated. Seed is harvested from a small acreage of alfalfa each year. Nearly all the alfalfa is baled or stacked as loose hay and is hauled and fed to livestock during the winter. Native grass meadows are also cut for hay for winter feed.

Barley and corn are minor crops in the county. Barley is grown as feed. Corn is grown for silage and for winter livestock feed. In 1969, according to the Census, winter wheat was harvested from 31,347 acres; hay was cut from 50,042 acres; oats and other small grain were harvested from 14,168 acres; and corn was harvested from 2,010 acres.

The trend in Dawes County is toward fewer and larger farms and ranches. During the past 10 years there has been a slight increase in the acreage of irrigated land and a decrease in the acreage of summer

fallow. The acreage of cultivated crops in the county fluctuates from year to year, but only that for oats and barley has significantly decreased. The number of cattle and hogs has increased, and the number of sheep has decreased.

Additional information about crop and livestock raising in Dawes County can be obtained from the annual reports of Nebraska Agricultural Statistics.

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Glossary

Alkali soil. Generally, a highly alkaline soil. Specifically an alkali soil has 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 the growth of most crop plants is low from this cause.

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

Available water capacity. The capacity to store water for use by plants, usually expressed in linear depth of water per unit depth of soil. Commonly defined as the difference between the amount of soil water at field capacity and the amount at the wilting point of most plants. In this report, the classes of available water capacity for a 60-inch profile, or to a limiting layer, are—

0 to 3 inches	-----	very low
3 to 6 inches	-----	low
6 to 9 inches	-----	moderate
more than 9 inches	-----	high

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

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

Clayey soils. A broad term for soils that includes sandy clay, silt clay, and clay textures.

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

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

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

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

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

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

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

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

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

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 wind (sandblast), running water, and other geological agents.

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

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the oven-dry weight, after the gravitational, or free, water has been allowed to drain away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity*, *normal moisture capacity*, or *capillary capacity*.

Glass shards. Fragments of rock material having characteristically curved surfaces; formed by volcanic explosion or aerial explosion from a volcanic vent.

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

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

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

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

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Loamy soils. A broad term that includes all sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, and silty clay loam soils.

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

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

Excessively drained soils are commonly very porous and rapidly permeable and have a low available water capacity.

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

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

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

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

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

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

Organic matter (soil). The organic fraction of the soil. Includes plant and animal residues at various stages of decomposition, cells and tissues of soil organisms and substances synthesized by the soil population. Commonly determined as those organic materials which accompany the soil when put through a 2 millimeter sieve. In this report, organic matter was rated as follows:

Less than 0.5 percent	-----	very low
0.5 to 1.0 percent	-----	low
1.0 to 2.0 percent	-----	moderately low
2.0 to 4.0 percent	-----	moderate

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

Permeability (soil). The quality of a soil that enables water or air to move through it. In this report, permeability ratings given are for the part of the profile below the Ap horizon or equivalent depth and above either a depth of 60 inches or bedrock. If there is a change of two or more permeability classes within a short vertical distance, both classes and depth are stated. Classes of soil permeability are—

<i>In of water per hr</i>		
less than 0.06	-----	very slow
0.06 to 0.2	-----	slow
0.2 to 0.6	-----	moderately slow
0.6 to 2.0	-----	moderate
2.0 to 6.0	-----	moderately rapid
6.0 to 20.0	-----	rapid
more than 20.0	-----	very rapid

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

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

Saline soil. A soil that contains soluble salts in amounts that impair growth of plants but that does not contain excess exchangeable sodium.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral compo-

sition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Sandy soils. A broad term for soils of the sand and loamy sand classes; soil material with more than 70 percent sand and less than 15 percent clay.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Silty soils. A broad term that includes all silt loam, silt, and silty clay loam soils.

Slope. The degree of deviation of a surface from the horizontal usually expressed in percent or degrees. In this report, the following slope classes are recognized:

0 to 1 percent	-----	nearly level
1 to 3 percent	-----	very gently sloping
3 to 5 percent	-----	gently sloping
5 to 9 percent	-----	strongly sloping
9 to 11 percent	-----	moderately steep
11 to 30 percent	-----	steep
Over 30 percent	-----	very steep

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent materials, as conditioned by relief over periods of time.

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

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

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Surface layer. A term used in nontechnical soil descriptions for one or more layers above the subsoil; normally, the A horizon.

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

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

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."

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

Underlying material. A term used in nontechnical soil descriptions for the part of the soil below the solum.

Variant, soil. A soil having properties sufficiently different from those of other known soils to suggest establishing a new soil

series, but a soil of such limited known area that creation of a new series is not believed to be justified.

Water spreading. Diverting runoff from a gully or watercourse onto gently sloping, absorptive land to conserve waste water or increase plant growth, to reduce flood peaks, or to replenish ground-water supplies.

Water table. The highest part of the soil or underlying rock

material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

Wilting point (or permanent wilting point). The moisture content of soil, on an oven-dry basis, at which plants (specifically sunflower) wilt so much that they do not recover when placed in a dark, humid atmosphere.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. In referring to a capability unit, a range site, a woodland suitability, or a windbreak suitability group, read the introduction to the section it is in for general information about its management. Woodland suitability groups are described on pages 80 and 81; windbreak suitability groups are described on pages 83 and 84.

Map symbol	Mapping unit	Page	Capability unit		Irrigated		Range site	Page	Windbreak suitability group
			Dryland						
			Symbol	Page	Symbol	Page	Name		Number
AcB	Alliance silt loam, 1 to 3 percent slopes-----	14	IIE-1	56	IIE-4	65	Silty	76	4
AcD	Alliance silt loam, 3 to 9 percent slopes-----	16	IIIe-1	57	IIIe-4	67	Silty	76	4
AcD2	Alliance silt loam, 3 to 9 percent slopes, eroded-----	16	IIIe-1	57	IIIe-4	67	Silty	76	4
Ba	Badland-----	16	VIIIIs-8	64	-----	--	-----	--	10
Bc	Bankard loamy fine sand, 0 to 2 percent slopes-----	17	IVe-5	59	IVe-11	70	Sandy Lowland	75	3
Bd	Bankard loamy fine sand, wet variant, 0 to 2 percent slopes--	18	IVw-5	60	IVw-11	71	Subirrigated	74	2
Bf	Breaks-Alluvial land complex-----	19	VIe-7	61	-----	--	-----	--	10
	Breaks-----	--	-----	--	-----	--	Thin Loess	78	--
	Alluvial land-----	--	-----	--	-----	--	Silty Overflow	75	--
Bg	Bridget silt loam, 0 to 1 percent slopes-----	19	IIC-1	57	I-6	65	Silty	76	4
BgB	Bridget silt loam, 1 to 3 percent slopes-----	19	IIE-1	56	IIE-6	65	Silty	76	4
BgD	Bridget silt loam, 3 to 9 percent slopes-----	19	IIIe-1	57	IIIe-6	67	Silty	76	4
BgF	Bridget silt loam, 9 to 20 percent slopes-----	20	VIe-1	61	-----	--	Silty	76	4
Bh	Buffington silty clay, 0 to 1 percent slopes-----	20	IIIIs-2	58	IIIIs-1	68	Clayey	76	4
Bn	Buften silty clay loam, 0 to 1 percent slopes-----	21	IIIIs-2	58	IIIIs-3	68	Limy Upland	77	4
BnB	Buften silty clay loam, 1 to 3 percent slopes-----	21	IIIe-1	57	IIIe-3	68	Limy Upland	77	4
BnD	Buften silty clay loam, 3 to 9 percent slopes-----	21	IVe-1	59	IVe-3	69	Limy Upland	77	4
BnF	Buften silty clay loam, 9 to 20 percent slopes-----	22	VIe-1	61	-----	--	Limy Upland	77	4
BoD	Buften-Slickspots complex, 0 to 9 percent slopes-----	22	VIIs-1	62	-----	--	-----	--	--
	Buften soils-----	--	-----	--	-----	--	Saline Lowland	75	4
	Slickspots-----	--	-----	--	-----	--	Panspots	78	10
BuC	Busher loamy very fine sand, 1 to 5 percent slopes-----	23	IIIe-5	58	IIIe-8	68	Sandy	76	3
BuC2	Busher loamy very fine sand, 1 to 5 percent slopes, eroded-----	23	IIIe-5	58	IIIe-8	68	Sandy	76	3
BuD	Busher loamy very fine sand, 5 to 9 percent slopes-----	23	IVe-5	59	IVe-8	70	Sandy	76	3
BuD2	Busher loamy very fine sand, 5 to 9 percent slopes, eroded-----	23	IVe-5	59	IVe-8	70	Sandy	76	3
BuF	Busher loamy very fine sand, 9 to 20 percent slopes-----	23	VIe-5	61	-----	--	Sandy	76	3
BxF	Busher and Tassel loamy very fine sands, 5 to 20 percent slopes---	23	VIe-5	61	-----	--	-----	--	--
	Busher loamy very fine sand---	--	-----	--	-----	--	Sandy	76	3
	Tassel loamy very fine sand---	--	-----	--	-----	--	Shallow Limy	78	10

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit		Range site		Windbreak suitability group	
			Dryland	Irrigated	Name	Page		
CaG	Canyon-Bridget-Rock outcrop association, steep-----	25	VIIIs-4	64	-----	--	-----	--
	Canyon soils-----	--	-----	--	-----	--	Savannah	76
	Bridget soils-----	--	-----	--	-----	--	Savannah	76
	Rock outcrop-----	--	-----	--	-----	--	-----	--
CcF	Canyon soils, 3 to 30 percent slopes-----	25	VIIs-4	63	-----	--	Shallow Limy	78
CcG	Canyon soils, 30 to 50 percent slopes-----	25	VIIIs-4	64	-----	--	Savannah	76
Cf	Clayey alluvial land-----	25	VIW-1	63	-----	--	Clayey Overflow	75
DuB	Duroc very fine sandy loam, 1 to 3 percent slopes-----	26	IIe-1	56	IIe-6	65	Silty	76
EpF	Epping silt loam, 3 to 30 percent slopes-----	27	VIIs-4	63	-----	--	Shallow Limy	78
EsG	Epping-Badland complex, 3 to 50 percent slopes-----	27	VIIIs-3	63	-----	--	-----	--
	Epping soils-----	--	-----	--	-----	--	Shallow Limy	78
	Badland-----	--	-----	--	-----	--	-----	--
GbB	Glenberg loamy very fine sand, 0 to 3 percent slopes-----	28	IIIe-5	58	IIe-8	65	Sandy Lowland	75
GoB	Glenberg loamy very fine sand, occasionally flooded, 0 to 3 percent slopes-----	28	IIIW-6	59	IIIW-8	69	Sandy Lowland	75
Gr	Gravelly alluvial land-----	28	VIIIs-3	63	-----	--	Shallow to Gravel	78
HaB	Haverson silt loam, 0 to 3 percent slopes-----	29	IIc-1	57	I-6	65	Silty Lowland	75
HbB	Haverson silt loam, occasionally flooded, 0 to 3 percent slopes--	30	IIW-3	56	IIW-6	66	Silty Overflow	75
HcB	Haverson silty clay loam, occasionally flooded, 0 to 3 percent slopes-----	30	IIW-3	56	IIW-3	66	Silty Overflow	75
JmC	Jayem loamy very fine sand, 1 to 5 percent slopes-----	31	IIIe-5	58	IIIe-8	68	Sandy	76
JmD	Jayem loamy very fine sand, 5 to 9 percent slopes-----	31	IVe-5	59	IVe-8	70	Sandy	76
JvD	Jayem and Vetal loamy very fine sands, 5 to 9 percent slopes---	31	IVe-5	59	IVe-8	70	Sandy	76
KaB	Kadoka silt loam, deep variant, 1 to 3 percent slopes-----	32	IIe-1	56	IIe-4	65	Silty	76
KaD	Kadoka silt loam, deep variant, 3 to 9 percent slopes-----	32	IIIe-1	57	IIIe-4	67	Silty	76
KaD2	Kadoka silt loam, deep variant, 3 to 9 percent slopes, eroded---	32	IIIe-1	57	IIIe-4	67	Silty	76
KeB	Keith silt loam, 1 to 3 percent slopes-----	33	IIe-1	56	IIe-4	65	Silty	76
KeD	Keith silt loam, 3 to 9 percent slopes-----	33	IIIe-1	57	IIIe-4	67	Silty	76
KfD	Keith and Ulysses silt loams, 3 to 9 percent slopes-----	33	IIIe-1	57	IIIe-4	67	Silty	76
	Keith silt loam-----	--	-----	--	-----	--	-----	--
	Ulysses silt loam-----	--	-----	--	-----	--	-----	--
KoB	Keota silt loam, 1 to 3 percent slopes-----	35	IIIe-1	57	IIIe-7	68	Limy Upland	77
KpD	Keota-Epping silt loams, 3 to 9 percent slopes-----	35	IVe-1	59	IVe-7	70	-----	--
	Keota silt loam-----	--	-----	--	-----	--	Limy Upland	77
	Epping silt loam-----	--	-----	--	-----	--	Shallow Limy	78
Ky	Kyle silty clay, 0 to 1 percent slopes-----	36	IVs-2	60	IVs-1	70	Clayey	76

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit				Range site	Windbreak suitability group	
			Dryland		Irrigated				
			Symbol	Page	Symbol	Page	Name	Page	Number
KyC	Kyle silty clay, 1 to 5 percent slopes-----	36	IVe-4	59	-----	--	Clayey	76	9
Kz	Kyle-Slickspots complex, 0 to 2 percent slopes-----	36	VIIs-1	62	-----	--	-----	--	--
	Kyle soils-----	--	-----	--	-----	--	Clayey	76	9
	Slickspots-----	--	-----	--	-----	--	Panspots	78	10
La	Las Animas soils, 0 to 2 percent slopes-----	36	IIw-4	57	IIw-8	66	Subirrigated	74	2
Lo	Loamy alluvial land-----	37	VIw-3	63	-----	--	Silty Overflow	75	10
MnC	Minnequa silty clay loam, 1 to 5 percent slopes-----	37	IVe-9	60	IVe-3	69	Limy Upland	77	4
MnD	Minnequa silty clay loam, 5 to 12 percent slopes-----	38	VIe-9	62	-----	--	Limy Upland	77	4
Mt	Mitchell silt loam, 0 to 1 percent slopes-----	38	IIc-1	57	I-6	65	Limy Upland	77	5
MtC	Mitchell silt loam, 1 to 5 percent slopes-----	38	IIIe-1	57	IIIe-6	67	Limy Upland	77	5
MtD	Mitchell silt loam, 5 to 9 percent slopes-----	38	IVe-1	59	IVe-6	69	Limy Upland	77	5
MtF	Mitchell silt loam, 9 to 20 percent slopes-----	39	VIe-1	61	-----	--	Limy Upland	77	5
MxF	Mitchell-Epping silt loams, 9 to 30 percent slopes-----	39	VIe-1	61	-----	--	-----	--	10
	Mitchell silt loam-----	--	-----	--	-----	--	Limy Upland	77	--
	Epping silt loam-----	--	-----	--	-----	--	Shallow Limy	78	--
NrB	Norrest silty clay loam, 1 to 3 percent slopes-----	39	IIIe-1	57	IIIe-3	66	Clayey	76	5
NrD	Norrest silty clay loam, 3 to 9 percent slopes-----	40	IVe-1	59	IVe-3	69	Clayey	76	5
NrF	Norrest silty clay loam, 9 to 20 percent slopes-----	40	VIe-1	61	-----	--	Clayey	76	5
OgF	Oglala loam, 9 to 30 percent slopes-----	40	VIe-1	61	-----	--	Silty	76	4
OhF	Oglala-Canyon loams, 9 to 20 percent slopes-----	40	VIe-1	61	-----	--	-----	--	--
	Oglala loam-----	--	-----	--	-----	--	Silty	76	4
	Canyon loam-----	--	-----	--	-----	--	Shallow Limy	78	10
OrF	Orella silty clay loam, 3 to 30 percent slopes-----	42	VIIs-4	63	-----	--	Saline Upland	78	10
OsG	Orella-Badland complex, 3 to 50 percent slopes-----	42	VIIIs-3	63	-----	--	-----	--	10
	Orella soils-----	--	-----	--	-----	--	Saline Upland	78	--
	Badland-----	--	-----	--	-----	--	-----	--	--
PeG	Penrose-Shale outcrop complex, 10 to 50 percent slopes-----	42	VIIIs-3	63	-----	--	-----	--	10
	Penrose soils-----	--	-----	--	-----	--	Shallow Limy	78	--
	Shale outcrop-----	--	-----	--	-----	--	-----	--	--
PmF	Penrose and Minnequa silty clay loams, 5 to 20 percent slopes---	42	VIIs-4	63	-----	--	-----	--	--
	Penrose silty clay loam-----	--	-----	--	-----	--	Shallow Limy	78	10
	Minnequa silty clay loam-----	--	-----	--	-----	--	Limy Upland	77	4
PrC	Pierre silty clay, 1 to 5 percent slopes-----	43	IVe-4	59	-----	--	Clayey	76	9
PrF	Pierre silty clay, 5 to 30 percent slopes-----	43	VIe-4	61	-----	--	Clayey	76	9

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit		Irrigated		Range site	Page	Windbreak suitability group
			Dryland						
			Symbol	Page	Symbol	Page	Name		Number
P sD	Pierre-Slickspots complex, 3 to 9 percent slopes-----	44	VIs-1	62	-----	--	-----	--	--
	Pierre soils-----	--	-----	--	-----	--	Clayey	76	9
	Slickspots-----	--	-----	--	-----	--	Panspots	78	10
R hB	Richfield silt loam, 1 to 3 percent slopes-----	44	IIE-1	56	IIE-4	65	Silty	76	4
R oG	Rock outcrop-Canyon complex, 30 to 60 percent slopes-----	44	VIIIs-3	63	-----	--	-----	--	10
	Rock outcrop-----	--	-----	--	-----	--	-----	--	--
	Canyon soils-----	--	-----	--	-----	--	Shallow Limy	78	--
R sB	Rosebud silt loam, 1 to 3 percent slopes-----	46	IIIe-1	57	IIIe-7	68	Silty	76	5
R xD	Rosebud-Canyon loams, 3 to 9 percent slopes-----	46	IVe-1	59	IVe-7	70	-----	--	--
	Rosebud loams-----	--	-----	--	-----	--	Silty	76	5
	Canyon loams-----	--	-----	--	-----	--	Shallow Limy	78	10
S a	Saline-Alkali land-----	46	VIs-1	62	-----	--	Saline Lowland	75	10
S bF	Samsil silty clay, 3 to 30 percent slopes-----	47	VIs-4	63	-----	--	Shallow Clay	77	10
S hG	Samsil-Shale outcrop complex, 9 to 50 percent slopes-----	47	VIIIs-3	63	-----	--	-----	--	10
	Samsil soils-----	--	-----	--	-----	--	Shallow Clay	77	--
	Shale outcrop-----	--	-----	--	-----	--	-----	--	--
S n	Sandy alluvial land-----	47	VIw-6	63	-----	--	Sandy Lowland	75	10
S rC	Sarben fine sandy loam, 1 to 5 percent slopes-----	48	IIIe-3	57	IIIe-8	68	Sandy	76	3
S rD	Sarben fine sandy loam, 5 to 9 percent slopes-----	48	IVe-3	59	IVe-8	70	Sandy	76	3
S rF	Sarben fine sandy loam, 9 to 30 percent slopes-----	48	VIe-3	61	-----	--	Sandy	76	3
S vF	Sarben and Vetal loamy very fine sands, 9 to 30 percent slopes---	48	VIe-5	61	-----	--	Sandy	76	3
S yF	Schamber soils, 3 to 30 percent slopes-----	49	VIs-4	63	-----	--	Shallow to Gravel	78	10
T aF	Tassel soils, 3 to 30 percent slopes-----	50	VIs-4	63	-----	--	Shallow Limy	78	10
T r	Tripp silt loam, 0 to 1 percent slopes-----	51	IIC-1	57	I-6	65	Silty	76	4
T rB	Tripp silt loam, 1 to 3 percent slopes-----	51	IIE-1	56	IIE-6	65	Silty	76	4
T s	Tripp silt loam, saline-alkali, 0 to 2 percent slopes-----	51	IVs-1	60	IIIs-6	69	Saline Lowland	75	8
U sF	Ulysses silt loam, 9 to 20 percent slopes-----	52	VIe-1	61	-----	--	Silty	76	5
V aB	Valent and Dwyer loamy fine sands, 0 to 3 percent slopes-----	53	VIe-5	61	IVe-11	70	Sandy	76	3
V aF	Valent and Dwyer loamy fine sands, 3 to 17 percent slopes-----	53	VIe-5	61	-----	--	Sands	76	7
V eC	Vetal and Bayard soils, 1 to 5 percent slopes-----	53	IIIe-5	58	IIIe-8	68	Sandy	76	3
W x	Wet alluvial land-----	54	Vw-7	61	-----	--	Wet Land	74	10

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